Centre for Distance & Online Education

UNIVERSITY OF JAMMU

JAMMU

SELF LEARNING MATERIAL
B.Ed.
SEMESTER-II

SUBJECT : Teaching of Physical Science **UNIT : I-IV**

Course No. : 205 **LESSON NO. : 1 to 12**

Programme Coordinator

Dr. Jaspal Singh Warwal

jaspaljammuuniversity@yahoo.com

Printed and Published on behalf of the Centre for Distance & Online Education, University of Jammu, Jammu by the Director, CD&OE, University of Jammu, Jammu

http:/www.distanceeducationju.in

TEACHING OF PHYSICAL SCIENCE

Course Coordinators :
Dr. Navdeep Kaur
Department of Education,
Guru Nanak Dev University,
Amritsar (Punjab)

Dr. Savita Gupta
School of Education,
Lovely Professional University,
Jalandhar (Punjab)

Dr. Nishtha Rana
MIER College of Education,
Jammu.

Format Editing / Course Editor
Dr. JASPAL SINGH
CDOE, University of Jammu.
Jammu

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Printed at : Mehjoor Art Press, Sidco Industrial Complex, Rangreth, Srinagar Ph : 9419009510

Bachelor of Education(B.Ed) through Open and Distance Learning (ODL)
Semester –II
(For the examination to held in the year 2025,2026 & 2027)
Methodology of teaching subject-I

Course no. 205 **Title: Teaching of Physical Science**
Credits 4 **Total Marks : 100**
Maximum Marks Internal : 30 **Maximum Marks External : 70**
Duration of Exam : 3hrs
Objectives:

To enable the pupil teachers to :

- Acquaint themselves with the concept of physical science.
- Familiarize themselves with the concept of curriculum, text books and co-curricular activities in physical science.
- Prepare a lesson plan.
- Understand some important areas of physical science.

Unit -I

Origin and development of physical science. History of physical science.
Aims and values of teaching physical science in secondary school
Behaviouralobjectives .Meaning and importance of behavioural objectives, steps for preparing behavioural objectives for teaching of physical science.

Unit- II

Curriculum: Meaning, importance and principles of designing a good curriculum for physical science.
Concentric, topical and integrated approaches in organising curriculum for physical science.
Textbooks: Meaning importance and role of textbooks in teaching of physical science. Qualities of a good textbook of physical science.
Co-curricular Activities: Meaning and importance of co-curricular activities . Steps of organising co-curricular activities.

Unit -III

Lesson planning: Meaning, importance and principles of writing lesson plans in teaching of physical science.
Steps for preparing a lesson planning through Herbartian and RCEM approach.
Preparing a lesson plan on a topic of physical science.

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Unit IV

Electric current –potential difference, effects of electric current ; flow of heat- conduction, convection and radiation. Force-concept, constant and non-constant forces .Friction- concept, types, advantages and disadvantages, methods of increasing and decreasing friction.

Acid, bases and salts – types, properties and applications in day-to- day life; structure of matter- elements, compounds and their properties, mixtures, atomicity.

Sessional work:

Analysis of a unit / chapter in a physical science text book- to identify the concepts, principles and underlying scientific theories.

Note for Paper Setters

The Question paper consists of 9 questions having Q no 1 as Compulsory having four parts spread over the entire Syllabus, with a weightage of 14 marks .The rest of Question paper is divided into four Units and the students are to attend four Questions from these units with the internal choice. The essay type Question carries 14 marks each. Unit IV having the sessional work/field work (section) could also be a part of the theory paper.

Internship/field work Unit IV having the components/activities of the internship are to be to be developed in the form of the Reflective Journal. All the activities under the internship are to be evaluated for credits and hence all the activities are to be showcased by the trainee and are to be fully recorded with the complete certification of itsgenuineness .

The Theory paper is to have 70 marks (external) . 30 Marks are for the In House activities

Books recommended

- *Gupta ,S.D. & Sharma, D.R.(2002). Teaching of science.Malhotra brothers, Jammu.*
- *Kohli, V.K. (2001). How to teach science.VivekPublishers,Ambala city.*
- *NCERT. (2013) .Science. Publication Division.NCERTCampus,New Delhi*
- *Sharma, R.C. (1981). Modern Science Teaching.Dhanpat Rai Publishing Co. New Delhi*

Teaching of Physical Science

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LESSON NO. 1 UNIT-I

ORIGIN AND DEVELOPMENT OF PHYSICAL SCIENCE

STRUCTURE

1.1 Introduction

1.2 Objectives

1.3 Origin and Development of Physical Science

- 1.3.1 Ancient and Medieval Period
- 1.3.2 Modern Period
- 1.3.3 Development of Science Education after Independence
- 1.3.4 Indian Parliamentary and Scientific Committee
- 1.3.5 UNESCO Planning Mission
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- 1.3.8 National Council of Educational Research and Training (NCERT)
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1.4 History of Physical Science

1.5 Let us sum up

1.6 Unit Ends Exercises

1.7 References and Suggested Reading

1.8 Answers to check your progress

1.1 INTRODUCTION

Today the world is facing three major problems of population increase, pollution and poverty. The developmental efforts of the developing countries, such as India, are being nullified by increasing population and increasing poverty. Although science and technology have improved the lot of large number of human beings some of the worst

problems of humanity today such as mentioned above have either been brought about or aggravated by science and technology. Education is one of the potent instruments in the development process if it is properly geared for that purpose. Science education being an important component of the education system should contribute in the solution of the problems of the country by developing desirable understanding, skills, abilities and attitudes. The greatest challenge is to ***'humanize'*** science that is to make it relevant to human needs and aspirations. Thus, Science is a great human enterprise not only endless and faceless but also stable and fluid.

The strength of a modern economy depends on the strength of its industry and industrial development in turn depends upon technology,that is upon the application of new scientific knowledge, thus all progress grows out of man's creative capacities. It has become essential to train and equip men at every level - research workers, engineers, executives, technicians, office workers and manual workers. Long-range planning is no less important. Economist, statisticians and sociologists are the support, now and in the future, of the work of scientists and technicians.

1.2 OBJECTIVES

After going through this unit, you should be able to:

- Acquire knowledge about science and its origin.
- Discuss the development of physical science.
- Understand the position of science education in ancient India.
- Understand the history of science education.

1.3 ORIGIN AND DEVELOPMENT OF PHYSICAL SCIENCE

1.3.1 Ancient and Medieval Period

India made a pioneer headway in the field of mathematics, medicine, astronomy, agriculture and architecture till about 600 A.D. The oldest Indian scripture, ***Rig-Veda,*** which was written about 4000 years ago, refers tophysicians and speaks of the healing power of medicinal herbs. The concept of atom and the formation of the world as discussed in ***The Vaiseshika,*** one of the ***Upanishads,*** approaches the modern western thought. The Sankhya philosophy by Kapila is very much like ***Darwinism.*** The ***Upa-Vedas,*** or secondary ***Vedas*** discuss various sciences. One of these ***Upa-vedas***is ***Ayurveda*** which consists of six books on surgery, nosology, anatomy, therapeutics, toxicology and

supplementary section dealing with various local diseases. Great attention was given to diet. In surgery they attained great proficiency. The ***materiamedica,*** of the Hindus embraced a vast collection of drugs belonging to the mineral, vegetable, and animal kingdoms many of which have been adopted by western physicians. There were colleges and universities of international repute.

From the point of view of methods and techniques of acquiring ***scientific knowledge,*** there was considerable development and refinement of observation. ***Logical analysis*** as a tool for refinement of ideas and to arrive at generalizations, was also considerably developed. From the point of view of the institutions for acquiring knowledge and continuing the tradition, it may be noticed that they were centred round individuals, who passed on the knowledge and skills to their best disciples only. The result was that most of the scientific knowledge and traditions were lost with the time. The early universities of Taxila and Nalanda could be taken as a first step towards institutionalization of teaching and acquiring knowledge but their character must be fully studied, and also the reasons for their disappearance.

In a normal course, the scientific knowledge and the methods and techniques of acquiring it should have led to the next stage of development but unfortunately this did not happen. The philosophy of Buddhism (between 750 A. D. to 1000 A. D.) discouraged further development of life sciences. Rules of caste became stricter and Brahmins forbade to contaminate with blood and withdrew from all practice of medicine. They even shrank from touching dead bodies and as- a result of the decreasing number of good physicians public hospitals had to be closed. Later, on the gradual conquest of the country by invaders from West Asia and Central Asia brought an element of discontinuity of the ancient Indian tradition. The People brought with them different languages i.e. Arabic, Turkish and Persian, and also scientific knowledge, methods, techniques and concepts. There is, however, some evidence to suggest that many of the scientific ideas brought to India by foreigners during the medieval period had the Indian origin. A large number of scholars went out of India and were patronized at the courts of various feudal kings in West Asia and Central Asia. The information, methods, techniques and concepts which they took with them were synthesized and incorporated in the medieval Arabic and Persian scientific traditions of WestAsia and Central Asia. This was further developed as a part of the scientific and intellectual developments of these civilizations, the form in which they came to India. There is, however, still a controversy on the origin of many

scientific ideas, concepts, methodology and techniques and further studies need to be made before we can fully understand the evolution of scientific thought in medieval India. .

1.3.2 Modern Period

The modern period brings another sharp break in the scientific thought and tradition of India with conquest of the country by the British. Modern science was introduced in India along with the British, in opposition to the earlier two traditions and again in a foreign language i.e., English. Modern science came to India at a stage of development which marks a radical change from the medieval and ancient sciences, newer branches of science had been developed, experimentation developed as a full-fledged technique of acquiring information/Language of science had taken a definite shape, scientific institutions had been developed and technology and made a decisive breakthrough.

Modern science did not make significant headway in India during the British Period for various reasons. Its character was not radically different from the earlier scientific tradition in the country but the new language made the process of its assimilation in Indian culture difficult. Secondly, it either aroused awe or hostility as 'a British Thing' alien and hostile to the Indian tradition. The effort, therefore, became once again, one of choice rather than of a synthesis to evolve a scientific tradition in the Indian context.

As a result of the alien language whose knowledge was limited to a small group associated with the then rulers and the hostile attitude of the general public towards anything which was 'British', the new knowledge and information of science could not reach the artisans and craftsmen to make an impact on their trades and crafts, to help them draw cut of their stagnation and improve upon their old industries. The social and intellectual dialogue could not take place in a sufficiently large scale to make a breakthrough in the scientific outlook of the people. The result was that India remained far behind in scientific and technological development as compared to countries in the West.

In order to study the development of science education in India during the modern period, we have to look to the history of science in the West because whatever happened there was followed in India though at a slower pace.

At the end of 18th century the Universities sadly neglected the teaching of science and it had no place in the school curriculum. Chief scientificdiscoveries were made by amateurs such as ***Cavendish, Priestly, James Watt***and ***Hershel***. A number of philosophical societies were started to fill the gap between the educational provision and social need, such as Society of Arts, London, Literary and Philosophical Society of Manchester founded in 1781 and Lunar Society of Birmingham (1766). These societies did remarkable work for popularising science among the general public. In 1799, Rumford was influential in founding the ***Royalinstitute***of Great Britain. It was intended for teaching youngmen in the mechanical profession by courses of philosophical lectures and experiments on the application of science to common purpose of life. But later, its policy was altogether changed by the influence of Sir, Humphry Davy and of Faraday, and this society become the centre of research.

An important event in the history of teaching science commenced with the Mechanic's Institute of the early nineteenth century. **John Anderson** was perhaps the first who attempted to give the course of lectures on ***Experimental***Physics. He was, however, convinced of the cultural possibilities of ***science***teaching. Eventually, in 1823 Glasgow Mechanics Institute was established which was raised to Technical College in 1866. Many other mechanical institutes were started in nineteenth century. In the early part of the nineteenth century many other philosophical societies were at work for the spread of education. By the middle of nineteenth century, however, there were very few schools which were imparting instruction in science. It was in 1847 that first practical Chemistry lessons were started by ***Thomas Hall***at City of London School. The centenary of science teaching was celebrated by a large and eminent gathering at the school in 1948.

Most of our knowledge of the state of science teaching in schools is revealed by the reports of Royal Commissions of Education. The Commission reported that in none of the schools Science was taught as an independent subject though at Rugby, Natural Science was taught to boys who elected to study it instead of languages. They described it as 'a plain defect and a great practical evil'. They, therefore, suggested that Natural Science should be taught and should include two main branches, one comprising Physics and Chemistry and other Comparative Physiology and Natural History. As a result of this, Physics was introduced in 1837 at Rugby under Dr. Arnold. Dr. Tait, his successor, introduced Botany, Chemistry and Geology in the curriculum in 1859 and a science lecture room and laboratory were built for the first time at a cost of over £1,000.

The 'great Exhibition of 1851 gave a further impetus for ***teaching science*** in schools and as a result, a Department of Science and Art was established in 1853. In 1854, three eminent scientists urged the claims of science as an essential part of general education. ***T.H. Huxley*** delivered an important addresson the Educational Value of the Natural History of Sciences; ***John Tyndall***lectured on the study of physics as a branch of education; ***Faraday***stressed the importance of cultivating a scientific outlook. In 1853 ***Faraday***wrote, "As a branch of barning, men are beginning to recognize the right of science to its own particular place, but now the fitness of university degrees in science is under consideration, and many are taking a high view of it, as distinguished from literature, and think that it may well be studied for its own sake, i.e. a proper exercise of human intelligence, able to bring into action and development all powers of the mind." In 1861, ***Herbert Spencer***believed that 'Knowledge of life was the important knowledge for all Moral and Physical.' The most staunch advocate of teaching science in the 'sixties' and 'seventies' was ***Huxley***. The establishment of natural science course in the universities of Oxford and Cambridge further paved the way for the inclusion of Science in the curriculum of Secondary Schools. A full survey of the position of Science teaching in Secondary Schools is contained in the ***Devonshire Commission Report***published in 1895. The report begins with the discussion on the difficulties attending the introduction of Science teaching in the schools and recommended that (i) in all public and endower schools a substantial portion of the time allotted to study be devoted to Natural Science, and the not less than six hours a week on the average should be assigned for this purpose; (ii) school laboratories should be constructed to supply accommodation for practical work in physics as well as in Chemistry. The publication of this Report marked the beginning of the widespread introduction of Physics and Chemistry in the curriculum of Boys' schools and of Botany into that of Girls' schools.

Public examination in science and other subjects are of very recent origin. Society of Arts of London held science examination in 1852, designed to qualify for membership. In the course of few years the system became established and papers were set in Chemistry, Physiology, Botany, Mathematics and Mechanics. And for the guidance of candidates the society published a handbook entitled. ***"How to Learn and What to Learn."***

The most outstanding contribution to the history *of teaching science* in the last quarter of nineteenth century was that of ***H.E. Armstrong***, professor of Chemistry in the

Central Technical College, City of Guildes of London Institute. He was very much dissatisfied with the science work in schools and was critical of the teaching method that was adopted. He advocated that all pupils, even beginners, should be allowed to discover things for themselves, and should be placed in the position of the original observers. Later on, This method was known as the ***Heuristic method***. It has been largely modified now. Nevertheless, the ***heuristic spirit***should permeate the whole of Science teaching.

Since the beginning of twentieth century there has been an adequate increase in the equipment and facilities for teaching science in schools. The Great World War of 1914-18 opened the eyes of the general public to the importance of general science in the modern world. ***Sir J.J. Thomson*** appointed a committee, in 1916, to inquire into the position of Natural Science in the educational system and as a result so named **'Thomson Report'** was published under the title ***'Natural Science in Education'.*** As a consequence many advanced courses in science were added to many schools. The Science Masters' Association and the Association of Women Science Teachers were formed in the early century. School Science Review, the S. M. A. Periodical, created a good influence on the teachers as well as the public.

Board Education set up a consultant committee on secondary education, in 1933, under the chairmanship of Sir ***Will Spens.*** The report was published in 1938 under the title ***"Spens Report".*** The teachers were, however, disappointed with the attitude of the Report towards school science. A few years later, a committee of the Secondary School Examination Council under the chairmanship of***SirCyril Norwood*** was formed. Their recommendations and conclusions were published in 1943, and briefly known as ***'Norwood Report'*** contained a chapter dealing with Teaching of Science. As a consequence of all this the ***Education Act of 1944*** came into force in April, 1945 which has meant an increase in the amount of science taught though not to the extent to which it should have been.

1.3.3 Development of Science Education after Independence

In India, the pattern of education was influenced by what happened in England; the only difference is that things moved at a much slower pace. The reviews issued by the Government of India in the years 1877-92 gave an insight into the sorry state of science teaching. Even in the beginning of this century science was not a school subject in our country and it was only in name in the universities. Indian Science Congress was formed a few decades back but it also did not do any notable work towards the Teaching of Science

in schools. The ***Report of the Secondary Education Commission, 1953,*** Recommended the teaching of General Science as a compulsory subject in the high and higher secondary schools.

All India Seminar on Teaching of Science

The ***All-India Seminar*** on the teaching of science in secondary schools held at Tara Devi (Simla Hills) in 1956, dealt with almost all the problems facing the inclusion of General Science as a core subject for the Higher Secondary Classes. It was the first of its kind which touched almost all the aspects concerning the teaching of science in schools viz. syllabus, equipment and apparatus method of examination, teaching aids in science and otherallied topics like Text Books, Science Clubs, Museum etc. It had suggested a unique and uniform system of science teaching for the entire country, suited to its needs and resources.

1.3.4 Indian Parliamentary and Scientific Committee

In view of the rapid influence of science on society and of the Government policies, it was felt that both the scientists and the politician should be brought on a common platform to formulate new policies and procedure in accordance with the scientific developments. The Parliamentarians, who are the makers of the policies, must be acquainted with the developments of science and technology and with the scientific viewpoint. As a result of this new ideology, the *Indian Parliamentary* and *Scientific Committee* was set up in August, 1 961, under the Chairmanship of***LateShri Lai Bahadur Shastri.*** This Committee took up in early 1962 the study of the problem of ***"Science Education in Schools",*** with the view to find out the relation between the policies and decision of the Centre and the States, and the courses offered in the schools. They also studied the allied problems of :

(i) growth of school population.

(ii) shortage of qualified teachers.

(iii) accelerated achievements in science.

(iv) the demand for increase in technically trained manpower.

(v) growing importance of science in the affairs of mankind.

(vi) changes in the processes and goals of science, and

(vii) the views held by different thinker in regard to the structure of the school system

and the content necessary for education of youth.

1.3.5 UNESCO Planning Mission

In 1963, the USSR Experts of the UNESCO Planning Mission visited India on technical assistance Projects. They worked on the problems from 3rd December, 1963 to 10th March, 1964 and gave their recommendations on different issues of Science Education in Secondary Schools. Three reports were prepared by the team. These reports gave the total picture of position of Science and Mathematics education in India and suggested ways to improve it.

As a follow-up programme of the Report of UNESCO Planning Mission of Experts, the Department of Science Education in the National Council took up the pilot projects of preparing new curriculum, text books, teacher'sguides etc. To start with, these experimental projects were started in about 20 selected schools in Delhi.

A Conference of Science Education was convened from 21st-23rd April, 1966 under the chairmanship of Dr. D. S. Kothari, to plan an effective programme for the development of a total curriculum of science education for different stages. Indian, Russian, American and UNESCO experts in science education participated in the conference.

1.3.6 Indian Education Commission (1964 - 66)

The progress, welfare and security of the nation depend critically on a rapid, planned and sustained growth in the quality and extent of education and research in science and technology. Science is universal and so can be its benefits. Science represents a cumulative and cooperative activity of mankind and its rate of growth is extremely rapid. The knowledge of science is doubling in a period of ten to fifteen years.

The Commission has pointed out that our science education is in bad shape and it becomes worse if we fail to reckon with the explosion of knowledge. To meet this immediate threat, the commission recommended upgrading school curricula by 'research in curriculum development, the revision of the text-books and teaching learning material.' The Commission recommended that:

1. Science and mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling.
2. In the lower primary classes science teaching should be related to the child's

environment. The Roman alphabets should be taught in class IV to facilitate understanding of internationally accepted symbols of scientific measurement and use of maps, charts and statistical tests.

3. At the higher primary stage emphasis should be on the acquisition of knowledge and the ability to think logically, to draw conclusions and to make decisions at a higher level. A disciplinary approach to the teaching of science will be more effective than the general science approach.

4. A science corner in lower primary schools and a laboratory-cum lecture room in higher primary schools are minimum essential requirements.

5. At the lower secondary stage, science should be developed as a discipline of the mind. The newer concepts of physics, chemistry and biology and the experimental approach to the learning of science should be stressed.

6. Science course as an advanced level may be provided for talented students in selected lower secondary school with necessary facilities of staff and laboratory.

7. Science teaching should be linked to agriculture in rural areas and to technology in urban areas.

8. The methods of teaching science should be modernized, stressing the investigatory approach and the understanding of the basic principles. Guide materials should be made available to help teachers adopt the approach. Laboratory work will need considerable improvement. There should be flexibility in the curriculum in order to cater to the special needs of the gifted.

9. The development of science must derive its nourishment from our cultural and spiritual heritage and not bypass it.

10. At the university level better conditions for research should be provided.

1.3.7 Ishwarbhai Patel Committee (1977)

As a follow-up of the Kothari Commission Report, the Ministry of Education and Social Welfare appointed an expert group in 1973 to develop curriculum for the 10+2 pattern. The group drafted an Approach Paper in 1975. A publication entitled ***"The Curriculum for the Ten-Year School-A framework"*** was published by the NCERT which also prepared syllabi, textbooks and the materials in a phased manner. Materials for classes IX and X were prepared in a few subjects for 1975-1976 session, and for

classes I, III and VI for 1976-1977 session. The Central Board of Secondary Education adopted some of the text-books prepared by NCERT for classes IX and X and the first ***badge***of candidates appeared in the public examination for class X held in April 1977.

The syllabi and the textbooks prepared by NCERT, specially for classes IX and X, evoked a lot of criticism from parents, teachers and students. The main criticism was that the scheme of examination contained many subjects of students, the textbooks were too many and too voluminous and, therefore, there was no time for self-study and physical activities. Another area of criticism was that work experience did not find a proper place in the teaching-learning process in the new pattern of education, thus maintaining the same system of bookish education.

As a result of the criticism of the new syllabi and textbooks, the Union Minister of Education and Social Welfare appointed a Review Committee in June, 1977 under the chairmanship of Sri Ishwarbhai J. Patel, Vice-Chancellor, Gujarat University with 30 members on the Committee from various organizations. The Committee submitted its report in November 1977 under the title ***"Report of the Review Committee on the Curriculum for the Ten Year School".***

The following were the terms of reference of the Committee:

(1) to review the stagewise and subjectwise objectives identified in the NCERT document ***"The curriculum for the 10-Year School"***

(2) to scrutinize the NCERT syllabus and textbooks, in the light of the review as per (1) above.

(3) to scrutinise the scheme of studies, as given in the said document, and examine whether any suitable modifications in either the scheme of studies or the timetable or both should not be made and to propose suitable staffing pattern.

(4) to review the present scheme of studies and the time allocated for various subjects with a view to ensure that:

(I) theinstitution/teacher has adequate time for experimentation, creative work, remedial instruction etc.

(it) to accommodate the needs of the bright child for advanced level courses; the specific interests and aptitude, or the lack of it, in children, in only certain subject areas, keeping in view the national goals of development and objectives of

education.

In the opinion of the Committee the terms of reference were wide enough not only to permit a review of the objectives and scheme of studies set out in the document ***"The Curriculum of the Ten-Year School"*** but also to identify the principles for formulating a new scheme.

1.3.8 National Council of Educational Research and Training (NCERT)

The NCERT was established on September 1, 1961, as an autonomous organisation with its headquarters in New Delhi. At the headquarters it has the *National Institute of Education* (NIE) which is concerned with research, Instruction and evaluation. The NIE functions through its various departments like the Department of Education in Science and Mathematics, Department of Education in Social Sciences and Humanities, Department of Educational Psychology and Foundations of Education, Department of School Education, Department of Teacher Education, Department of Text Books, Department of Teaching Aids, Publication Department and Workshop Department. In addition to the Departments there are units of Library/Documentation, National Science Talent Search, Work Experience/Vocationalisation, Survey and Data Processing and Examination Reform. The structure of the NCERT has recently been reorganised.

In addition to the NIE, the Council runs four *Regional Institutes of Education* at Ajmer, Bhopal, Bhubaheswar and Mysore. These Regional Institutes are meant to functions as centres of excellence in the field of teacher education. They organise various types of courses such as content-cum-pedagogy course of 4 years duration leading to B. Sc., B. Ed. degrees. They also run one-year B. Ed. course and M. Ed. course. M. Sc. in Science Education course has also been started in these colleges. Besides the regular courses they also organise Summer School-cum-Correspondence Course (SSCCC) for teachers of Secondary Schools.

A Central Science Workshop was also established under the NCERT to produce prototypes of School equipment and to develop low-cost kits for the primary and the middle school stages.

Through the various departments of NIE and the Regional Institutes of Education, the NCERT discharges functions relating to the improvement of education at all levels of school education and teacher training in India. It also functions as the academic wing of

the Ministry of Education and Youth Services of the Government of India. It also maintains a close liaison with the Education departments and the schools in the different States and Union territories of India.

1.3.9 State Councils of Educational Research and Training (SCERT) and State Institutes of Science Education (SISE)

Some States have now established State Councils of Educational Research and Training (SCERT) on the pattern of the NCERT. In these States SCERT incorporates the functions of the State Institutes of Education.

SISEs have been set up in all the states with a view to improve the quality of science education in the schools. The main functions of these institutes are to provide in-service training to science teachers in the new developments in the field of science education; prepare instructional materials in science; conduct research studies in science education of their respective states; provide guidance service in science to schools; take up innovative programmes in science education; and participate in the national science programmes.

"Science Education Programmes will be designed to discover the relationship of Science with health, agriculture, industry and other aspects of daily life."

– National Policy on Education (1986)

Check your progress

Note: Write your answers in the space given below.

1. Discuss any two recommendations of indian commission education?

   .....
   .....
   .....
   .....

2. What do you mean by logical analysis?

   .....
   .....
   .....
   .....

1.4 HISTORY OF PHYSICAL SCIENCE

Before eighteenth century science had not developed as much as we see it in the present form. Today scientific investigations and researches are being made with such a fast speed that their knowledge needs a complete knowledge of science. Thus, science has become an integral part of human life. All our means of communication, radio, television, foodgrains, clothes and medicines depend upon the development of science. We begin to feel unhappy as soon as we are deprived of any of these scientific investigations and researches even for a short period of time.

Advantages of Science Education

There are numerous advantages of science education. For example- (1) Thinking and memory develops, (2) Principles are formulated, (3) Self-confidence and self-reliance develop, (4) Love for truth enhances, (5) Confidence regarding unity in diversity increases, (6) Devotion towards nature increases, (7) Avenues open for newer and newer vocations. Besides these advantages, science has become the basis of our cultural heritage and social progress. Not only this, like other disciplines, education being an independent discipline of study, is placed in the Faculty of Science. This is the reason why education is not only an art but science also. Most of the principles of modern education are scientific and almost all the strategies, tactics and techniques of teaching are going to be scientific in nature today

Scientific Attitude

In modern times the chief aim of education is to enable a citizen to develop a scientific attitude of mind to think objectively and base, his conclusions on tested data. With the development of such a scientific attitude an individual is able to have the understanding and intellectual integrity to sift truth from falsehood, facts from propaganda and to reject the dangerous appeal of fanaticism and prejudice. In short, the more the scientific attitude of an individual is developed with regard to a particular idea or object, the more objective his decisions and conclusions become on the basis of his tested data. Scientific attitude includes the following elements.

1. Identifying causes of the problem
2. Establishing relationship between cause and effect
3. Believing in intellectual integrity

4. Raising above blind beliefs and dogmas.

5. Having full faith in truth irrespective of one's own likes and dislikes.

6. Developing the capacity of clear thinking and receptivity to new ideas.

7. Accepting the authentic ideas even with caution.

8. Possessing a critical and constructive attitude while solving a challenging problem.

9. Arriving at no conclusion at all on the availability of incomplete or false data.

10. Basing conclusions on tested data only.

11. Keeping certain exceptions into consideration while determining a principle.

SCIENCE EDUCATION IN INDIA

Science Education in Ancient India

India is not a science-oriented nation. Its signal contributions in the realms of philosophy, ethics and religion have obscured its scientific aura. However, certain sections in the *Vedas* and the *Upanishads* are replete with scientific information. There are references to the origin of the universe, the concept of atom, medicinal herbs and so on. The study of Mathematics, Astronomy and Medicine flourished in ancient India. The 'O' sign was the remarkable discovery of the Indians. Dhanwantri was the legendary founder of the Indian Medicine. Charak was a great physician and his *Matcria Medico* is still remarkable, Subshruta was a very famous surgeon who performed various kinds of operations known to the modern medical science, Tarka Sastra (Logic) was fairly well-developed. The ancient Indians were experts in military science. The Universities at Taxila and Nalanda were famous centres of learning. But due to propaganda caused by foreign aggressors and native religious leaders, the glory of ancient Indian science sank into oblivion.

Science Education in British Period

With the advent of the British in. 1600 A.D., modern science began 10 spread in India. But science education did not progress well during the British period. As the medium of instruction to leach science, English stood in the way of people who showed interest in learning science. The hostility against the British was extended to the Western Science too. Thus, scientific knowledge and outlook did not reach the masses which was

the main reason for the backwardness of India in science and technology.

Science Education in Independent India

1. **University Education Commission:** The University Education Commission (1949, Dr. Radhakrishnan Commission) made recommendations for improving laboratories and libraries. It was against narrow specialization in science and technology. The Commission opined that the curriculum of general education should have relevance to the student's physical and social environment and have sciences, language and literature at various levels up to the end of the secondary stage. The three-year degree course for science students should have two options like Mathematics and Physics, Physics and Chemistry and so on. Admission to P.G. course should be made on merit preferably on All-India basis.

2. **Secondary Education Commission:** The Secondary Education Commission (1952-53, Dr. A.L. Mudaliar Commission) recommended the teaching of General Science as a compulsory subject in the High and Higher Secondary schools. Science found a place in the diversified courses too. The suggestion to retain General Science as a core subject is a significant milestone in the history of science education in India.

   The Commission envisaged the teaching of specialized sciences at an advanced level in the Higher Secondary Schools by competent and highly qualified teachers.

3. **National Council of Educational Research and Training (NCERT):** Sponsored by the National Government at the centre has re-organized and re-planned the education of science in all areas, and fields. This central organization has launched various schemes through its extension services for the improvement of scientific education at all levels and in all fields of human work. Some of its working schemes are as under:-

(i) Various schemes have been launched to stimulate the urge for scientific education among school children. Class-room teaching is augmented with independent investigations and research at all levels of school and college teaching by providing guidance and equipments for experimental work.

(ii) Establishment of science clubs is promoted to popularise scientific education among common people. These clubs are provided with adequate equipments and

facilities for experimental and practical work.

(iii) Science fairs, seminars and symposiums are organized. Through newspapers, teachers of sciences arc encouraged more and more to develop their knowledge of the subject-matter and adopt the most uptodale devices and techniques of teaching.

(iv) Talented and gifted children in the field of science are selected through examinations and encouraged by the award of scholarship, stipends and appreciations in various ways.

(v) On the advice and under the guidance of talented and learned members of UNESCO, the council has established a central science workshop for imparting effective instruction to" science teachers in practical investigations, workshop methods together with techniques of work and instruction. After such experience and training, teachers as well as students are encouraged to prepare designs, models and scientific instruments for laboratories. The central workshop also tries to improve models and designs prepared by Indian schools besides modifying foreign equipments to suit Indian needs and conditions.

(vi) A part time curriculum for teacher training has been organized at various important places in the country to prepare efficient science teachers for effective teaching and productive guidance. After these courses, it is expected that participants will be able to set right the instruments, models and machines lying useless in schools and colleges. Thus, huge wastage of, resources will be saved through these schemes and part time courses to teachers, students; laboratory worker, and technicians.

4. All India Seminar at Simla: In 1956 in Simla (at Tara Devi) an AH India Seminar on the Teaching of Science was organised. It resulted m the publication of the Proceedings of the All India Seminar on the Teaching of Science'. The seminar was designed to do the following:

(i) To critically evaluate the draft syllabus in Physics, Chemistry and Biology in General Science;

(ii) To examine the Elementary Science syllabus at the primary stage and middle school stage;

(iii) To consider the various aspects of the teaching of science at the Higher Secondary level such as the needs of equipment and apparatus, practical work and so on;

(iv) To review the methods of testing and examination in Science subjects,

(v) To consider the instructional materials and co-curricular activities to be used in science teaching:

(vi) To the utility of the UNESCO kit for teaching science subjects: and also

(vii) To suggest a dependable and uniform pattern of school science education for the whole nation. But the seminar could not satisfy the very great expectations. Anyhow it brought to light some weak points in the teaching of science in our country and also suggested suitable remedial measures.

5. **Mahalanobis Committee:** The National Council of Educational Research and Training (NCERT) set up a committee with Prof. Mahalanobis, a member of the Planning Commission, as its President. This committee was expected to study and make recommendation on the following:

(i) Qualitative and quantitative improvement of science-teaching at all stages, especially at the school level;

(ii) Promoting science talents in the country; and

(iii) The training programmes for science teachers.

It published its findings in 1962, which has useful information regarding:

(i) The number of schools providing for elective sciences;

(ii) Laboratory work at various levels;

(iii) Science clubs-their number and activities;

(iv) Publications on the teaching of science and the nature of financial assistance given and so on.

6. **IPSC (1962):** Under the presidentship of Mr. Lai Bahadur ' Shastri, the Indian Parliamentary and Scientific Committee (1962) studied all the problems of science education at the primary, secondary and higher secondary stages at the Third Five-Year Plan. It found out, "The gap between what is taught and should be taught at various levels." It observed that, "Quite a number of school buildings are lacking in physical facilities of laboratory equipment, apparatus, library, etc., and the building itself has not been devised from the functional point of view in many cases." But it acknowledged the good work carried out by the Committee on Plan

Projects on School Buildings, Hostels, Science Laboratories and Equipment. The report of this Committee on "Science Education in Schools" contains the following information :

(i) The essential requirements of science laboratories;

(ii) The financial procedures in force in the various States;

(iii) Conditions of laboratories, apparatus and equipment;

(iv) Various types of grants in different States;

(v) Money allotted for buying equipment and apparatus in schools in different Stales and the methods of expenditure; and

(vi) Tools required for workshops in high schools and teacher-training institutions.

7. UNESCO Mission: The UNESCO Planning Mission stayed in India from 1963 to 1964. Prof. S.G. Shapovalonko was the leader of the Mission. It studied the following:

(i) The objectives and tasks of science and mathematics education in general type of schools in India;

(ii) The place of science and mathematics in school curriculum;

(iii) The content of science and mathematics education;

(iv) The philosophy of preparation of syllabi, text-books, methods and organisation of education; and

(v) What should be done essentially before the completion of the Third Five-Year Plan and during' the Fourth Five-Year Plan with a view to improve the quality of science and mathematics education in India,

The Report was submitted in six parts and the areas coveredby the six parts are as follows :

Part I (a) Scientific Technical Progress, and

(b) Science and Mathematics Education.

Paft II(a) Science and Mathematics education in classes I to VIII, and the content of science and mathematics education in classes IX to XI;

(b) Polytechnic education and science and mathematics teaching;

(c) Interest, aptitudes and abilities in Science and ways and means of fostering them; and

(d) Salient factors to be considered in the preparation of science text-books.

Part III (a) Plan of laboratories-cum-lecture rooms with necessary equipment to teach Physics, Chemistry, Biology and Mathematics;

(b) Establishment of Central Science Workshops for manufacturing scientific equipment.

Part IV (a) Training of Science teachers.

Part V - Research in mathematics and science education.

Part VI Describes the order and the time of putting into practice the recommendations, and the nature of the Indian specialists to e deputed to the USSR. Besides the six parts related above, the Report contains two papers by Professor Kilpatrick and Professor Buschsbaum on science teaching in India. The main recommendation is to introduce Physics and Biology in the IV Standard and Chemistry in the VII Standard and lo do away with General Science in the Middle Schools.

8. **Indian Education Commission (1964-66):** It directed our attention to the fact 'that our science education is in bad shape and it will become worse if we fail to reckon with the explosion of knowledge. There is an urgent need to upgrade school curricula by research in curriculum development, the revision of text-books and teaching-learning material. Regarding the improvement of science education in India, the commission has made the following recommendations:

(i) During the first ten years of schooling science should he core subject of study for all pupils;

(ii) Environmental approach in the teaching of science must be followed in the lower primary level. To enable pupils understand symbols, graphs and scientific data, the Roman alphabets have to be taught in class IV itself;

(iii) The acquisition of knowledge and the ability for logical thinking have to be fostered through science leaching at the higher primary stage;

(iv) Among the basic minimum requirements of science teaching, a science-room in

the lower primary schools and a laboratory-cum- lecture room in the higher primary schools are essential;

(v) The modern concepts in physics, chemistry and biology and learning science through experiments have to be stressed at the lower secondary stage with a view to develop science as a discipline of the mind.

(vi) Accelerated or advanced courses in science may be provided for talented pupils and such a programme has to be started in selected lower secondary schools that have adequate facilities of staff and laboratory;

(vii) Depending on the locality, flexibility in science teaching has to be provided. Science leaching should be agriculture based in rural areas and technology-oriented in urban areas;

(viii) Modern methods of teaching science have to be followed, giving prominence to the Heuristic approach. In order to help the teachers follow this approach, teacher guides have to be prepared. It also involves the toning up of the laboratory work;

(ix) Curriculum must be flexible enough to adapt it in order to satisfy the greater needs of the gifted;

(x) Science-leaching should not ignore our rich cultural and spiritual heritage. On the other hand, it must be based on them;

(xi) Research in the field of science has to be improved by providing better facilities for scientific research in institutions of higher learning.

9. State Institutes of Science Education (SISE): SISE have been set up in all stales to effect improvement of science education in schools. The following are the main functions of the SISE:

1. In-service training to science teachers with a view to make them aware of the new developments in science education.
2. Preparation of Instructional Materials in Science.
3. Research on science education in the region.
4. Arrange for guidance service in science at schools.
5. Find out and introduce innovations in science education.
6. To actively take part in the national science programmes.

Today science is regarded with due admiration and respect. The curricula and the text-books have been upgraded and the examination has assumed a new dimension. Learning science by doing is stressed and liberal grants are given to schools to build up laboratories and buy equipment. Mobile science laboratories supplement built-in school laboratories. In-service training is provided to teachers teaching science at various levels. The importance of organizing Science Clubs in schools has been recognized. The Science Talent Search Scheme is being put into practice and thus science talent is identified and fostered. Plenty of audio-visual aids are available to make science teaching and learning effective.

Obstacles in Science Education

1. **Curricula:** The curricula in science are revised arbitrarily and such evasions are not based on scientific research.

2. **Content:** The content in school science is upgraded without adequate preparation to teach them effectively. Teachers are not ready to meet this challenge. It is a well-known fact that science teachers teaching science for standards VI to VIII are unfamiliar with the upgraded contents in the syllabus. The in-service training provided for those teachers is not up to the mark and all the teachers do not gel this training too.

3. **Laboratories and Equipment:** The school laboratories and equipment are not enough to teach science through experiments. Consequently, science teaching continues to be oral and merely verbal

4. **Not Functional:** General Science has lost its original favour and it is no longer general and functional. The contents in Physics, Chemistry and Biology arc so advanced that only specialists in the three areas alone can teach effectively the respective content area. Such specialist teachers are not available in each and every school in sufficient numbers. The Team-Teaching approach alone can solve this problem to some extent. While appointing teachers to schools, administrators have to sec that each school has specialists in adequate numbers in Physics, Chemistry and Biology.

5. **Training :** Pre-service training of science-teachers still continues to be isolated from the realities of the classroom work.

PANEL ON SCIENCE EDUCATION IN THE SECONDARY SCHOOLS (1964)

A panel was set up in May 1964 to examine the procedure for the allotment of funds and procurement of equipment in secondary schools and thereafter draw standard lists of equipment for science laboratories of secondary schools and suggested grants for the purpose.

Dr. K.N. Mathur served as the chairman of the Panel. Its other members were Prof. S.VC. Alva, Dr. R.C. Majumdar, Dr. P.D. Shukla, Shri K. Sachidanandan, Shri M.V. Patankar, Dr. R.N. Rai, Sh. Omparkash, Shri M.M. Pandya, Sh. J.L. Sehgal, Dr. S.N. Saroj, Dr. B. Patnaik, Sh. D.I. Lall, Sh.S.C. Roy, Sh. Arjan Singh Shante, Sh. R. Shahmugham, Prof B.D. Karve, Sh. S.D. Pant, Sh. B.L. Chadha, Sh. Jagdish Singh (Member Secretary)

Recommendations

A) Financial Procedure

1. The education department of each state should frame proposals for the new academic year at least a month before the start of the academic session furnishing full details.
2. When science teaching is to be introduced in a high school, a minimum amount of Rs 10,000 may be earmarked for setting up a well-equipped laboratory for physics and chemistry.
3. For middle schools, a sum of Rs 4, 000 for science equipment is considered essential.
4. Where science fees are charged from the students, the amount so collected should be allowed to be retained by the schools.

B) Science Equipment

1. State education department may make purchases for scientific equipment on stale/regional/ district basis till such time as the purchase specifications are laid down by concerned agency in the interest of ensuring the purchase of quality products at reasonable prices.
2. Each stale should be able to plan (heir approximate needs on a time year basis in accordance with their proposals for the time-year plans.

3. The lists of equipment for Physics, Chemistry and Biology laboratories of high schools be prepared on the basis of the syllabi of Maharashtra and U.P. Boards. Necessary modifications may be made to suit requirements of syllabus of the Board concerned.

4. The lists of equipment required in middle schools, as prepared by the NCERT is considered essential.

5. Each middle and high school should have a workshop attached to it for which a grant of Rs 1, 000 should separately be sanctioned.

6. Adequate facilities should be provided to science teachers and students and also refresher courses for the subjects as well as for workshop training should be arranged for teachers.

7. The NCERT may be requested to set up, on a high priority basis, a semi-autonomous agency for undertaking the work of laying down norms and standards for science apparatus.

8. Teachers training institutions should be provided with appropriate workshops to impart necessary skills to the prospective science teachers.

C) Planning For Laboratories

1. The laboratories should always be located on the ground floor.

2. A space of 76.8 sq.m. would be reasonable adequate for theory and practical work in science for a class of upto 42 students working at a time.

3. The tables, as provided in the laboratory *cum* theory room arc of such dimensions that two students could do practical work in one table.

4. In the case of laboratory tables, it is suggested that the standard size of a (4.0." x 1'9") as recommended by the UNESCO experts team may be adopted. And the size of the teachers table should be (8'.0 x 2'6") and kept on a platform raised to a height of 7" from the room level.

5. There should be adequate provision for wall, shelves as wellas RCC or stone ledgers for balances.

6. The following service facilities are recommended-

   i) Four water points with sinks 12" x 6".

ii) The teachers' table should be provided with 10 amp. electric socket for power and three 5 amp. sockets for usual-aiel experiments.

D) For increased production of science equipment, it is recommended that the state Governments may estimate their requirements during the next plan period and thereafter the planning commission may take up the question of increased production with the manufacturers direct or through the council of scientific and Industrial research.

E) The creation of a separate branch of science education in each state department of education under a special officer would strengthen considerably the steps that are being taken at various levels for improvement of science teaching.

Institutes for Co-ordination and Training

1. NCERT at the National level.
2. SCERTs and Institutes of Education at the State level.
3. Extension Services departments in the various corners of theStates.
4. Institutes of Science Technology and Education at the Regional level.
5. Non-Government Institutions at the Regional level.

1. **NCERT:** (National Council of Educational Research and Training), established on September, 1960 is an autonomous organisation which plays a major role at the national level in the ^formulation and implementation of national policies and programmes in school education and teacher education. The Council is fully financed by the Government of India. It does all what can be done for bringing qualitative improvement in school education and teacher education. At present its organisational work and structure is composed of the following:

(a) ***National Institute of Education (NIE):***Composed of various departments, NIE is situated at the national headquarters, Shri Aurovindo Marg, New Delhi. It caters to the need of science education with the help of the following departments:

(i) Department of Education in Science and Mathematics.

(ii) Department of Teacher Education, Special Education and Extension Services.

(iii) Department of Measurement. Evaluation Survey and DataProcessmg.

(iv) Department of Field Services, Extension and Coordination.

(v) Department of Policy Research, Planning and Programming,

(vi) Department of Library Documentation and Information

(vii) Publication Department

(viii) Workshop Department

(ix) Journal Cell

(x) International Relations Unit

(b) ***Central Institute of Educational Technology (CIET):*** As one of the constituent units of the NCERT, CIET is engaged in discovering and implementing the hardware and software technology for the improvement of education (including formal and informal science education).

(c) ***Regional Colleges of Education (RCEs):*** These colleges are located at Ajmer, Bhopal, Bhubaneswar and Mysore. These are residential institutions with adequate laboratory, library and other facilities. Each college has a Demonstration Multipurpose School attached to it where developed methodologies may be tested in the actual classroom conditions. In the field of science education, these colleges do not only prove a centre for the provision of pre-service training and providing B.Ed, degree but also prove a good centre for the organisation of inservice training and programmes of science education for the benefit of the teacher and schools falling within the region of location of the college.

(d) ***Field Offices:*** NCERT has set up a number of field offices at the main places spread out in the whole country to provide effective liaison with the State education authorities as well as with the State level institutions like SCERT State Institutes of Science Education and extension departments working in the training colleges for providing academic and training inputs to the school education system. These places are seventeen in number namely, Ahmedabad, Allahabad, Bangalore, Bhopal, Bhubneswar, Kolkata, Chandigarh, Guwahati, Hyderabad, Jaipur, Chennai, Patna, Pune, Shillong, Shimla, Srinagar, and Thirunantpuram.

2. **SCERT and State Institutes of Science (At the State Level):** State Governments have established in their respective States, "State Council of Educational Research and Training (SCERT)" for bringing! qualitative improvement in school education and teacher education. The department of education in the States and Ministry of

Education of the states helps in coordinating and organising the activities of these councils. The guidance and help is also available from the liaison field offices of the NCERT located in the State.

Slate Institutes of Scienceestablished at a suitable place in the; respective States by the State Governments are mainly responsible for the planning, research, coordination and implementation of the work related with science education at the State level. Their main functionare:

(i) Arranging in-service (raining programmes and guidance services to the science teachers.

(ii) Working as a centre for conducting research studies in science education and implementing innovative ideas and programmes related with the study of science.

(iii) Preparing instructional materials and aids for the teaching of science.

(iv) Working as a guide and source for organising non-formal science education for the students and masses.

3. Extension Services Departments: Work at the selected training colleges. They are financed by the NCERT and State governments for running suitable projects and activities to bring qualitative improvement in education. They can prove a good media, source and centre for bringing improvement in the quality of science education, by providing inservice teacher training programmes .guidance and information to the teachers working in the schools situated in the region.

4. Institutes of Science, Technology and Education: Like IndianInstitute of Technology (situated at Kanpur, Delhi, Chcnnai, Mumbai, Kharagpur). Regional Engineering colleges and Regional colleges of Education can play a big role in bringing the improvement in science education and contributing towards the professional growth of the science teacher.

5. Other Government or Voluntary Institutions and Agency: Voluntary institutions and special agencies established by the government may also prove a good media and centre for bringing qualitative improvement in the field of science education and teacher education. They can provide good leadership in the field and aspects of formal and non-formal science education. As examples of such agencies and institutions working in our country, we can cite the name of:

(i) Centre of Sciences for -Villages, Wardha.

(ii) Rural Development Seva Centre, Endel (Chennai).

(iii) Science for Society, Salt Lake City, Kolkata.

(iv) Vikram A. Sarabhai Community Science Centre, Ahmedabad,

(v) Bengal Social Service League, etc.

In addition to the above mentioned sources and activities for the professional growth of the science teacher, we can also name some Bother measures and sources for meeting out the need in question. A few mentionable are the following:

- Educational tours and excursions
- Teacher exchange programmes at the regional, national and international level,
- Listening to Radio, watching television programmes and other films related to scientific knowledge and science education.
- Gaining information about the new trends and experimentsin science education.
- Getting acquainted with the new schemes and proposals of the State and Central Governments like National Science Talent Search Scheme, etc.

The sources and measures cited above are self-explanatory in their nature for contributing towards the professional growth of the science teachers. However, for the sake of providing more help to the teachers, we would like to discuss, the last two namely, 'the new trends and experiments in science education' and 'National talent search scheme' in the chapters to follow.

1.5 LET US SUM UP

- Science during ancient and medieval period
- Science during modern period
- Development of science education after independence
- All India Seminar on teaching of science
- Indian Parliamentary and Scientific Committee

- UNESCO Planning Mission
- Indian Education Commission (1964-66)
- Ishwarbhai Patel Committee (1977)
- National Council of Educational Research and Training (NCERT)
- State Councils of Educational Research and Training (SCERT)

1.6 UNIT ENDS EXERCISES

1. *Trace the history of science from the ancient period to the modern period.*
2. *Why didn't science make a significant headway in India during the British period?*
3. *How did the scientists contribute to popularise science during 18th and 19th century?*
4. *What steps have been taken by the Government of India to improve the quality of the science education in Schools ?*
5. *What is the role of the following organizations in the improvement of science education?*

   (i) NCERT (ii) SISE (iii) SCERT

   How the development of science was accelerated after independence?

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1.8 ANSWERS TO CHECK YOUR PROGRESS

1. a)At the higher primary stage emphasis should be on the acquisition of knowledge and the ability to think logically, to draw conclusions and to make decisions at a higher level. A disciplinary approach to the teaching of science will be more effective than the general science approach.

   b)A science corner in lower primary schools and a laboratory-cum lecture room in higher primary schools are minimum essential requirements.

Logical analysis as a tool for refinement of ideas and to arrive at generalizations, was also considerably developed.

LESSON NO. 2 **UNIT-I**

AIMS AND VALUES OF TEACHING PHYSICAL SCIENCE IN SECONDARY SCHOOL

STRUCTURE

2.1 Introduction

2.2 Objectives

2.3 Aims of Teaching Physical Science in Secondary School

2.4 Values of Teaching Physical Science in Secondary School

- 2.4.1 The Cultural Value of Science
- 2.4.2 Intellectual Value
- 2.4.3 Practical Value
- 2.4.4 Vocational Value
- 2.4.5 Moral Value
- 2.4.6 Aesthetic Value
- 2.4.7 Psychological Value
- 2.4.8 The Utilitarian value of Science
- 2.4.9 Disciplinary value of Science

2.5 Let Us Sum Up

2.6 Unit End Exercises

2.7 References and Suggested Reading

2.8 Answers To Check Your Progress

2.1 INTRODUCTION

For carrying out any activity it is significant to know its purpose. If the purpose is clear, the activity will be carried out effectively. If one knows clearly what is to be achieved the planning will be done accordingly and the work will be carried out properly. Even if it is not carried out properly at least it can be measured or evaluated as to what extent the activity has been successful. This (evaluation) is only possible by comparing the achievement of the activity with its planned purpose, goal or objectives.

In the same way in education or in any particular field of education the identification of goals, aims and objectives is a very important activity. Here the question is what should be the aims and objectives of science education and science teaching? Before knowing the aims and objectives of science education, as a teacher we should also know that aims and objectives of teaching of any subject should be directly related to the educational philosophy and policies. Educational philosophy and policies give justification for teaching various subjects in school including science.

2.2 OBJECTIVES

After going through this unit, you should be able to :

- Know the aims of Teaching of Physical Science
- Understand the importance of teaching physical science
- Analyze the impact of Science and technology on modern living

2.3 AIMS OF TEACHING PHYSICAL SCIENCE IN SECONDARY SCHOOL

Aims and objectives of science education have undergone many changes because the goals of education are also changing with the changes in the society.

Aims of teaching science at different stages of school Education

There have been many attempts from time to time in our country and abroad by the educationists to think about the aims of science teaching at different stages of school education. One of such attempts in our country was made in 1956 at Tara Devi Hills through a seminar on the topic "Science Teaching in Secondary Schools". The other one relates to the recommendations of Kothari Commission in 1966 followed by the observations of the National Policy on Education. Based on these' attempts, the following aims can be set at different stages off education.

2.3.1 Objectives of Teaching Science at Different Levels

A. According to Taradevi Report (1956)

According to All India Seminar on Science Teaching, held at Taradevi, aims and objectives of science teaching should be:

I. Primary Level

1. Arousing and maintaining interest in nature and in the physical and social environment, arosusing love for nature and the habit of conserving nature and its resources.
2. Developing the habit of observations, exploration, classification and a systematic way of thinking.
3. Developing the child's powers of manipulation and the creative and inventive faculties.
4. Developing neat and orderly habits.
5. Inculcation of habits of healthful living.

II. Middle School Level

In addition to the "above, the following aims arid objectives are suitable for inclusing at the Middle School Level.

1. Acquisition of a fund of information concerning nature and science which may also serve as the basis for a later General Science course.
2. Developing the ability to reach generalizations and to apply them for solving every day problems.

On the Development of Education and National Policy of Education, in this connection are worth considering

"We lay great emphasis on making science an important element in the school curriculum. We, therefore, recommend that science and mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling. In addition, there should be provision of special course in these subjects at the secondary stage, for students of more than average ability."

At primary stages (Class I to IV)

1. To make the children interested in the study of nature and to help them in getting acquainted with their natural surroundings.
2. To inculcate good habits of cleanliness and healthful living among children.
3. To develop their faulty of observation.
4. To give them the basic knowledge of numerals and alphabets for the comprehension and understanding of scientific vocabulary and language.
5. To provide opportunities for the development of their inventive and creative faculties.
6. To cultivate the habit of doing work systematically.
7. To encourage the Children to read and listen to the life story of great inventors and scientists.
8. To educate them regarding the application of science in their physical and social environment.
9. To develop the ability to read and understand simple graphs,charts, maps and statistical tables.

At Middle or Higher Primary Stage (Class V to VII)

1. To provide knowledge about the basic primary facts, principles and theories related wit science.
2. To help the students to get acquainted with the impact of science over the environment surrounding them and to develop their interest in the study of

science.

3. To develop scientific attitude among children.

4. To cultivate the habit of systematic and. logical thinking.

5. To develop the habit and ability of drawing correct inferences out of the available facts and evidences.

6. To provide essential base for further studies in the higher classes.

7. To acquaint the students with the history of the development of science and help them to understand and appreciate the progress and development made in this sphere.

At the Lower Secondary Stage (Class VIII to X)

1. To provide deeper insight of the facts and principles of science.

2. To develop their ability to perform scientific experiments more skillfully.

3. To help them to get better insight into the application of science.

4. To provide appropriate opportunities for the development of inventive and creative faculties of the students.

5. To provide essential base for the higher specialized studies in the areas and fields of science and technology.

6. To equip the students with all the basic scientific knowledge and skills helpful in day to day life.

7. To help the students adopt and learn useful scientific activities as hobbies and leisure time activities.

8. To develop understanding and attitudes for scientific appreciation.

Higher Secondary Stage (Class XI to XII)

1. To attain desirable proficiency in the specialized areas of science.

2. To acquaint them with the latest concepts and advancement in these specialized branches of science.

3. To prepare them for study of work related specialized vocations like

medicine, agriculture, engineering etc.

4. To encourage the students in independent deep study of their specialized branches/areas.

5. To provide opportunities and inspiration through relevant reference material and specialized magazines to the students for the understanding as well as creation of something new in the field of science.

Check your progress

Note: Write your answers at the space given below.

1. What are the objectives of teaching science at middle school level?

2.4 VALUES OF TEACHING PHYSICAL SCIENCE IN SECONDARY SCHOOL

Apart from the reasons discussed in the previous chapter for making a case for the inclusion of science in school curriculum, it must satisfy the following multifarious values for leading a successful and satisfying life in the modern world.

Science is one of those human activities that man has created to gratify certain human needs and desires. The 'Search of truth'became the dominant motive in the prosecution of science. It has been pursued for so many centuries and attracted ever-wider extent of attention of a very persisted group of people. Science is valued mostly for its practical advantages though it is also valued for gratifying disinterested curiosity and as an object of great aesthetic charm. It is quite obvious that the bulk of mankind value science chiefly for the practical advantages it brings with it. In the words of Indian Education Commission (1964-66) "There is, of course, one thing about which we feel no doubt or hesitation; education, science based and in coherence with Indian culture and values, can alone provide the foundation as also the instrument for the nation's progress, security and welfare".

Science in its various forms and shapes help us to understand ourselves and the environment around us. However, this task to understand ourselves and the environment is not so simple as it appears otherwise. It will be futile to prepare

separate case for the inclusion of science in the curriculum because the reasons for its inclusion are exactly the same as those for the inclusion of subjects other than science though it has been given a core place in the curriculum because of some special values provided by science only and not by any other subject. Science takes its place side by side with other subjects as an essential element of one's education. It affords a knowledge of certain facts and laws and an insight into methods and data peculiar to the domain of science. However, the inclusion of any subject in the curriculum should satisfy the intellectual, utilitarian, vocational, cultural, moral and aesthetic values. Besides these, the teaching of science imparts training in the 'Scientific method1 and develops 'Scientific attitude' which are very valuable and at the same time are transferable to other situations in life.

The Secondary Education Commission has recommended that every secondary school pupil should study general science as a compulsory subject, so that he gains a basic quantum of scientificknowledge as a part of his general education. The rapid advancement of science and technology and increasing need for scientists and technologists have made it all the more important to provide for science based education in the schools. To facilitate and serve the purpose in a better way, therefore, attempts are made to divide the subject matter and knowledge of the science into some distinctive branches like Physics, Chemistry, Zoology, Botany, Microbiology, Astronomy, Medical Science, Biotechnology, Biochemistry etc. Such division helps in the deep and thorough study of the specific area covered by a particular branch and ultimately in this way one may be led in a proper way to understand oneself and his environment.

The primary goal of education should be the intellectual development of the individual. With its accelerating importance in our society; science has become an increasingly important part of general education and knowledge. Science has now become a compulsory subject in the school curriculum because of its multifarious value to the individual as well as the society.

2.4.1 The Cultural Value of Science

Now that science enters so widely and so intimately into every department of

life, especially in all questions relating to health andwell-being, it is important that the community should have a general knowledge of its scope and aims, of the mode in which it envisages and attacks its problems, and of scientific method generally. It is, however, beyond question that it should be a general knowledge on broad lines; a specialized training in some highly technical branch of science is neither necessary nor desirable. But the general knowledge must be an accurate knowledge, a closely reasoned-out knowledge, built up on a basis of undisputed facts.

As a means of culture, the history of scientific discovery opens up to the imagination great pictures of the work of great: men, thereby placing science in the front rank of humanistic studies. A knowledge of the methods of observation and experiment in the different branches of science helps to develop a logical mind, a critical judgement, and a capacity for methodical organization; while a knowledge of the great questions with which science as a whole is concerned, fosters the broad outlook which is essential for the successful solution of the problems of life.

Assuredly any science course should not only train pupil's to weigh and interpret observed experimental evidence, but should also make them acquainted with the broad outlines of greatscientific principles, with the way in which these principles are exemplified in familiar phenomena, and with their applications to the service of man. There is a certain body of scientific knowledge and a certain number of scientific ideas with which everybodyought to be familiar. These ideas permeate the whole atmosphere of common thought at its higher levels, and provide the basis of most forms of human activity. The ritual of laboratory must not be confused with the spirit of science. The spirit of science cannot be weighed and measured, even if weighing and measuring are necessary for tracking it down. The bedrock facts of science are, of course, of fundamental importance, but, as an introduction to the teaching of science, they are certainly rather unexciting to children. In the early stages, facts which are not given a background of interest repel rather than attract the children. A first-year school course, designed to give a grounding in elementary science, ten consists of colourless and uninspiring data.

2.4.2 Intellectual Value

Science is organised common sense. It has introduced us to new ways of thinking and reasoning. It has its own disciplines. It teaches people to sharpen their intellect and makes them more careful and systematic in their reasoning. It provides a unique training in truth, inculcates a spirit of enquiry, the capacity to know the unknown and the strength to face hardships and failures. The pursuit of science requires diligence and patience. A true scientist has a high regard for truth. His judgments are above prejudice and rest on facts alone. Persons other than scientists find it too hard to have the calm detachment and unemotional judgements of men of science. It teaches to arrive at conclusions without any emotional bias or prejudice.

It trains the minds of the people, creates very good habits and develops increasing awareness about themselves, about fellow creatures and about the material universe we live in. Obviously it helps to understand, evaluate and, solve numerous social problems of life. Thus the individual begins to reason things he meets in daily life and discharges his duties in a better manner and leads a happy,successful and satisfying life.

2.4.3 Practical Value

We are living in an age of science and everything around us concerns science. Some knowledge of the present position and progress of science is, therefore, necessary for an adequate understanding of the world around us. We are becoming more andmore dependent on scientific discoveries and their daily applications.

So much depends upon electricity that life will be hell without it. The stock broker of Delhi knows what happened in Mumbai a minute or two ago and can fix his prices accordingly. One can converse by wireless telephone or mobile with a passenger on a liner in mid-sea or speak to a friend sitting in the remotest corner of the world. Science has revolutionized means of transport. The aeroplane has brought different countries much closer together. In other words, the science has shortened the world. It has enabled men to fly like birds. The motor car, the bus, the train etc. have made the transport very comfortable and enjoyable.

Science has a great medicinal value and has worked miracles in the fields of

surgery and medicine, every year shows new drugs and new applications of physical and biological sciences for curing diseases, prolonging life and preserving health. It has, thus, reduced the miseries of humanity and enabled people to live longer and happier.

Leisure is no longer a problem. Science has enabled people to use their leisure to the best advantages. A number of science studies at school can loan the basis of useful hobbies in a later life.'Gardening' cannot be hilly enjoyed, appreciated and benefited from unless the gardener knows something of plant-breeding, soil-physics, chemistry and scientific manuring etc. similarly photography requires some knowledge of the optics, chemistry of developing etc.

A knowledge of the facts and principles of science and their applications results in better understanding of world.

2.4.4 Vocational Value

Science forms the basis of many of the studies of a purely vocational nature and thus prepares pupils for various professions like medicine, engineering, agriculture etc.

Science has opened vast vistas of professions, because it forms the basis of so many studies which are purely vocational in nature. For example, a student of science can choose medical engineering, agriculture or any other profession in which he is interested in and is fit for. The study of science at school forms the basis of many useful hobbies and other productive activities in the later life of the students.

Scientific inventions have helped widely all the traditional vocations nowadays like agriculture, poultry farming, dairy farming etc. Science has also revolutionized modern vocations liketelephone, radio and television broadcasting. Banking through computerization, complicated machinery in factories are other marvels of science, Petroleum, natural gas departments, atomic energy, biotechnology,, irrigation, power plants are new fields of profession.

Thus it is quite clear that a subject which is so closely associated with our daily life and the-world which surrounds us and is so useful loan individual as well as to community as a whole cannot be neglected from the school curriculum. In an age

of science, and education intended to prepare us for a complete and purposeful living will be defeating its purpose if it takes an account of the need of the hour and the climate of the day which is permanent with the ideas and the hopes of the scientists.

2.4.5 Moral Value

Of the great values that condition our activities and make out lives worth-living-Goodness, Beauty and Truth, the man of science is mainly concerned with the disinterested passion of truth. Though comparatively, in the daily activities of mankind, that is the most unpopular of virtues yet it plays' an important role in science. The reason most obviously is that science is an activity where truthfulness is the most essential condition for success, wheresuccess is not possible on any other terms. A scientific man who misrepresents his observations or deliberately makes fictitious arguments to reach a false conclusion would merely be deceiving himself as a scientific man. He would not be prosecuting science but will be wasting his time and energy for nothing. His generalisations by concocted arguments and false observations will not stand the test of the time for long and will stand rejected. But on the other hand, a businessman may become rich by concealment, smuggling, misrepresentation of things and such other false and stupid means. A politician, by giving the real picture of things and by sticking to the money standard at the time of election, may not stimulate that degree of conviction and moral favor which is necessary to sway large audience. And an advocate who should have high morality and love for truth in order to save innocent from the pangs of punishment, may not have a very successful career. But all this does not mean that scientific men invariably speak the truth about their science. They have been known to lie, not in order to serve science but usually, religious or anti-religious prejudices. They were aiming at different type of success.

When a scientific theory has a religious, philosophic or any other kind of human interest, it no longer remains the disinterested passion for truth. The Copernican Theory and the Darwinian Theory give sufficient evidence of this. However, the moral integrity manifested in scientific work is due to the nature of the subject-matters. Science is truthful because it has practically no temptation to be anything else. In his work the scientific man has superb moral standard, but the value

of his example to the rest of mankind is limited by the fact that in his work, the scientist is not a perfect man-he is only a seeker of truth.

Science develops morality by teaching truthfulness and reasoning, every scientist is a speaker of truth- although in the modern materialistic world, truth may not always succeed. A business man earns millions by false ways and means, a successful politician may not draw the real picture of things to attract followers, a lawyer may flourish only by lying. But that does not mean that training in truthfulness is bad. Actually a scientist or a student of science aims at a different type of success.

A popular anecdote from the life of Mr. Huxley may be worth mentioning here. Once a priest and friend of Mr. Huxley was discussing with him the topic of the existence of God. He gave anumber of religious arguments, which were not convincing or reasonable. Mr. Huxley then humorously remarked, "Show me the existence of God by the test tube method."

So these arguments weigh down to the view that everything must be tested on the touch stone of reason and truthfulness, which arc perfectly developed by the learning of science.

2.4.6 Aesthetic Value

Every man of science has a passion for truth. But according to a well-known English poet Keats. "Truth is Beauty." In nature everything we find is beautiful and the discovery of the mysteries of nature is the concern of science.

Every scientist relished the aesthetic aspect of his discoveries and inventions. He feels an intrinsic charm in unfolding the pleasures of nature and natural phenomenon. He manifests his aesthetic impluse when he undertakes a probe for universal laws and comprehensive theories.

Moreover, science is an art. Every man of science is an artist. Actually there is no fundamental difference between art and science. An artist aims more deliberately at beauty while scientist ultimately comes to beauty through reasoning and truthfulness.

2.4.7 Psychological Value

The entire teaching and learning process of science is based on fundamental principles of psychology. The principles of 'learning by doing, 'activity method,' learning by observing concrete and living specimen, are the primary things in psychology. Moreoverstudy of science fulfils the psychological needs of man and helps in evolution of natural curiosity and other instincts like instinct of collection, ego, and self expression. The instinct of curiosity isresponsible for the urge of investigation, experimentation and research. Study of science thus develops all the latent faculties of a child. This triggers the opportunity of developing the mental faculties of reasoning, imagination, observation, concentration analysis and systematic thinking. We are able to do useful work and search for truth with the help of wisdom acquired through science.

2.4.8 The Utilitarian value of Science

Modern age is a science age. We are living in an age of science and technology. We see network of scientific gadgets based on latest scientific inventions all around us. Our activities are controlled andfashioned by science. Olden days oil lamp, has given to electrical bulbs, tube lights for illuminating modes of transport like horses and camels are replaced by cars, trains and aeroplanes. The sourceof entertainment has shifted from listening to stories to newspapers, radios, television, cinemas etc. Today, man has reached moon, stepped on it an is busy in exploiting it. Man has made Mars a destination to search for the possibility of extra terrestrial life. Science has wrested from nature almost all the hidden treasures. It has restored eyes to the blind, hearing to the deaf, legs to the lame. It has improved crop varieties and increased crop production.

There is a miraculous change in the ways and methods of doing our work and also in our way of living. We have devised labour saving gadgets and machines. They have made all our complicated work not only easy but also these are done much faster. Scientific knowledge and a population sufficiently educated to understand how to apply it to everyday life are primary requisite for raising the standard of living in any country.

It to said today to learn that the minds and energy of scientists are being channelised, probably by the politicians, to find out the weapons of death. Country is thought to be powerful which has the weapons that can kill million of people in a matter of seconds. They say, when the advance of destructive weapons enables everyone to kill everyone else, on one will want to killanyone at all. And thus there will be peace all over the world. It is a pleasant thought it is only a thought. Everything depend upon the mind of divine man or the devil man. It is for the man to decide whether he will kill himself or build himself with the atomic and nuclear energy.

2.4.9 Disciplinary value of Science

Science develops our personality as a whole. It inculcates spirit of enquiry, seriousness and systematic thinking. It brings about total transformation of one's view point and makes thought process more organized. Science makes us think seriously and helps to observe the real nature of the problem. It helps us to judge all the good and bad points, together, with the gain and loss likely to be incurred in the plan of action contemplated.

Science also checks one to take a hasty action prompted byone's sentiments and influenced by the biased opinion of others which are against the principles of science. Science is the only subject which promotes interest in study, concentration and habit of viewing a problem impartially with an alert mind. This helps to lead one's life successfully in a well organized and systematic way.

2.5 LET US SUM UP

Science has now established to be one of the compulsory subjects in the school, curriculum because of its multifarious value:

1. Intellectual value
2. Utilitarian value
3. Vocational value
4. Cultural value

5. Moral value
6. Aesthetic value
7. Training in the Scientific Method
8. Inculcation of Scientific Attitudes
9. Psychological value

2.6 UNIT END EXERCISES

1. "The claims of science for a place in school curriculum are now "well-recognised." What has brought about this victory? What in your opinion is the chief value of science as a school subject?
2. In educating for leisure rather than vocational or utilitarian purposes can science legitimately claim a place in the curriculum? If so, why?
3. "The study of science as a school subject is certainly useful for community and individuals." Justify the above statement. What in your opinion is the chief value of science as a school subject?
4. Make out a case for the introduction of science teaching in schools.
5. Until recently science was regarded to be a subject meant for less promising students. What is the position now and why has the change taken place?
6. What do you understand by the "intelligent adjustment to the environment ?" What could be the contribution of science teaching in education to make such an adjustment?
7. What is the value of science teaching in education? What place should science occupy in the school curriculum?
8. What are the views of National Policy on Education (1986) regarding Science teaching? What has been implemented in this regard by the Government of India?

2.7 REFERENCES AND SUGGESTED READINGS

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2.8 ANSWERS TO CHECK YOUR PROGRESS

1. Acquisition of a fund of information concerning nature and science which may also serve as the basis for a later General Science course.

Developing the ability to reach generalizations and to apply them for solving every day problems.

LESSON NO. 3 UNIT-I

BEHAVIOURAL OBJECTIVES

STRUCTURE

3.1 Introduction

3.2 Objectives

3.3 Meaning and Importance of Behavioural Objectives

3.4 Steps for Preparing Behaviour Objectives For Teaching of Physical Science

3.5 Let Us Sum Up

3.6 Unit End Exercises

3.7 References and Suggested Reading

3.8 Answers To Check Your Progress

3.1 INTRODUCTION

Prof. B. S. Bloom and associates have developed classification of educational objectives. Educational objectives indicate the nature of education system and give direction for further development. Objectives also provide guidance for teaching and learning. These also provide indications for curriculum development, text-book writing and evaluation procedures.

In this chapter, you will study classification of educational objectives as attempted by Bloom and associates. It is true that we should give emphasis on all the three domains, that is, cognitive, affective and psychomotor.

3.2 OBJECTIVES

1. Explain the meaning of goals, aims, objectives and instructional objectives.
2. Explain the meaning of Taxonomy of Educational Objectives.
3. Explain the meaning of cognitive, affective and psychomotor domains of educational objectives.
4. Give criteria of classifying cognitive as well as affective domains.

5. Discuss the classification of : (a) Cognitive, (b) Affective, © Psychomotor domain.

- Acquire knowledge about aims, objectives of Blooms Taxonomy
- Classify objectives in cognitive, affective and psychomotor domains
- Write down the objectives in behavioural terms.
- Understand the objectives of teaching science at primary level.
- Understand the objectives of teaching science at secondary level.
- Understand the objectives of teaching science at higher secondary level.

3.3 MEANING AND IMPORTANCE OF BEHAVIOURAL OBJECTIVES

Educational objectives are broad goals which nations pursue through their education system and through their schools. These objectives serve as a general framework of the education system and represent the economic, social and political aims of the nation. For example, the National Policy on Education, 1986 has clearly mentioned that education is essentially fundamental for allround development of the individual. "It has responsibility to refine sensitivity, contribute to national cohesion and the development of scientific temper and independence of mind and spirit."

1. Aims of Science Teaching

(a) are broadly phrased in statements.

(b) are long term.

(c) generally apply to systems rather than individual schools.

2. Goals of Science Teaching

(a) are more precise statements of curriculum intent.

(b) are medium to long term.

(c) are directed to student achievement.

3. Specific Objectives

(a) are specific statements.

(b) are short term.

(c) are usually expressed in terms of learner behaviours.

(d) are often devised by teachers

Classification of Educational Objectives

Originally the term taxonomy was taken as science of the classification laws of life forms. By extension, it is taken as a general term for classification and also taken in use for classifying the educational objectives. Thus, Taxonomy of Educational Objectives is a classification constructed according to one or two explicit principles.

The term Taxonomy of Educational Objectives is closely associated with the name of Benjamin S. Bloom. In 1956, Taxonomy of Educational Objectives, Part I was edited by B. S, Bloom. Since then it earned a world wide recognition.

Bloom's taxonomy was soon followed by Krathwohl's Taxonomy of Educational Objectives Part II Affective Domain. Other efforts such as Guilford's Taxonomy (1958), Dave's Taxonomy (1969), Kibler's Taxonomy (1970) are also meaningful.

Bloom and his associates (1956) categorised educational objectives into three major areas which are known as cognitive domain (concepts, ideas, factual knowledge and intellectual skills), affective domain (appreciation, ideals, attitudes and morals), psychomotor domain (motor skills such as piano laying, basket weaving, swimming, that involve the intelligent use of motor functions). This classification has been further specified which leads to the objectives of a particular subject.

Some of the Advantages of Classification of Educational Objectives are as follows:

1. Classification of educational objectives is helpful in :

- planning curriculum, and in
- planning learning-teaching activities.

2. It is helpful in identifying desired behavioural outcomes.

3. It is helpful in preparing testing/evaluation material.

4. It is also helpful in identifying higher order mental processes.

5. It is helpful in establishing relationship between groups andindividuals.

It has been mentioned that three domains (cognitive, affective and psychomotor) are inter-related and interdependent It also been accepted that knowledge is something that exists with interests, attitudes and appreciations. Similarly, emotions and feelings cannot be separated from our capacity to learn. It shows interdependence between

knowledge and feelings.

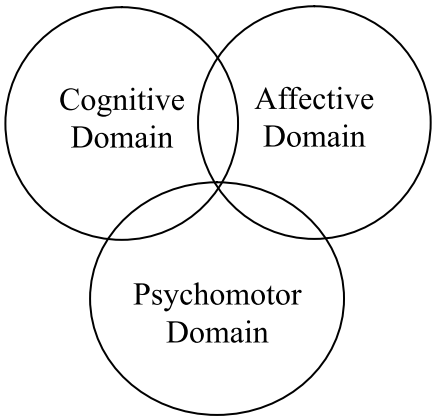


Fig. Showing Inter-relationship between/among Three Domains of Educational Objectives

Description and Classification of Cognitive Domain

Bloom and associates (1956) have arranged cognitive educational objectives according to the complexity skills and abilities. The resulting taxonomy presents a hierarchical view from simple to complex mental processes. Bloom and associates (1956) have given detailed discussion of cognitive domain in the following book:

Taxonomy of Educational Objectives : The Classification of Educational Goals : Handbook I : Cognitive Domain, Benjamin S. Bloom (ed) 1956, David McKay Co., New York.

Cognitive domain is further divided into six categories which are arranged in hierarchical order. These categories are as follows:

1.0 Knowledge

2.0 Comprehension

3.0 Application

4.0 Analysis

5.0 Synthesis

6.0 Evaluation

The lowest level is Knowledge which begins with the student's ability to recall and

recognise knowledge. At the highest level is evaluation where a student can judge the quality of knowledge.

The arrangement of these categories can be observed as follows which shows from the highest to the lowest, namely, from evaluation to knowledge:

Highest

6.0 Evaluation—to make quantitative or qualitative judgements.

5.0 Synthesis—to put together parts so as to make a whole.

4.0 Analysis—to break down information into its parts.

3.0 Application—to use abstracts in concrete situations.

2.0 Comprehension—to know what is being communicated and to be able to use ideas.

1.0 Knowledge—to be able to recall information.

Lowest

The above mentioned six categories have been arranged from the Highest level to the lowest one. 'Low level' objectives can be achieved by memorisation, therefore, knowledge category is related to recall of information. But the 'high level' objectives require more complex forms of learning. Some description of these categories has been given here.

1. Knowledge

This is the first and the lowest level of cognitive domain. It includes recall of information such as specifics, methods, processes, patterns, etc. For example, recalling the name of some person, natives of the bones in the human body. Similarly, it lays emphasis on recalling specifics such as the form of water. Thus, the knowledge level emphasizes what can be described as memory.

2. Comprehension

This second category includes translation from one form to another and interpretation. This is also related to the use of ideas. For example, drawing a graph of changes from a list of temperatures recorded over a period of time. It also includes explaining of the statements.

3. Application

The third level includes the ability to apply abstract ideas to a concrete situation. The working of a thermometer is one of the examples where pupils can explain the relationship between heat and the expansion of the liquids. Similarly, classification of animals OK some criteria can be another example.

4. Analysis

This category is concerned with the breaking down of information into its parts or elements. The study of different parts of an experiment clearly indicates different aspects of that experiment suchas the hypothesis, the method, the data, etc.

5. Synthesis

This category is just the opposite of analysis. In this category the parts of an experiment arc put together to make it whole. Another example can be formulating a 'hypothesis to explain why some animals are less active in the day and more active at night time.

6. Evaluation

This is the highest category of the six levels of the cognitive domain which is concerned with the qualitative and quantitative judgements based on some criteria or value judgements. The example is the ability to tell the mistakes committed in an experiment. Similarly, to give judgement about the popular beliefs about, health is another example.

Each of these six categories are further divided. For example, the Taxonomy of Educational Objectives : cognitive domain, lists three groups in the first category, that is, knowledge :

1. Knowledge of specifics.
2. Knowledge of ways and means of dealing with specifics.
3. Knowledge of universals and abstractions in the field.

These three groups of objectives under knowledge are further subdivided. Similarly, other categories are subdivided.

The Affective Domain

The affective domain is one of the inner growth that takes place as a person

becomes aware of and then adopts the attitudes, principles, interest, values and development of appreciation and adjustment. Krathwhol and associates have discussed these objectives in detail in the following book.

Taxonomy of Educational Objectives : The Classification of Educational Goals. Handbook II Affective Domain David R. Krathwohl (ed), 1964

The main organising principle for the cognitive domain were from simple to comlex and from concrete to abstract. To classify affective domain objectives Krathwhol and associates have considered the principles of the degree of internalisation, that is, the degree of incorporation of the affects within the personality. When the process of internalization is completed, the person feels as if the interests, attitudes and values were his own and lives with them.

This taxonomy includes :1. Receiving, 2. Responding, 3. Valuing, 4. Organisation, 5. Characterisation by value or value complex.

The major categories in this taxonomy, which have been arranged in a hierarchy, which are as follows :

1.0 Receiving

1.1 Awareness

1.2 Willingness to receive

1.3 Controlled or selected attention

2.0 Responding

2.1 Acquiescence in Responding

2.2 Willingness in Respond

2.3 Satisfaction in Response

3.0 Valuing

3.1 Acceptance of a value

3.2 Reference for a value

3.3 Commitment

4.0 Organisation

4.1 Conceptualisation of a value

4.2 Organisation of a value system

5.0 Characterisation by Value or Value Complex

5.1 Generalised set

5.2 Characterisation

The Psychomotor Domain

The Psychomotor domain is important because it is concerned with motion. Motion is a necessary condition of survival and of independent life sometimes depends on physical strength property applied, on agility, and on rapidity. Locomotorbehaviour is needed to explore the environment and sensory motor activities are essential for the development of intelligence. Some psychomotor behaviour such as walking and grasping, arc also necessary for physical and mental health to be maintained. Dexterity is essential for the worker (Landsheere, 1990).

The psychomotor domain is linked to development of children's motor skills and physical coordination. This domain has seven levels, such as (Allen and Bacon, 1994).

1. **Perception**

   Originates in the brain and must occur if students are going to be aware of such attributes as left right, up-down, rows-columns, foreground-background etc.

2. Set illustrates physical readiness to perform a task such as properly grasping forcepts before beginning to move masses on a balance.

3. **Guided Response**

   It is a behaviour guided by the teacher. A child follows a sequence of instructions properly, such as the correct way to grasp a lamp, pick up a test tube, and move it to a new location.

4. **Mechanism**

   It is the label used when a child no longer has to think through each mechanical step as it is done, the task appears to be done automatically.

5. **Complex overt response** is a more complicated extension of the mechanism level.

6. Adaptation is shown when children can adapt their physical performance to the situation's demand.

7. Origination

It is demonstrated when children create new movements to fit particular learning requirements. This level of psychomotor domain is referred to as a student's style.

Taxonomies on Psychomotor Domain have been developed by Ragodale (1950), Guilford (1958), Dave (1969), Kibler (1970), Simpson (1966).

Psycho-motor Domain-Dave's Taxonomy

The psycho-motor concerns itself with levels of attainment on neuromuscular co-ordination. As the level of co-ordination goes up, the action becomes more refined, speedy and automatic.

In this domain also, following five objectives have been identified:

1. Imitation

Imitation accounts for the lowest level of psycho-motor behaviour. It starts as an inner push or impulse. It is represented by convert inner push or impulse. It is represented by convert inner rehersal of the muscular system which may be taken to be more of an action at the mental level. Soon it may grow into an overt act with capacity to repeat the performance with very rudimentary co-ordination.

Specifications:

1. Initiation
2. Impulsion
3. Repetition

2. Manipulation

Manipulation is the next higher level of psycho-motor behaviour. It involves follow up of directions, selecting certain actions in preferences to others and acting accordingly. It makes the beginning of the fixation of operation and the end of initial fumbling in the manipulative actions. Student develops the manipulation skills in using mathematical instruments and apparatus.

Specifications:

1. Follow directions
2. Manipulation

3. Selection

4. Fixation

3. Precision

Precision is the third category and is attained when reproduction of operations is carried out with speed and refinement, giving the learner the ability to control his/her action according to requirement.

Specifications:

1. Reproduction

2. Control

3. Refinement

4. Articulation

Articulation is the fourth category, which can be said to have been attained when the learner is able to handle a number of actions in unison keeping in view their sequence and rhythm. It involves co-ordination in action i.e. right sequence in right proportion of time or at the right moment.

Specifications:

1. Sequencing of actions

2. Co-ordination of actions

3. Completion of task

5. Naturalization

It is the final stage which is the equivalent of a perfect habituation ranging from automatisation to routinisation. At this level the performer does not remember the order of operations. His/her actions are more or less mechanical and without any conscious thinking or planning. It is a mere reflex action.

Specifications:

1. Automatism

2. Interiorisation

The classification of objectives of the psycho-motor domain may not interest the teachers of all subjects but in curricular area as writing, speech, drawing, crafts etc. it will

find a very wide application. Unlike cognitive and affective domains, the transfer value of an objective in the psychomotor domain from one context to another may not be quite so easy.

Objectives of Science Education Represent Different Domains of Educational Objectives. The following objectives represent, different domains but some objectives sustain more than one domain (Alien and Bacon, 1994).

Cognitive Domain

1. Understand and use new ideas and scientific information.
2. Develop problem solving skills.
3. Understand the interactions of science, technology and society.
4. Recognise that data may be interpreted differently by different people.
5. Develop a knowledge and understanding scientific principles and concepts.
6. Learn to think critically and creatively.
7. Develop process skills so that he can think scientifically.
8. Realise that science and technology are relevant to all fields of employment.
9. Recognise that scientists and technical hands should be strengthened.
10. In formed about the contributions of scientists to society.

Affective Domain

1. Develop attitude and skills necessary to become a responsible consumer.
2. Recognise how the advancement of science and technology has changed the lives of people in local, national and global communities.
3. Develop attitudes, values and ethics of science to use as a basis for science related decisions.
4. Develop effective and positive work habits to science.
5. Recognise that scientists are not stereotyped.

Psychomotor Domain

1. Develop problem solving skills needed to respond to a changing society and environment.

2. Develop process skills so that they can think scientifically.

Develop psychomotor skills so that they can properly manipulate equipment anal instruments.

Check your progress

Note:

1. Classify the educational objectives according to bloom and his associates?

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3.4 STEPS FOR PREPARING BEHAVIOUR OBJECTIVES FOR TEACHING OF PHYSICAL SCIENCE

A key to writing instructional objectives is the use of verb that shows the terminal behaviour of the learner. But equally important are the conditions under which these behaviours will be observed and third the extent to which this can be performed. Thus, there are three conditions of writing a behavioural objectives:

1. The behaviour desired : It means, what a student should be able to do at the end of instruction. The terminal behaviour is to be identified. For example, label the parts of a flower.
2. The conditions under which this behaviour is to occur. For example, in the given diagram students label the parts of a flower.
3. The level of expected performance. For example label sepals, petals, androecium and gynoecium in a given diagram of a flower.

The complete format of behavioural objective shall be as follows: In a given diagram of a flower students shall be able to label sepals, petals androecium and gynoecium,

Robert F. Mager (1974) has presented a meaningful way to prepare and analyse instructional objectives. He has indicated three characteristics of a clearly stated behavioural objectives :

1. **Performance :** Under this a observable behaviour is to be specified which is to be exhibited by the learner.

2. **Condition :** In this the conditions to be written under which learning outcome will be assessed.

3. **Criterion:** It specify the minimum level of acceptable performance that the learner will be able to exhibit.

Similarly, Ten Brink (1982) has mentioned a criteria for constructing a good instructional objective;

1. It should be student oriented
2. It should be descriptive of a learning outcome
3. It should be clear and understandable
4. It should be observable

Finally, instructional objectives are observable behaviours, that is, they state learning outcomes that can be seen. The action verbs are used in specifying the objectives or the expected behaviours.

Precautions in Writing Behavioural Objectives

Groundland (1968) and Mager (1972) have mentioned some precautions for writing behavioural objectives, such as :

1. Behavioural objectives should be stated in terms of student's performance.
2. Such objectives reflect terminal behaviour of the learner whichoccurs after the completion of instruction.
3. These objectives represent one behaviour at a time.
4. As a science teacher you should avoid general terms whileconstructing a behavioural objective. Such general terms are vagueand has double meaning. Consider the following terms given byMager (1972):

General terms open to more than one meaning	**Specific terms open to definite meaning**
— to know	— to write
— to understand	— to recite

— to appreciate — to interpret

— to enjoy — to identify

— to believe — to classify

— to have a faith in — to solve

5. One should be careful in identifying and writing the performance term. Performance terms always reflect action verb. These action verbs are open to one meaning and show the terminal behaviour. These action verbs should be identified from three different domains of educational objectives. Some examples are given below:

Cognitive	**Effective**	**Psychomotor**
define	differentiate	Adjust, built
distinguish	set apart	construct, display,
recall	formulate	dissect, focus
recognise	resist	manipulate
translate	assert	measure
deduce	applaud	organise
analyse	argument	prepare
detect		To be able to throw a ball 30 feet.
		Walk 50 metres in 10 seconds.

6. Science process skills can be used in writing instructional objectives. Instructional objectives are those objectives which teachers achieve through interaction concerning behavioural change among students. This desired behavioural change is expressed through action verb. These action verbs represent those changes which are observable or measurable. In this context science process skills are rich source of selecting appropriate action verb. Some of these science process skills are as follows :

– Observe – Identify and control variables

– Classify – Form operational definitions

– Communicate – Design and conduct experiments

– Measure – Interpret data

– Predict – Draw inferences

– Infer – Defend conclusions

7. Instructional objectives do not necessarily have to be written in the three component parts, condition, performance and criterion. It can be written in a simple form also. Such as students shall be able to recognise different parts of human heart.

Simple or Criterion Referenced Behavioural Objectives

Behavioural objectives may be either simple or criterion referenced. The difference is that a simple objective states only what the pupils will be able to do after the-'instruction, while a criterion referenced objective states not only the terminal behaviourexpected but also what standards ofperformance pupils should attain. Criterion-referenced objectives set forth at least three essentials (Callahan and Clark, 1990).

1. Some observable, and therefore measurable, behaviour that thepupils will be able to perform at the completion of instruction.
2. The standard at which the pupils are expected to perform.
3. The conditions under which the pupils are expected to perform inorder to meet the standard.

Functions of Instructional Objectives

Some of the useful functions of behavioural objectives have been as follows :

1. Behavioural objectives are useful in identifying those student behaviours which correspond to a given set of content or curriculum materials.
2. Behavioural objectives provide criteria for the selection of learning activities.
3. Behavioural objectives provide accurate means to evaluate the progress of the learner.
4. Behavioural objectives provide situations to analyse and improve learning activities.
5. The use of behavioural objectives has been helpful in developingprogrammed text material.

6. Behavioural objectives have been useful in organising contentsequentially and in the selection of instructional strategies.

7. Behavioural objectives have been an important part of lesson plan.It also helps in developing evaluation test items.

8. Behavioural objectives are useful in Computer Assisted Instruction.

9. It is possible to develop a hierarchy of behavioural objectives and test this sequence for learning (Kurtz Jr.)

10. Behavioural objectives have been helpful in the planning of instructions. These are useful in performance assessment (DeCecco) and a student can direct his own attention and efforts in a better way after knowing before hand what he must learn.

11. Behavioural objectives minimize vagueness both in teaching and learning. It gives specific direction to teaching.

12. Behavioural objectives have been used in identifying the training components.

Limitations of Behavioural Objectives

It is true that in most of the situations instructional objectives can be written in behavioural terms but in some situations it cannot fulfil therequired conditions.

Sometimes behavioural objectives hamper the range of exploration. Sometimes writing behavioural objectives delimit the freedom of teachers, their creativity and his spontaneity.

3.5 LET US SUM UP

1. Instructional objectives are precise statements of learning outcomesthat both teachers and students understand.

2. Instructional objectives are an essentials part of a lesson plan.

3. Good instructional objectives always describe a learning outcomethat states what the student should be able to do as a result ofinstruction.

4. To write behavioural objectives three conditions are necessary:

   - the behaviour (it is expressed by the use of a verb).
   - the condition (it is the situation where behaviour is expected to occur).
   - the level or degree (it is the expected level of performance).

5. Teachers should use the criteria given by Ten Brink (1982) for writing a good behavioural objectives:

   - It should be student oriented.
   - It should be descriptive of a learning outcome.
   - It shouldbe clear.
   - It should be observable.

6. Action verbs represent expected behavioural change. These verbscan be selected from cognitive, affective and psychomotordomains.

7. Instructional objectives written in behavioural terms indicate thelearning outcome that can be observed.

8. Educational objectives are the broad goals.

9. Three major domains of Educational Objectives have been cognitive, affective and psychomotor.

10. The most widely used Taxonomy of Educational Objectives have been : Taxonomy of Educational Objectives: Cognitive Domain by Benjamin S. Bloom and Associates, Taxonomy of Educational Objectives : Affective Domain by David Krathwohl and his Associates and Taxonomy of Educational Objectives : Psychomotor Domain by Kibler and Associates.

11. The affective domain includes feelings, emotions, interest and attitudes. It includes five classes: Receiving, Responding, Valuing, Organisation, Characterisation by value.

12. The psychomotor domain deals with skilled ways of moving, such as, handwriting, typing, dancing etc. It includes four classes: gross body movements, finely coordinated movements, non-verbal communication sets and speech behaviours.

13. Educational objectives are useful in developing teaching learning activities, lesson plans, curriculum development, evaluation and test development.

3.6 UNIT END EXERCISES

1. Define instructional objectives.

2. Write three conditions required for constructing behaviouralobjectives as given by Mager.

3. Write five action verbs to be used in writing behavioural objectives.

4. Write three behavioural objectives on any topic from any sciencesubject.

5. Write five functions of behavioural objectives.

6. Write an essay on specific objectives of science leaching.

7. What are instructional objectives ?Wrtie five instructional objectivesin Physics or Biology.

8. Write five differences between general and specific objectives.

9. What do you understand by educational objectives ? What is their importance?

10. Define the meaning of cognitive, effective and psychomotor domains.

11. Discuss the characteristics of cognitive domain. Give classification of cognitive domain.

12. Discuss the characteristics of affective domain. Give classification of effective domain.

13. Discuss the characteristics of psychomotor domain.

3.7 REFERENCES AND SUGGESTED READING

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3.8 ANSWERS TO CHECK YOUR PROGRESS

1. Bloom and his associates (1956) categorised educational objectives into three major areas which are known as cognitive domain (concepts, ideas, factual knowledge and intellectual skills), affective domain (appreciation, ideals, attitudes and morals), psychomotor domain (motor skills such as piano laying, basket weaving, swimming, that involve the intelligent use of motor functions).

CURRICLM

STRUCTURE

4.1 Introduction

4.2 Objectives

4.3 Meaning of Curriculum

4.4 Importance of Curriculum

4.5 Principles of Designing A Good Curriculum For Physical Science

4.6 Concentric, Topical And Integrated Approaches In Organising Curriculum For Physical Science

4.6.1 Concentric Approach

4.6.2 Topical Approach

4.6.3 Integrated Approach

4.7 Let Us Sum Up

4.8 Units End Exercises

4.9 References And Suggested Reading

4.10 Answers To Check Your Progress

4.1 INTRODUCTION

The term curriculum includes educational objectives, values, materials, students' experiences and learning outcomes. We may say that curriculum is one of the significant parameters in the process of education, representing intent and content of educational. Curriculum is an evolutionary process. It is dynamic in nature. It meets the personal and social needs of pupils. Curriculum reflects the ethos of the society and it has global perspective. It represents contemporary sociocultural, socio scientific and socioeconomic perspectives of the society with a futuristic outlook.

In last five decades we have evolved our own curriculum which provides

educational experiences to students. Many useful curricular documents have been developed from time to time to improve school education. Recently, National Curriculum Framework for School Education, 2000 has reaffirmed some of the recommendations given by the NPE 1986 and the National Curriculum for Elementary and Secondary Education : Framework, 1988.

In this chapter we will Curriculum: Meaning Importance and Principles of designing a good curriculum for physical science, concentric, topical and integrated approaches in organising curriculum for physical science Structure

4.2 OBJECTIVES

Outcomes

1. Define curriculum.
2. Discuss the process of curriculum.
3. Develop a criteria of evaluation of' curriculum.
4. Discuss some characteristics of evolving school curriculum.
5. Discuss the concept, importance and need of life skills.
6. Recall that selection of content, sequencing of content and establishing relationship between content and experience are important aspects of curriculum development.

4.3 MEANING OF CURRICULUM

Historically, the term curriculum originates from the Latin word 'Currere'. Etymologically, the term curriculum means a chariot course–a kind of route Over which the learner travels. Metaphorically speaking, the meaning of the term curriculum is explained as a seasoned traveller :the teacher helps the learner to travel over the route. Therefore, curriculum is taken as a course to be covered for reaching a certain goal.

For a long period curriculum was taken 'as a course of study'. It was also considered synonymous to the 'subjects', offered by the school. But in recent times, curriculum is taken in a writer context which includes all the activities or experiences, organised by the school, to achieve the objectives of education. These experiences are organised by the teachers for the pupils. It is now generally believed that the curriculum embodies all of the learners' experiences, organised by the school, for the physical, mental, emotional, social and spiritual development of the learner.

Some of the definitions of curriculum will prove helpful in understanding its meaning:

All the experiences that learner has undertaken in the guidance of the school (Foshay, 1969).

A curriculum is a plan for learning (Taba, 1962).

The Secondary Education Commission (1952-53) has very aptly defined curriculum as follows :

"Curriculum is the totality of experiences that pupils receive through the manifold activities that go on in the school, in the classroom, library, laboratory, workshop, playground, and numerous informal contacts between teachers and pupils."

N. S. S. E.Yearbook, Rethinking Science Education (1960) has defined curriculum as a total spectrum of content, resources, materials and methods of teaching, through which the purposes of education are achieved.

Trump and Miller (1979) has defined it in these words, "Curriculum is a vital, moving, complex interaction of pupils and things in free wheeling setting. It includes questions to debate, forces to rationalise goals to illuminate, programmes to activate and outcomes to evaluate."

Tanner and Tanner (1975) have defined curriculum as, "The planned and guided learning experiences and intended learning outcomes, formulated through,the systematic reconstruction of knowledge and experience, under the auspices of the school for the learners' continuous and wilful growth in personal social competence."

Similarly, Jenkins and Shipman (1976) has defined curriculum as follows: "A curriculum is the formulation and implementation of an educational proposal, to be taught and learned within a school or other institution and for which that institution accepts responsibility at three levels: its rationale, its actual implementation and its effects".

On the basis of above mentioned definitions or curriculum you can construct your own definition, such as.

Curriculum includes all planed learning experiences, undertaken by pupils, organised by schools, based upon the educational intended outcomes, in a particular social set up, to fulfill the personal and social growth of the learner.

Some of the essentials characteristics of school curriculum are as follows:

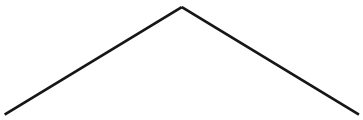
Curriculum is an essential means of education reflecting the expected learning outcomes. Curriculum is a comprehensive term which includes both the intended outcomes as well as the means used to achieve them. Curriculum is an evolutionary process. It is dynamic in nature. In essence, curriculum is a tool of educationto educate and humanize the whole man." Curriculum is basic to the intellectual, physical and emotional development of the child.

4.4 IMPORTANCE OF CURRICULUM

Curriculum helps in teaching learning process to both the teacher and students. It gives direction to all the activities in teaching learning process. Thus the curriculum is of great importance. The need of curriculum development is for teachers and students i.e.

Need of Curriculum Development

For



Teacher Students

1. **Need for Teacher:** The curriculum gives direction to all the activities of teacher. After all teacher is performer of all the activities. The need of curriculum development can be seen from following points:

(i) **Direction to work :** The teacher starts has activities from curriculum. He first understands what the curriculum is. If the teacher knows what to do, only then he will be able to proceed. He plans his activities which has been to perform during the session. Thus, the curriculum gives direction to the teacher's activities.

(ii) **Provides objectives of teaching:** The curriculum contains the objectives i.e. why we are going to teach? What should be the outcome? The objectives are the base of all the activities. The activities are designed according to the objectives formulated.

(iii) **Deciding most worthwhile:** Curriculum helps in deciding what is most worthwhile? What is the nature of thought processes? How are various thought processes and cognitive process skills related to each other?

(iv) **Selecting Methodology:** Curriculum provides guidelines for selecting the teaching methods, techniques etc. according to the requirements of students. The learning will be best if the teacher uses the appropriate methodology which suits the students most.

(v) **Provides Content:** Curriculum also contains the content and subject matter guidelines. The teacher finds himself in difficulty without content. This difficulty is overcome by the curriculum.

(vi) **Guidelines for Evaluation:** Evaluation is also an important task which is performed by the teacher. The teacher comes to know which evaluation techniques to use. The selection of appropriate evaluation techniques helps in knowing whether we have achieved the objectives or not.

(vii) **Managing time:** The curriculum provides a wholistic picture of activities of the session to the teacher. The teacher after having the picture in front of him, can plan the time to spend on each activity. Thus,the time can be managed according to the curriculum.

2. **Need for Students:** Curriculum is also needed to the students for many reasons. Students get a lot of guidelines from the curriculum. This can be seen from following points :

(i) **Objectives of learning:** The students get knowledge of objectives of learning. The clear their doubts about why they are studying iall this. Once the doubt is cleared they can concentrate on the activities of learning.

(ii) **Knowledge of Content:** The students get knowledge of all that content which they are going to learn. They have a clear picture of what they will learn during the next year in the beginning of year.

(iii) **Planning Learning Activities:** When the students know what they have to do, they can plan their learning activities. If the planning is done before hand, maximum output can be obtained.

(iv) **Integrate knowledge:** The curriculum provides a wholistic picture of all the subjects. The students can correlate content and activities of various subjects. Thus, the knowledge related to various teaching subjects can be integrated.

(v) **Maximising output:** Curriculum provides all the necessary knowledge to the

students. The students modify themselves accordingly. Thus, they work for the best. Thus curriculum helps the students in maximising their output.

4.5 PRINCIPLES OF DESIGNING A GOOD CURRICULUM FOR PHYSICAL SCIENCE

The construction and organization of curriculum in the subject science usually means the type of learning experiences to be given to the child at the various age andgrade levels for the realization of the set goals at that particular age and grade level. It is a scientific process involving basic principles on which the credibility of the curriculum rests. It will need a systematic and sequential planning so as to widen the sphere of learning experiences not each level by keeping in view the principle of integration and correlation. Some of the principles of curriculum construction or organization are:

1. **Principle of need :** A well-designed curriculum should provide appropriate opportunities for fulfilling the varied needs of the pupil like the physical, emotional and social needs. There is a need of differentiation of curriculum to suit the varying needs of pupil's e.g. different curricula for urban and rural children.

2. **Principle of Child-Centeredness :** The learning experiences organized in the form of curriculum should suit the age and mental development of the child. The intelligence and mental functioning of the children grow with their age and this is correlated to their capacity of understanding and grasping learning experience. Children will be able to learn better in which they have special taste and inclination of mind. It is also found that at different stages of age group, children have different interest patterns. The learning experiences should be designed to suit the interest and tastes of the age group of the students. Such experiences can be retained by the children for a long time.

3. **Principle of Variety :** The curriculum should be flexible enough to cater to students of different ability, aptitude and intelligence. It should be broad-based, capable of satisfying the varying interests and needs of students.

4. **Principle of Community-Centeredness :** The curriculum should determine the purpose of a society. It should be relevant to the personal needs of the student as well as to the needs of the society.

5. **Principle of Utility :** The curriculum should help the children in living a wholesome and self-fulfilling life. Itshould provide the child with sufficient opportunities for both academic and social growth so that the child can use his knowledge in his day-to-day life. The curriculum has to be a living curriculum.

6. **Principle of integration :** It should integrate the child's activities and his needs on one hand, and the needs of the twenty-first century on the other, thus making it socially relevant. It should help to tap a child's potential to the full so that he may be able to contribute to the social good and future advancement of the society.

7. **Principle of Readiness :** The curriculum should be based on sound principles of learning. The learning environment should be appropriately geared to the maturity and the degree of receptivity among the students. It should not be organized only to increase the bulk andcontent.

8. **Principle of Conservation :** The curriculum should help in preserving and spreading the traditions and culture of our nation. It should help in preserving and transmitting the traditions, standards of conduct on which the culture and civilization depend.

9. **Principle of Environmental-Centeredness :** The content of the learning experiences for children should be linked with the needs of the environment in which they live. The children of rural and urban areas can understand and grasp easily the respective information which is directly connected with their experience in their own rural and urban environment.

10. **Principle of Balancing :** While organizing a curriculum, there should be a realistic balance between :

- Objectives and content.
- Objectives and abilities.
- Objectives and learning experiences.

The content should be selected based on up to-datedness, accuracy and adequacy.

11. **Principle of Creativity :** It should place the student in place of discoverer and provision should be made for creative type of activities to harness the creativity of the students.

12. **Principle of Activity-Centeredness :** There should be emphasis on learning by

doing. Provision should be made for individual laboratory work and field experiences. Students take interest in the things and events related with the playful activities. They enjoy the activities and experiences where they find opportunity for self-doing and exploring or discovering the things with their own sense organs.

13. **Principle of correlation with other subjects :** The learning experiences in science at different levels should be essentially correlated with the learning experiences of other subjects of the school curriculum. It is because all the subjects in the curriculum are designed for the realization of the aims of education.

14. **Principle of Entertainment Value:** Curriculum, especially science curriculum should have provisions for purposeful entertainment to the students. It should include learning experiences in the form of interesting activities, scientific hobbies and useful practical work suiting the age and grade level of the students. However, realization of the set objectives should not be sacrificed for getting the mere entertainment.

15. **Principle of Scientific Attitude:** One of the major objective of science education is the development of scientific attitude. The science curriculum should foster open-mindedness, acquisition of correct knowledge, search for truth, development of problem solving skills, to give up false beliefs and superstitions, independent thinking etc.

16. **Principle of Proper Inspiration :** It must give provision to learning experiences which may prove helpful in providing due inspiration to the children. Biographies and life history of great scientists, developmental history of the scientific inventions and discoveries should find a place in science curriculum.

17. **Principle of Flexibility :** It should not be rigid but should have scope for flexibility and dynamicity. Science curriculum should be flexible enough to be redesigned and remodelled as to suit the changes in the social set up and environmental surroundings which are bound to appear with the lapse of time and other factors. The content and learning experiences related with science education need to be varied according to the variation in the physical and social environment, prevailing situations and circumstances and even the physical and mental level of the children belonging to a particular community, society or region. The learning experiences are to be enriched and updated in the light of the development and

advancement made in the field of science and technology.

According to Secondary Education Commission, the curriculum should be based upon the totality of experiences, relation to community life, variety and elasticity, training for leisure, integration and correlation etc.

The Kothari Commission gave a number of suggestions for the improvement of curriculum which are as follows :

- School curriculum should be upgraded through research and should be undertaken by University, Training colleges, Departments of Education, State Institutes of Education and Boards of School Education.
- Curriculum should be periodically revised based upon research.
- The preparation of text-books and teaching-learning material should be taken up on a large scale.
- The teachers should be oriented to the revised curriculum through the organization of orientation programmes.
- Freedom should be given to schools to devise and experiment with new curriculum suited to their needs.
- The subject Teacher's Association in different school subjects should be formed which will help to stimulate experimentation and the upgrading of curricula.
- Ordinary and advanced curricula should be introduced in a phased manner in schools keeping in mind the conditions of staff and facilities.

Check your progress

Note:

1. Discuss any two suggestions given by Kothari Commission regarding curriculum development?

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4.6 CONCENTRIC, TOPICAL AND INTEGRATED APPROACHES IN ORGANISING CURRICULUM FOR PHYSICAL SCIENCE

The organization of subject material for different classes very important problem which has a great significance in the teaching of economics. It is very important that the subject matter should be properly organised in a comprehensive way. So the following approached for organising content material in leaching of economics.

4.6.1 Concentric Approach

In concentric approach efforts are made Lo finish the whole course in a single stage and to repeat, it again and again in the next stages. The process being more detailed in the higher stages. In this approach only simple concepts are taught at first. Then complex and different concepts are introduced on later stages. The degree of difficult}' given increases in this approach. This approach is based on the psychological principles that children come to know tilings in the first instance as 'wholes' and gradually' learn to analyse them. It implies widening of knowledge just as concentric circles go on extending and widening. The subject matter of teaching of economics at each succeeding stage gradually increases in difficulty but the growing and developing child seems to be ready for comprehending each new aspect. So this method resolves, to some extent, the problem of adaptation of the teaching material to the age and understanding of the pupil. For cxp. In the first year, the review of the entire subject-matter is very sketchy. Energy subsequent year means the provision of greater detail. In the initial stages, thinking is at simpler level. As the pupil advances in age and understanding he develops his capacity of thinking in abstract terms and greater detail. The learning sequence progress from the simple to the more detailed sequence. This approach proceeds to parts from complex whole and helps the students help at every step asneeded and to creates interest in students.

Advantages of concentric approach: The main advantages of concentric approach as following :

1. **Based on psychologically thinking:** psychologically, concentric approach is sound basis for the study of the subject.It takes into consideration the mental level of the students.
2. **Based on principles of teaching :** Concentric approach is based upon the principles of teaching i.e. principle of student-centredness, principle of

community centeredness and activity centredness etc.

3. **Based on maxims of teaching :** Concentric approach is based on maxims of teaching i.e. 'simple lo complex' to proceed from 'whole to parts', 'known lo unknown' concrete to abstract and 'easy to difficult' etc.

4. **Helps the students needs :** This approach helps to the students need at every step.

5. **Creates interest :** This approach arouses interest of students in teaching of economics.

6. **Easy revision :** The revision of every new information about the subject of economics is very easy. So previous knowledge or comprehension of a topic is revised year after year, so this approach

7. **Continues study :** The whole course of the study continues for many years in this approach.

8. **Development of intellect values :** This approach development of intellect values i.e. Power of imagination, Power of thinking, and reasoning are developed to the fullest extent.

9. **Development of mental values :** This approach pays full development of mental powers of the students and mental progress of the students.

10. **Very suitable approach :** This approach is very suitable for learning of economics students.

11. **Basis for specialisation:** This approach provides basis for specialisation.

12. **Easy Path :** Concentric approach follows a very easy and simple path.

Demerits (Limitations) Concentric Approach : Some (limitations) demerits of concentric approach as following :

1. **Unpsychologically approach:** Concentric approach is unpsychologically. It is not based on child-centred. It repeats same facts again and again. It is devoid of new and psychological things.

2. **Lacks understanding:** This approach is not helpful in understanding the complex problems There are many topics in economics which require detailed study. But in concentric approach, the teacher is not able to go into details.

3. **Lack of clarified concepts :** In this approach as a result the concepts involved, are

not clarified. It leads to confusion in the minds of students.

4. **Uninteresting and difficult:** Concentric approach uninteresting and very difficult.

5. **Repetition and boredom :** This approach is based on repetition and boredom. So some facts are repeated again and again. A sense of boredom and dullness is inherent as the students go through the whole course more than one.

6. **Lacks fresheners and novelty :** Concentric method lacks novelty and freshness. It fails to arouse curiosity and sense of wonder in pupils.

7. **Short cut method :** Concentric approach is a short cut approach It is not able to cover various topics of economics in a detailed and comprehensive manner.

8. **Non availability of capable teachers:** This approach requires very able and experienced teachers which are not available easily. So very capable teachers are needed for following this approach, but capable teachers are generally not available.

Conclusion : Inspire of certain limitations or demerits, concentric approach is useful for organising the contents of economics as it is psychologically sound, based upon principles of teaching, based on maxims of teaching, motivation of students, follows a simple and mental values of students. So in this way we can increase the knowledge of students in a proper way.

4.6.2 Topical Approach

Topical approach is a system of arrangement of subject-matter than a methods of teaching. Topical approach connects the topics of teaching of economics round some topic. It implies the revolving of contents of economics around a series of topics connected together. This approach involves the breaking up of a topic into suitable portions, whereas topical method aims at keeping it intact. A topic is taken as a unified whole or as an unbreakable unit. The students tell what-ever they know about the subject matter. The student develop the topic by mutual discussion. They tell their disables also and get them removed. The other approach to this method is that a topic is selected.

Ace. to this approach the organisation of content matter is done of the basis of topics. All topics of economics fire divided class wise according to the capacities, mental abilities, needs mid interests of the students of a particular class. There topics are called,

"linked lessons". Each topic in independent in itself. So the teacher establishes links among them and teacher establishes the material in simple topics, such as distribution of materials, classification of demands, utility etc.

For exp : At the primary class those topics are taught with which they are familiar i.e. food, shelter housing, clothing, health, income. It means of transport and communication. At the middle stage, they are taught some what difficult topics from economics.

Merits or Advantages of Topical Approach

The main merits or advantages of topical approach as follows :

1. **Proper knowledge :** The students are given proper knowledge.
2. **Interest and motivation :** Topical approach arouses interest and motivation of the students.
3. **Related to life :** Topical approach is related to life because learning is related to life and our environment.
4. **Proper attention :** Topical approach continuous teaching of a topic saves the students from divided attention and proper attention of the students.
5. **Psychologically sound :** Topical method is psychologically sound because the topics are arranged according to the age, ability' needs, interests and. aptitudes of the students.
6. **Meaningful teaching :** Topical approach is a meaning full teaching. As the study of economics a sense of purpose of pupils. They and clear about what they are studying.
7. **Correlates with other subjects :** This approach is correlated with other subject. It illustrates the advantages of correlation.
8. **Purposeful teaching-learning process :** Topic wise organisation of material makes the teaching of economics more purposeful teaching learning process because every topic proceeds from easy to difficult.
9. **Easily organised:** In this approach the content matter is very easily organised according to the difficulty level of the students which is easily understood by them.
10. **Needs of the students :** This approach enabled the needs to the students.

11. **According to serial order :** This approach enables the students to understand the subject matter in a serial order.

Rational arrangement : In this approach the content matter is rational arranged ace. to the difficulty level of the students.

Limitations of Demerits of Topical approach: The topical approach of content is more useful and psychological than the concentric approach, but it also has certain demerits which are as under:

1. **Development of wrong concepts :** Many topics require detailed study. If a topic is not presented in detail. It may become difficult for the teacher to handle it which may result in developing wrong nations and concepts among pupils.
2. **Not suitable for initial stages :** This approach is not suitable for initial stage i.e. primary stage.
3. **Based on Bookish knowledge :** Topical approach is only based on bookish knowledge. It is very difficult to include various kinds of practical activities.
4. **Pre-supposes Library Facilities :** Topical approach pre-supposes library facilities.
5. **Non development of social skills :** Topical method is not so useful in developing the desired social skills.
6. **Non-availability of resourceful teachers :** Topical approach requires very competent and resourceful teachers, which are generally not available.
7. **Difficult task :** This approach is leather difficult to be adopted It is difficult to present and discuss all the topics from all the angles.
8. **Lose interest in the subject :** This approach is lose interest, in the subject matter in the subject.
9. **Not helpful in developing sense of time and space:** Topical method does not help in developing the sense of time and space.
10. **No opportunity for year to year revision :** This approach does not provide any opportunity for year to year revision
11. **Experiences teachers are not available:** This approach requires very able and experienced teacher, which are not available sufficiently.

Conclusion : We can say that, If the topics are selected wisely and the treatment sound, and based on individual differences, and based on proceeds from 'Simple to complex', the topical approach can prove very useful in all the stages.

4.6.3 Integrated Approach

This approach attempts to help pupils in obtaining a coherent view of science by establishing numerous links between the various branches of science. However, this becomes a difficult exercise to achieve when science is taught as three separate subjects like chemistry, physics and biology and also that they are taught by three separate science teachers. It is found that most of the applications of science like the motor cars, involve more than one science. In case of the motor car, it involves physics, chemistry and biology but linking these subjects by a teacher is difficulties they are taught by different teachers in the same school.

4.7 LET US SUM UP

1. Curriculum is an outline of the educational and social development of the learner. It is implemented through schools.
2. Curriculum is a dynamic and continuous process for the intellectual, physical, emotional and spiritual development of the pupils.
3. Curriculum process includes both curriculum development and its implementation.
4. Curriculum development depends on varied principles which are useful during curriculum organisation.
5. National Curriculum Framework for School Education, 2000 has laid emphasis on the following points:

(a) Integrating diverse auricular concerns.

(b) Relating Education to the world of work.

(c) Child as a constructor of knowledge.

(d) Developing emotional intelligence.

(e) Developing scientific literacy, scientific temper, and scientific attitude.

(f) Continuous and comprehensive evaluation.

(g) Education as a life long process.

(h) Selection of content, sequence of content, integration of content and experiences arc important aspects of curriculum organisation.

(i) Life skills are abilities for adaptive and positive behaviour.

4.8 UNITS END EXERCISES

1. Define curriculum in your own words.
2. Explain the process of curriculum.
3. Discuss five principles of curriculum organisation.

4.9 REFERENCES AND SUGGESTED READING

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4.10 ANSWERS TO CHECK YOUR PROGRESS

1. School curriculum should be upgraded through research and should be undertaken by University, Training colleges, Departments of Education, State Institutes of Education and Boards of School Education.

2. Curriculum should be periodically revised based upon research.

LESSON NO. 5 UNIT-II

TEXT BOOKS

STRUCTURE

5.1 Introduction

5.2 Objectives

5.3 Meaning Of Text Book

5.4 Importance Of Text Books

5.5 Role Of Textbooks

5.6 Qualities Of Good Textbooks

5.6.1 Traits Of Defective Text-books

5.6.2 Science Text-books In India

5.6.3 Analysis And Evaluation Of Science Text-book

5.6.4 Procedure Of Text-book Selection

5.7 Let Us Sum Up

5.8 Unit End Exercises

5.9 References And Suggested Reading

5.10 Answers To Check Your Progress

5.1 INTRODUCTION

"As the text-book, so the leaching and learning." But unfortunately, the text-books written at present are not up to the standard. The science text-book should aim at aiding the pupil in the development of personality, and developing open-mindedness, critical attitude inorder to enable him to discover new knowledge, to appreciate and understand nature and to mould it to one's own ends and not merely stuffing of facts.

5.2 OBJECTIVES

After going through this unit, you should be able to:

- Know the qualities of a good text book in science.
- Acquire the requisition of good text book of science.
- Understand the criteria in selecting a good textbook.
- Understand the criteria to evaluate a Science Textbook.

5.3 MEANING OF TEXT BOOK

SCIENCE TEXT BOOK

A book is one of the important aids and occupies a central and prominent place in any scheme of teaching - learning process related to the study of any subject or branches of knowledge. The quality of teaching and learning depends on the quality of text book. As it is generally said, "As the text - books, so the teaching and learning". The text books help the teachers and the taught to get acquainted with the limits and boundaries of the subject matter being taught or learning experiences to be gained with respect to a particular grade or class. They are helpful in saving the time and energy of the students as well as the teachers as they are readily available in the form of subject matter related to a particular subject and written by experienced and eminent authors. These textbooks are also helpful in maintaining the uniformity of the standard not only within the different sections of the school but also schools belonging to a region, state or country. But unfortunately, the textbooks which are written at present are not upto the standard and follow syllabi rather rigidly and units or lessons are seldom organized around pupil's interest and need. The science text book should aim at aiding the pupil in the development of personality, in developing open mindedness, critical attitude in order to enable him to discover new knowledge, to appreciate and understand nature and to mould it to ones own needs and not merely stuffing of facts.

Printed materials being essential part of science curricula play a key role in effective teaching and learning. Therefore, it is important that these text books do not prove to be mere suppliers of information and facts but also enable the student to understand, appreciate, concepts and principles and their relevance in our daily life.

5.4 IMPORTANCE OF TEXT BOOKS

A good science textbook should be in accordance with the aims and objectives of science-teaching. Some of them are as follows:-

1. A textbook serves as a guide while framing the syllabus or gets adopted and

becomes part of the syllabus. In situations and places where other educational aids are not usually accessible, textbooks are being followed unquestioningly. Textbooks hence give unity to a course.

2. Textbooks can be used to supplement or enrich the science syllabus which may have been developed by a faculty committee working in conjunction with specialists. Frequently, science teachers may use more than one science textbook for a given class. Science textbooks that supplement class instruction are usually recommended by teachers as reference or encyclopedia volumes to encourage students to seek additional information beyond that is covered in the classroom activity. The text used primarily as a reference is frequently employed by the student to look up specific information that may not have been understood in class.

3. A good science textbook should help to form correct understanding of basic concepts and principles of science.

4. It should inculcate scientific attitude in the pupils and develop open-mindedness and a cooperative attitude. It should develop an understanding about the scientific method. A child should be tempted to get into the "goods of scientific knowledge" while glancing through the book. It should open the gates of interest and develop proper attitude and love for science. It should show the pupils the method of solving a problem.

5. The science textbook should acquaint the child with the wide variety of the application of the scientific knowledge through proper exercises.

6. A science textbook should help to reinforce learning that may have originated in the classroom or laboratory, on the field trip or outside of school. Such reinforcement should come from self study and homework as well as from independent reading from supplementary books and periodicals.

7. A good textbook will have provision of homework or assignments which is used to drill or to give students practice in retaining information and being able to apply it in different situations or in solving problems. This process of reinforcing learning by reading again or by repetition of seeing or hearing experiences will become part of the pupil learning experience if it has meaning or purpose.

8. It should provide for the development of certain skills. This can be achieved if the teacher provides opportunities for pupils to handle the instruments in the

laboratory. The text books should also have adequate provision by way of exercises for the practice of the skills.

9. It should help to lead the classroom discussion to accurate conclusions. It should also give information about the past discoveries and some of the thrilling experiences made by the scientists. It should give directions for experiment and problem solving.

10. It should help the pupils for systematic and speedy revision of the lesson they have finished.

11. Science textbooks should be a source of basic information considered essential for developing the objectives of science education. This can be fulfilled if the textbook help to form correct understanding of basic concepts and principles of science.

12. New learning activities such as individual projects, laboratory experiments and demonstrations suggested in the textbook can be carried out by the students. Thus, textbooks can help the teacher to individualize instruction since they permit each student to read at his own pace of comprehension.

5.5 ROLE OF TEXTBOOKS

1. **To help to form correct understanding of basic concepts and principles of science.** Most of the books prescribed for primary, middle or even high classes simply narrate facts and if the teacher also reads such text-books word by word without introducing any type of activity in the class-room and weaving the facts in the text-books into proper concepts and principles, he is forfeiting the purpose of the text-book and is not attempting to reach the goals of education.

2. **To inculcate scientific attitude in the pupils and develop an understanding about the scientific method.** It should develop open-mindedness and a co-operative attitude. A child glancing through the book should be tempted to get into the shop of the "goods of scientific knowledge". He should be tempted to investigate the world around him. It should open the gales of interest and develop proper altitude and love for science. It should show the pupils the method of solving a problem. Every child faces a number of problems in his daily life. If the child, while in school, acquires the habit of attacking the problem in scientific way, he will face life problems with confidence Thus, the object of education to prepare the younger generation for life is automatically served. This requires previous

planning on the part of the teacher to mould the subject-matter to fit in with this technique.

3. **To acquaint with Application.** The science text-book should acquaint the child with the wide variety of the application of the scientific knowledge through proper exercises.

4. **To develop certain skills.** This can be achieved if the teacher provides opportunities for pupils to handle the instruments in the laboratory. There should also be adequate provision by way of exercises for the practice of the skills.

5. **To Supplement Experimentation.** The present science curriculum is so heavy that the pupils cannot learn everything in the laboratory through direct experience. So the text-book should supplement meagre experimentation that can be done in the class-room.

6. **To lead the classroom discussion to accurate conclusions.** It should also give information about the past discoveries and some of the thrilling experience made by the scientists. It should give directions for experiment and problem solving.

7. **To help in Revision.** It should help the pupils, for systematic and speedy revision of the lesson they have furnished.

Check your progress

Note: Write your answer in the space given below.

1. Discuss the role of textbooks?

……

……

……

5.6 QUALITIES OF GOOD TEXTBOOKS

1. **Author.** The author of the book should be experienced, efficient and expert of the subject.

2. **Style.** The book should be written in a psychological and logical style.

3. **Subject-matter.** It should be able to arouse the interest of that level of students for whom it is written. It should be able to satisfy their curiosity, help in the development of their natural inherent tendencies. The subject-matter should be

clear, well-organised and it should be written in an interesting manner.

(i) Good books are those which help in repetition of the subject-matter taught by teacher in the class by use of experiments, i demonstration and practical methods.

Unimportant lessons should not be given a place in the book. The described matter should be true and accurate.

(ii) The subject-matter should be according to the age, level and growth of students.

(iii) It should be related to life as well as with national goals.

(iv) Its matter should be inter-related. There should be a coordination between different chapters.

(v) It should be described in an interesting and psychological manner.

(vi) It should be able to make the students mentally disciplined and promote moral values.

(vii) It should be described aesthetically and should be inspirational.

(viii) It should be complete in itself and its chapters should have proper sequence.

4. Illustrations. The book should have ample and appropriate pictures, diagrams, graphs, maps, examples and these should be according to the level of the students. These should be clear and pleasing. The book should have some coloured pictures also.

5. Printing. The printing of the book should necessarily be clear and beautiful. Any printing mistake should be avoided as far as possible. The heading, sub-heading and the subject-matter should be printed in appropriate type as per the requirement.

6. Get-up. The book should look beautiful and attractive. The paper used should be of good quality and the binding should be strong. The size of book should also be appropriate. The external look and inner setting should be appropriate.

7. Cost. The book should be cost effective.

8. Contents. The book should have a table of contents in the beginning and bibliography and appendix/index at the end.

9. Questions. The questions given in the book should be scientifically true and technically accurate.

10. **Coverage.** The book must cover the complete curriculum/ syllabus. All parts of the syllabus should be explained thoroughly.

11. **Test Papers.** In the end of the book test papers and suggestions for practical work must be given.

12. **Objective.** The text-book should be in accordance with stipulated objectives of the class.

13. **Latest Knowledge.** The text-books should contain matter, related to new discoveries, inventions and changes.

14. **Proper Arrangement.** In the text-book, the arrangement of matter should be psychological and in logical sequence.

15. **Lesson Sequence.** The lessons should be based on the principle of 'easy to difficult'.

16. **Methods.** The text-book should be based on the modern and practical methods of leaching Physical Sciences.

17. **Revision.** There should be proper repetition of previous work.

18. **Practice.** There should be enough questions for practice and review exercises.

19. **Standardisation.** Those formulae, symbols, definitions and nomenclature should be used which accepted at the National and International level.

20. **Objective questions.** New type of objective questions should be given at the end of the lesson.

21. **Clues.** There should be clues for various learning activities.

22. **Reference Books.** There ought to be different books for teachers which should have innovative methods of teaching. The books for students should have ample exercises.

23. **Students Books.** They should have suggestions for plans, collection, home work, class work and other practical work. They should be readily available.

24. **Revised.** The books should, be revised from time to time and necessary changes should be made.

5.6.1 Traits of Defective Text-Books

1. Physical Sciences books cannot be used by students of all classes.

2. These text-books do not have the matter in an interesting and easy way.
3. They remain silent about new changes and discoveries.
4. There is deficiency of practice-exercises as per the level of the students.
5. They do not have indications for practical work and experiments.
6. The cost of the text-books is high.
7. The arrangement of subject-matter in psychological and logical sequence in the text-books is not taken into consideration.
8. Relevant figures, pictures and graphs are riot given.
9. The book is seldom revised after being written once.
10. There are number of printing errors in the books.

5.6.2 Science Text-Books In India

The Central Committee for Educational Literature has set up panels and Editorial Boards for 1.3 school subjects. These books are to be brought out in English and Hindi and then translated into the regional languages by the State Governments. The National Council .has also set up, under the Central Committee for Educational Literature expert panels and Editorial Boards for the production of model text-books and supplementary educational materials for schools.

NCERT has done an appreciable work during the last few years. The Biology text-book for higher secondary classes has been published in English and Hindi. The books on Physics, Chemistry and Mathematics are also available. Inexpensive Indian editions of the well tried-out books such as P.S.S.C. text-book, B.S.C.S. text-book (Yellow Version), School Mathematics Study Group text-books, etc. have also been published. These books are quite cheap as well as up-to-date and must be possessed by the teachers and the school libraries.

The text-books of Physics, Life Science and Chemistry for classesIX and X have been analysed by the Ishwarbhai Patel Committee.

5.6.3 Analysis And Evaluation Of Science Text-Book

As the teacher has to recommend the text-books to the students, care should be taken that the recommendation is based on objective analysis of books and keeping in view the principles of text-book construction. For making the rating of particular book easier and

objective, a number of score cards have been devised, two of which are reproduced here for reference.

1.	**Hunter's Score Card**		**Points**
1.	Educational rank of	...	50
2.	Mechanical make up	...	100
3.	Psychological Soundness	...	300
4.	Subject-matter	...	250
5.	Literary Style	...	110
6.	Questions for Exercises	...	140
7.	Teaching help	...	50
		Total	1,000

2. Vogel's Spot Check Evaluation Scale

Text-book...

Author...

Publisher...

Copyright year...

Price...

Score (Total...)

1. Qualifications of Author

(i)	The author has taught the subject about which he is writing	.... ( )
(ii)	The author holds advanced degrees in related fields	.... ( )
(iii)	The author has received assistance from specialist in preparing his manuscripts	.... ( )
(iv)	The author's point of view, theory, or philosophy is in harmony with that of my school	.... ( )
	Partial Score....	... ( )

2. Organisation (See table of contents, the preface, the section headings through one unit, and the end of one chapter)

(i) There is a central theme which correlates the whole textbook .... ( )

(ii) The text-books is organized into units which are based on student interest and probability of use in everyday life .... ( )

(iii) The organization makes use of topics already taught in my school .... ( )

(iv) Questions and/or problems at the end of chapter are graded explicitly in difficulty .... ( )

Patial Score... ... ( )

3. Content (See table of content, index, and five text chapters)

(I) The text-book contains all the topics necessary for my purpose. ... ( )

(ii) Material from one part of the text-books is cross-referenced with similar material in other part of the book. ... ( )

(iii) The historical development of science is given some place. ... ( )

(iv) Topics dealing with the latest advances of science such as atomic energy, are included. ... ( )

(v) The social significance of science is stressed. ... ( )

Partial Score ...

4. Presentation of material (See any five introductions to chapters)

(I) The inductive approach is used wherever possible in introducing a new topic. ... ( )

(ii) The problem-solving aspect of science method is stressed. ... ( )

(iii) The author's style is informal and interesting. ... ( )

(iv) Unfamiliar scientific terms are set in italics or bold face. ... ( )

(v) Important principles are set in italics or bold face. ... ( )

Partial Score...

5. Accuracy (Select any five topics in the index and look them up in the text)

(I) All items are on the pages indicated in the index. ... ( )

(ii) The items I looked up are scientifically correct. ... ( )

(iii) Teleological expressions are avoided. ... ( )

(iv) Personification is avoided. ... ( )

(v) No ambiguity is apparent. ... ( )

Partial Score ... ... ( )

6. Readability (See anyone text-page) ... ( )

(I) The average number of words per sentence is below 21. ... ( )

(ii) 60 per cent of the sentences are simple or compound as opposed to complex. ... ( )

(iii) There are at least four personal references per 100 words. ... ( )

(iv) There is at least one application for each abstract principle. ... ( )

(v) There are not more than 42 affixes per 100 words. ... ( )

Partial Score... ... ( )

7. Adaptability (See table of contents and any five text pages)

(I) The text-book is satisfactory for low, average and brilliant students. ...( )

(ii) Students with rural and city background will find the text useful. ...( )

(iii) The text-book is arranged so that certain sections can be readily omitted. ...( )

(iv) The authors treat controversial subjects impartially. ...( )

(v) In general the text fits my particular community need. ...( )

Partial Score... ...( )

8. Teaching Aids (See end of chapter and appendix) ...( )

(I) Summaries, questions and problems at the end of chapters are adequate. ...( )

(ii) References for teachers and students are annotated. ...( )

(iii) Appendix material is pertinent and useful. ...( )

(iv) The teachers manual is more than answer-book. ...( )

(v) An annotated up-to-date film list is provided. ...( )

Partial Score ... ...( )

9. Illustrations (See any ten illustrations) ...( )

(I) The illustrations are relatively modern. ...( )

(ii) The photographic reproductions are large and clear. ...( )

(iii) The line cuts are well-drawn and adequately labelled. ...( )

(iv) The figures are tied into the textual material by direct reference. ...( )

(v) The legends under the illustrations are useful learning devices. ...( )

Partial Score ... ...( )

10. Appearance (See cover and paper) ...( )

(I) The appearance of the cover is attractive. ...( )

(ii) The size and shape of the text-book would not be a handicap to students. ...( )

(iii) The placement of the illustrations is pleasing. ...( )

(iv) The design of most pages is open, rather than crowded. ...( )

(v) The size of the type makes for easy reading. ...( )

Partial Score ... ...( )

Note: Each item has the value of two points. The value of each item under each head is totalled against the part of score. The partial scores of each head are then counted and the overall value is written against the space provided against the score.

These score-cards are only suggestive. There is subjectivity in the evaluation of each item though the subjectivity has been minimized to some degree. Some proformae for analysing science text-books have been developed by the NCERT which should also be consulted.

5.6.4 Procedure Of Text-Book Selection

In India different states adopt different procedures for prescribing/recommending the text-books at the primary and secondary level. In some State the text-books have been nationalized up to class VIII. The State Board of Secondary Education appoints a panel of experts which write the text-books for different subjects and for different classes. In some states the books are invited from the open market. The books thus submitted are processed through the reviewers and the text-book selection committee at the State level.

The book which is considered the best is prescribed/recommended. Different States have different reviewers forms.

Reviewer's Form

The reviewers are expected to submit a composite report on each book with reference to each sub-head of .the questionnaire.

1. Syllabus

(i) Are all the instructions (in case of instructions issued) fully carried out in writing it?

(ii) Is there any omission of thing needed by the syllabus? (State please, if any).

(iii) Does the book conform to the prescribed syllabus?

(iv) Is there any departure from the syllabus? (Please note, if any).

(v) Is there anything outside the scope of prescribed syllabus? (Slate, if any)

2. Subject-matter

(i) Is equitable importance given to the different topics?

(ii) Is there any accuracy, mis-statement or misrepresentation of facts? Please not if any.

(iii) Is there anything that would offend a community or any section thereof, or any individual or individuals?

(iv) Is there anything that may be morally and politically offensive (including the things referred to (iii) and (iv) should be considered as grievous demerits of a text-book).

(v) Does the book contain any material that would be too difficultto understand for pupils for whom it is meant (If so, point out please).

3. Treatment of Subject-matter

(i) Is the subject-matter divided into suitable units and are suchunits properly organised?

(ii) Are the topics properly correlated where correlation isessential?

(iii) Does the presentation of the subject-matter keep in view the aim and the object of the curriculum and other instructions given in its behalf?

(iv) Is the subject-matter presented in a simple, effective style? Is the treatment suit to the age-level of children for whom the book is meant?

(v) Is the language simple, suitable and correct? (instances of faulty language, wrong spellings, wrong use of idioms, etc. are to be marked out and corresponding correct forms where necessary should be given in the body of the book itself).

(vi) Are there any special features worthy of notice, in regard to presentation of the subject-matter? (state in brief, if any).

4. Teaching Aids

(i) Are there sufficient exercises in the book to test the attainment of pupils and stimulate them to independent thinking?

(ii) Are the exercises of the proper type, well-graded and intelligent?

(iii) Is the book properly illustrated?

(iv) Are the pictures, portraits, etc. natural, and exact presentation of text, distinct in point and appealing to children?

(v) Are the pictures, portraits, etc., useful as teaching aids and helpfulin understanding the texts?

(vi) Are there any pictures, portraits, etc., inside the book whichno definite purpose to serve?

(vii) Are there necessary maps, charts, diagrams, etc. inside the book and are the incorporated ones correct, flawless and distinct inprint?

5. Physical Aspects (for printed books)

(i) Is the quality of the paper good?

(ii) Is the printing clear and pleasing to the sight?

(iii) Is the type head used suitable?)Pica type for all classes up to VI and small pica type for higher-classes are generally considered suitable).

(iv) Is there sufficient space between two printed lines (allowing facilities for free 'reading span').

(v) Is there sufficient marginal space on all sides of a page?

(vi) Is the binding satisfactory?

N.B.: The report on each book should be concluded with the remarks of the reviewer stating whether he selects or rejects it.In case of rejection, the reason justifying rejection should be stated in brief.

In case of selection he will certify in the following manner:

The book with the symbol No... (here state the Code No. of the book) is found suitable and stands... (here state the position of the book) in order or merit according to any impartial and unprejudiced judgement. It may be approved as a textbook if the following defects are removed... (here mention the defects).

Signature of reviewer - / with dalits

5.7 LET US SUM UP

Science Text-Books

Science text-book plays a pivotal role in educating the children. It helps in giving a correct understanding of the principles and concepts of science in developing certain skills and attitudes, in systematic and speedy revision.

Selection of text-books

The selection of science text-book will depend upon the following three factors :

1. The author, his qualifications and experience,
2. Mechanical features of the texbook.
3. The subject-matter-its nature and organisation.

5.8 UNIT END EXERCISES

1. What are the qualities of a good text book In General Science? Evaluate the text book that you might have used in the light of the criteria formulated by you.
2. What are requisites of good textbook of Physics and Chemistry? What use would you make of textbook in actual teaching?
3. How will you evaluate a textbook of science ? What are the basic principles that you will keep in view while evaluating the textbook ?
4. Comment on the quality of textbooks in science that are presently being used in schools. What improvements would you suggest in order to insure better learning by children ?

5. What points would you bear in mind while selecting a textbook in science? In the light of your points critically comment on the textbooks of your state in very specific and concrete terms.

5.9 REFERENCES AND SUGGESTED READING

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5.10 ANSWERS TO CHECK YOUR PROGRESS

1. To help to form correct understanding of basic concepts and principles of science.
2. To inculcate scientific attitude in the pupils and develop an understanding about the scientific method.
3. To acquaint with Application.
4. To develop certain skills..
5. To Supplement Experimentation.
6. To lead the classroom discussion to accurate conclusions.
7. To help in Revision.

LESSON NO. 6 UNIT-II

CO-CURRICULAR ACTIVITIES

STRUCTURE

6.1 Introduction

6.2 Objectives

6.3 Meaning and Importance of Co-curricular Activities

6.4 Principles of Good Co-curricular Programme

6.5 Guiding Principles For Organizing Activities

6.6 Some Important Co-curricular Activities

- 6.6.1 Science Clubs
- 6.6.2 National Service Scheme
- 6.6.3 National Cadet Corps
- 6.6.4 Science Students Council
- 6.6.5 The School Assembly
- 6.6.6 Field Trips
- 6.6.7 The School Magazine
- 6.6.8 The School Handbook
- 6.6.9 Athletics And Games
- 6.6.10 Boy Scouting
- 6.6.11 Girl Guides
- 6.6.12 Speech Activities

6.7 Let Us Sum Up

6.8 Unit End Exercises

6.9 References

6.10 Answers To Check Your Progress

6.1 INTRODUCTION

Co-curricular activities form a vital link in the pattern of blended educational experiences so necessary for all boys and girls in the-modern Indian School. Educative experiences comprise experiences inside as well as outside the classroom, curricular as well as extra-curricular. Co-curricular activities ensure balanced development of the child and good citizenship for the country. In fact, the distinction between the curricular and extra-curricular must cease to exist. The Education Commission also stressed: "We conceive of the school curriculum as the totality of learning experiences that the school provides for the pupils through all the manifold activities, in the school or outside, that are carried on under its supervision.

6.2 OBJECTIVES

After going through this unit, you should be able to:

- Know the meaning of co-curricular activities.
- Understand the Importance of Co-curricular activities.
- Able to organize different co-curricular activities in science.

6.3 MEANING AND IMPORTANCE OF CO-CURRICULAR ACTIVITIES

1. **Opportunities for the pursuit of established interests and the development of new interests.** The pursuit of desirable interests gives zest to life, broadens horizons, provides an excellent background for the profitable use of leisure time, and not material affects vocational choices. School clubs contribute more to the achievement of this objective than do any other types of activity. Athletics, music and school publications make substantial contribution to this function.

2. **Education of Citizenship.** Through experiences and insights that stress leadership, fellowship, co-operation and independent action. They educate for citizenship. By the social appeal of student activities, their co-operative methods, their spontaneity and their intrinsic interest, they are a social medium for the civic training of the young. Student council and school assemblies etc. make the greatest impact on the development of citizenship among the students of the school.

3. **School spirit and morale.** When students are persuaded to make sacrifices for the school, they learn to love it and take pride in its success. The need for enforcing

discipline ceases when there is an army of lovers of the school. When both students and faculty are proud of their school and enjoy working together the school has a strong instructional programme and good staff of teachers. Through inter-scholastic activities, student council and many other activities the activities programme creates a distinct school spirit and morale.

4. **Satisfaction of the gregarious urge.** These activities provide practice in right social conduct in actual social situations. Training for effective service comes to fulfilment when opportunities for service are presented in the school. They make for like-mindedness and provide opportunities for the exercise and development of aspirated corps. The individual identifies himself with the group of his own choice. He is no longer an individual but a member of the group. Through the activities like student council, clubs and societies, dramatics etc., his gregarious urge is satisfied.

5. **Moral and spiritual development.** The development of moral and spiritual values is basic to all other educational objectives. Uninspired by moral and spiritual values education is directionless. The best method of imparting moral training to the youths is to get him practice it in the actual life. "For every ounce of moral experience is worth a pound of ethical teaching." Co-curricular activities furnish innumerable opportunities for the inculcation" of moral standards and moral qualities such as honesty, truth, justice and purity. Through these, the pupils find opportunities to decide and choose the right. They learn the value of self-control and moderation. The child is brought gradually from the place where he is unable to control himself to the point where he is the master. Through the free community life of games, excursions, and the school societies an inner discipline is created which abides with the child as a directing and restraining influence when he is away from the school and ceased to be a pupil.

6. **Mental and Physical Health.** Well-conceived and supervised sports activities promote better physical health. Through provisions for a wide variety of activities in which the student has a chance to be at least moderately successful in something, be it learning to dance, writing a poem, or serving as a member of a committee etc. good mental health may be promoted.

7. **Well-rounded social development.** In a wide variety of social settings the pupils can be taught how to act properly. They can be instructed about the accepted procedure at a dance. They may beinstructed how to participate effectively in a

group discuss. They may be instructed how to use approved table etiquettes. All these make for well-rounded social development of students.

8. **Widening students contacts.** As individuals move toward maturity their horizons become more comprehensive. They broaden their contacts with people and learn new ideas and ways of doing things. They become concerned about new issues and problems. These co-curricular activities can help in this process of maturing through sports, trips, excursions etc.

9. **Opportunities to exercise creative capacities.** These activities provide opportunities for novel pupil expressions. Writing an editorial for the school, magazine, painting a mural, developing plans in the student council to improve the functioning of the school-all these demand the utilization of creative power and provide a chance to develop creative abilities.

10. **Improvement of curriculum.** The co-curricular activities supplement and enrich class-room experiences. Pupils are stimulated by certain class-room experiences and may form clubs to explore certain area still further. Dramatics, music and citizenship activities stem from stimulating class-room experiences.

11. **New learning experiences.** Learning experiences stemming from class-room activities, if found valuable in co-curriculum, can be made a part of the curriculum. A number of recognized class-room experiences e.g. music, intramural sports etc. serve their apprenticeship in the activities programme.

12. **Individual and group guidance.** With the help of the varied activities, the latest potentialities of the pupils can come to the surface and educational and vocational guidance can be given. Guidance is inherent in all of the co-curricular activities.

13. **Class-room instruction.** External stimulation is needed to insure that a student is learning best at his level of capability. Many a boy has been kept in school because of his interest in sports; Many pupils have become better oriented through school assembly: Interest in club activities has frequently generated greater in class work; interest.

14. **Effective school administration.** The co-curricular activities foster more effective work between students, faculty and administrative and supervisory personnel. Team work is essential for the smooth functioning of the various organs of the school. Teachers expect cooperation in the classroom. The student expects

his teachers to be interested in the things which interest him such as sports, plays and other similar activities. These activities provide opportunities for more personal and friendly relations between the students and the faculty. Through the student council, students help in the determination of school policies and in seeking the solution to some of the perplexing problems facing the school.

15. **Utilization of spare time.** Many students have one or more hours of leisure time at the end of the school day. Informal intramural activities, marching band rehearsals and play practices during these periods help in the proper utilization of the spare time. Thus, leisure can be converted from a curse into blessing.

16. **Teachers to understand the pupils better.** By studying their behaviour in play and other social activities of their own choosing teacher can get a more complete idea of his students. He may find a "dud" in his History class, having the thrill of his life as he plays a match or runs a race. He may see some of his shy pupils behaving in an unrestrained manner in groups of their associates. By standing around and listening, by going on trips with groups of students, or by becoming a fellow worker in any of these shared experiences. He may learn what students really think about their school experiences.

17. **Promotion of community relations.** The school and the community can be drawn closer together when the pupils go out on excursions and camps, the schools arrange debates, declamation and music concerts, citizens are invited; and the schools hold hobby fairs in which students, faculty and town people participate.

18. **Greater community interest in school.** When parents and other members of a community are well-informed about their school and have participated in some of its activities, their interest and cooperation increases. They may be motivated to improve the schools with the facilities at their disposal.

6.4 PRINCIPLES OF GOOD CO-CURRICULAR PROGRAMME

1. **Democracy of opportunity.** An opportunity for all to think and act without fear of ridicule, is to be provided with the belief that every individual, can make at least some contribution to the common welfare and to his own happiness.

2. **Diversity.** For this will help satisfying the diverse needs of the large number of students in a school. The number of such activities should be the maximum that a school can afford, and they should be as varied as possible.

3. **Few restrictions.** All interested students should be permitted to participate in different activities. The nature of the activity may make some restrictions necessary, which should be held to a minimum.

4. **Wide distribution of participation.** This will be possible through personal conference and group discussion.

5. **Accounting for special needs.** No two schools are ever exactly alike. The programme of each must be adjusted to the particular need of its own students. The needs of young people in a rural community will differ from those who live in a wealthy urban area. Even though clubs and assemblies are common place, the learning experiences made available through these activities should vary from school to school.

6. **Motivation for class instruction.** By using problems involving pitching averages in base ball or foul shooting in basket ball. Bearing to do percentage problems, in a mathematics class may be strongly motivated for some pupils.

6.5 GUIDING PRINCIPLES FOR ORGANIZING ACTIVITIES

French et al have suggested the following principles for organizing and administering co-curricular activities.

1. The justification for each activity must lie in the contribution it can make to the learning and development of youth. They shouldnot be used to publicize the school or glorify the principal.

2. The activity programme for each school should grow out of the life of that school and be adopted to the local situation.

3. To be vital, the student activity programme must be dynamic. When interest in any activity shows signs of waning, it should be discontinued.

4. Participation in student activities should be equally available to all students with restrictions related only to competency and interest in the given activity.

5. Student's activities should be a recognized responsibility school and as such should be planned and supervised.

6. There should be a continuous interpretation to the public of the activity programme. Many a time such activities are adversely criticized and therefore, the community should know the significance and importance of various activities in

the programme of education.

Check your progress

Note: Write your answers in the space given below.

1. What is the meaning and importance of co-curricular activities in curriculum?

……
……
……
……

2. Discuss the principles for organizing co-curricular activities?

……
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.....

6.6 SOME IMPORTANT CO-CURRICULAR ACTIVITIES

1. **Physical:** (i) Athletic, (ii) Games, (iii) Sports and mass exercises,(iv) Mass Drill, (v) Driving, Cycling, (vii) Boating, (viii) Swimming.
2. **Literary and Academic:** (i) School Publication, (ii) Dramatics, (iii) Debates and Discussions, (iv) Scientific and other club, (v) Symposiums, (vi) Brains Twist, (vii) Story and Essay writing.
3. **Social Service :** (i) Junior Red Cross, (ii) Social Educational, (iii) Labour Squads, (iv) Service on special occasions like fairs, (v) Scouting (vi) Girl Guiding, (vii) Helping Health authorities in the control of epidemics.
4. **Civic Training :** (i) Student co-operative, (ii) Student Council, (iii) School Bank, (iv) Visit to civic institutions, the legislature, court, etc. (v) School Panchayat, (vi) Assembly, (vii) Mock parliament, (viii) Celebrating festivals.
5. **Hobbies, Creative and Collective:** (i) Gardening, (ii) Collection of stamps, leaves, pictures, coins, stone, fossils, (iii) Soap making, (iv) Photography, (v) Pen friendship, (vi) Wood work, (vii) Metal work, (viii) Toy making, (ix) Clay-work, (x) Leather work, (xi) Cardboard work, (xii) Smithy, (xiii) Book- binding, (xiv) Basket making, (xv) Tailoring and knitting, (xvi) Spinning and weaving.

6. **Cultural Activities:** (i) Drawing, (ii) Painting, (iii) Music, (iv) Band, (v) Sculpture, (vi) Folk songs, (vii) Dancing, (viii) Dramatics, (ix) Community Activities.

6.6.1 Science Clubs

Science clubs are the important pan of science teaching. It provides the bases for "learning by doing" in science teaching. Present curricula docs no, provide opportunities to students for self-expressions and development. Science clubs provide his facility for the development of the personality These help in channelize thinking and stability of emotion. It helps in satisfying the instincts. Science club supplements the classroom work and laboratory.

Need and Importance of Science Club

1. **Educational value:** Science clubs help the pupils to know the facts and principles of science through various activities. It provides the scientific knowledge and knowledge of surroundings. It encourages scientific hobbies and projects of their interests. It provides knowledge of open mindedness and scientific method. It also include project work for inculcating scientific altitude. It also helps in inculcating scientific values like truthfulness. Aesthetic sense etc.

2. **Develop values in life:** Science clubs by different project work develop various values in life. Child develop moral values like love for nature, respect and belongingness in it. Science club also helps to develop the aesthetic sense among students. Pupils learn to do the experiment by them self truthfully. The also attain the sense of dignity of labour. It helps in inculcating social values among the students.

3. **Opportunity for Self-Expressions:** Science club provide opportunity to every student for their self-expression. Pupils can use their various skills and talent in different activities or in project work. Boys can develop manual skill and can channelize their interest. The students having different talent can use it in science-club.

4. **Dignity of Labour :** Science club make every student efficient in doing work As it develop interest in work it teaches the lesson of dignity of the students as every work has its own importance. Students do the things by themselves. It makes each student at work.

5. **Feeling of Cooperation:** Each and every student work together in science club. In arrangements and organization of activities the students play main role. As they work together this develop cooperation and feeling of belongingness among them.

6. **Adjustment:** Students work together for organize the science activities like science fair exhibitions, etc. They learn to adjust in social environment with cooperation.

Types of Science Club

1. **The specialized Interest Club:** Include: Radio club, Photographic club, Aviation Club, Agricultural club, Astronomical club, nature study club.

2. **The General Type Club:** It include science club Chemical Society, Physics Association, Biological club.

Factors Governing the Success of Science Club

Success of science club depends upon :

1. **Science teacher:** It is very important factor. Success or failure ofthe programmedepends upon his enthusiasm and resourcefulness. Every activity is organized under his supervision. If the science teacher is energetic all the activities of the clubs go smoothly. He guides the students at every step.

2. **Accommodation:** It is very important factor for those clubs that need space such as radio club, or photographic club for the placement fillings. Other clubs such as general club which provide activities like excursions and tours etc. do not need space. Museum and maintenance of aquarium and vivarium need adequate space.

3. **Equipment:** Equipment's are improvised in the science club as an activity. Necessary tools are required for preparing soaps, inks, chemicals. cosmetics etc. It become interesting in science club.

4. **Proper Guidance:** Guidance should be provided to science teacher and students. They should know objectives and organization of the science club.

Objectives of Science Club

1. To develop the interest in scientific hobbies like preparation of soaps, inks, cosmetics etc.

2. To develop scientific attitude among students and train them in scientific method.

3. To develop the habit of exploration and creativity.

4. To develop critical thinking among students.

5. To widen the outlook of the students and enable them to apply their knowledge in different life situations.

6. To provide the recent knowledge to the students.

7. To develop the sense of healthy competition among students.

8. To make the student science-minded and develop the power Of observation.

Organisation of Science Club

Science club constitute the following members for its organisation-

I. **Patron:** It is the Head of the Institution who can become the patron of the science club. As science club is a sort of constitution and members have to abide by it. Patron provides facilities and cooperation lo the club.

2. **Sponsor:** The teacher-in-charge should be the sponsor. He act as adviser and help in the activities. He guides the members of the club. He should be intellectually mature person and well educated.

3. **Executive Body:** These include chairman, secretary assistant secretary, treasurer, librarian, store-keeper, publicity officer and class representative. These are elected from among the students.

(a) **Chair person:** He preside over all the functions of the clubs and meetings of the committee.

(b) **Secretary:** He is to maintain the record of all activities of the club and carries out correspondence to invite guests.

(c) **Assistant secretary:** To help the secretary and to act for him in his absence.

(d) **Treasurer:** To keep all accounts maintained of expenditure and receipts.

(e) **Librarian:** To maintain a catalogue of the library', to issue and receive books.

(f) **Store-keeper:** To maintain a record of equipments of the club, lo buy new equipments.

(g) **Publicity officer:** Publicizes the activities of the club through newspaper,

meetings, exhibitions etc.

4. **Members:** All students of the science are the members of the club. But it should not be imposed. It should be open to all school students. Normal fee may be charged from each member.

Activities of the Club

1. Holding discussions, debates, meetings, declamations paper reading contests etc.
2. Arranging tours and excursions lo visit scientific places.
3. Improving hand made apparatus.
4. Holding exhibitions and fairs.
5. Collecting specimens for museum.
6. Preparation of ink, cream, soap, boot-polish etc.
7. Drawing of charts, pictures and models etc.
8. Arranging extension lectures of persons.
9. Celebrating science days.
10. Arranging seminars and workshops.

A. Science Club Constitution

Article 1. Name:

Section 1: This club shall be known as the.....

Article 2. Aims:

Section 1: The aims of the club will be.....

(a) To develop the scientific altitude among students.

(b) To increase our knowledge about science.

(c) To understand the importance of science in life.

(d) To learn various skills of science,

(e) To popularize science in community.

(f) To help carry out the programme of the club.

Article 3: Membership and Fees:

Section 1: Any boy or girl interested in the club shall be eligible for the membership.

Section 2: Application of membership must be hand written to the secretary of the club.

Section 3: Any individual satisfying the eligibility requirements may become a member.

Section 4: Members must attend the meeting regularly, three absence without reason will be considered for dismissal.

Section 5: At the beginning of the school year, membership shall be revised to include only active members.

Section 6: Membership fee of Rs.....shall be paid annually in the beginning of the school year.

Section 7: All expenditures must receive approval of the members of the club.

Article 4: Officers :

Section I: The officers of the club shall be as follows:

President, Vice-president, Secretary, Treasurer, Librarian, Reporter.

Section 2: The election of officers shall be by majority vote.

Section 3: Officers may resign by giving written notice to secretary

Section 4: Elections may held whenever office is declared vacant.

Section 5: The duties of the above mentioned officers shall beperformed by the officers.

Section 6: Any member can be removed due to in efficiency of work

Article 5: Meeting :

Section 1: Regular meetings shall be used on the day of each week during the school session.

Section 2: Special meetings may be called by president at any time

Section 3: Programme for each meeting shall be planned by the officers of the club.

6.6.2 National Service Scheme

According to a report of the department of Youth Affairs and Sports of the Human Resource Development Ministry, 1991-92 than a year of insulation with Indian youth to harness youth energy for nation-building activities. In sports our endeavor has been to achieve the twin goals of sports for all and excellence in performance. A national conference of youth leaders held in May 1990 recommended the establishment of Youth Council with the Prime Minister as chairman. A comprehensive new national policy on youth was drafted.

1. **The NSS Scheme:** Under the National Service Scheme (NSS), community development is carried out by university and college students in adopted villages. The students also participate in the efforts of the Government in the National Literary Mission.

2. **Nehru Yuvak Kendra:** The involvement of non-student youth in nation-building is promoted through the Nehru Yuvak Kendra (NYK). The report says that the NYK programme is being revamped and structured. A committee of Secretaries has recommended evaluation of the NYK programmes through the evaluation cell of the Planning Commission. It will go into the recruitment of the staff of NYKs with a view to spring up and restructuring the NYK. A new scheme for promotion of youth activities among backward tribes was launched during the year and an amount of Rs. 75 lakh was spent through Stale Government agencies and voluntary Organizations.

3. **National Integration Camps :** The Department of Youth Affairs and sports continued its efforts through national integration camps, festivals for university students, adventure programmes and exhibitions for youth. Integrated development of some areas of wasteland is being undertaken in selected districts in many states. In some districts kuchcha houses and houses of baked- bricks have been built for the homeless and the destitutes.

4. **Self-Employment:** Vocational training is also provided to young men and women to prepare them for taking up self-employment. The scheme for training youth, started in 1986-87, covers courses based on local needed and talents. The subjects of training relate to agricultural technology, crops, animal husbandry, dairy, poultry, bee-keeping pisciculture, puppetry, plumbing, pipe fitting, pump-set

repair, manufacture of agarbatti, health education, management at local level, and scientific methods of using smokeless chuhlas and bogies plants. The scheme is being implemented through agencies like R.K. Mission, Narendrapur, in West Bengal, educational institutions like the Allahabad. Agricultural Institute and over voluntary organizations. In 1990- 91, about 42000 youth were given vocational training.

5. **Voluntary Organizations:** The report acknowledges the good work done by some of the voluntary organizations by making a mention of their services in training youth. The organizations with the number of youth training by them are :BanwasiSeva Ashram, Govindpur, U.P, (60), Konkani KrishiVidyapith, Dapoli (150), MahilaJagritiAbhiyan Public Charitable Trust, Ahmedabad (50), R.K. Mission Lokshiksha Parishad, Narendrapur, West Bengal (525), Antar Bharati Mappilai, Madurai (685), Arvind Bharati VidyalayaSamiti, Jaipur (100) and Literacy House, Lucknow, U.P. (180).

The government provides assistance to voluntary organizations /or undertaking one activity or the other.

6.6.3 National Cadet Corps

The National Cadet Corps Directorate is a part of the Ministry of Defence. It has the following objectives:

(i) To develop character, comradeship, the ideal of service and capacity for leadership in the young men and women.

(ii) To provide service training to young men and women so as to stimulate interest in the defence of the country.

(iii) To build up a reserve of the potential officers to enable the Armed Forces to expand rapidly in a national emergency.

The Secondary Education Commission suggested the recruitment and the training for the N.C.C. should be brought under the Government of India with responsibility for its proper maintenance, improvement and expansion. The State should cooperate fully in the furtherance of this movement. The membership of N.C.C. is entirely voluntary and there is no liability for military service. It undertakes the training of the youth between the ages of 13 and 26. Free training is imparted to the cadets. Free uniforms are issued to them and

all expenses on account of messing and amenities for them during their camps are met by the State Governments. During special parades, some refreshment is also given to them.

The National Cadet Corps has three divisions:

(i) **Junior Division:** This unit is raised in the High School and the Public Schools. It comprises three units -Army, Navy and Air Force.

(ii) **Senior Divisions:** This unit is raised in the colleges. It also consists of three wings- the Army, the Navy and the Air Force.

(iii) **Girls Division :** This unit is gradually becoming popular.

6.6.4 Science Students Council

Reasons For Council

(i) A feeling of urgency to make democracy function as it should in view of increasing world tension;

(ii) A realization of the fact that intelligent participation in democratic action must be learned.

(iii) An increasing faith in the contributions that young people can make to democratic thought and action.

Specific Objectives

(i) To allow pupils to participate in or manage co-curricular affairs.

(ii) To develop student responsibility, initiative, leadership and school pride.

(iii) To promote the welfare of the school through proper student faculty relationships.

(iv) To promote citizenship training.

(v) To promote general welfare.

(vi) To aid in the internal administration of the school,

(vii) To provide for pupil expression,

(viii) To furnish a working model of government.

Guiding Principles

(I) **Desired by the School:** The students, teachers and administrators should believe in a council and what it can achieve. At no time should the organisation of the

council be hurried. It should be introduced in response to a felt-need of the school citizens.

(ii) The entire school should be represented.

(iii) Representation: The work of the school council should be so conducted that each member of the school community may feel that he is represented. Each individual should have the opportunity to suggest problems and projects for council consideration, to assist with the determination of policies and activities, to vote for certain council officers, and to otherwise participate in the work of the council.

(iv) Gradual: A council should be begun gradually. Even after there is an evident desire for a council, the succeeding steps should be taken slowly to insure that everybody understands and approves of them. It is better to sacrifice speed for firmness of foundation; particularly at a time when a new council is in the process of being born.

(v) Simplicity: The organisation of the Council should be kept simple. The organisational plan should be adopted to the conditions existing in a particular school. Plans borrowed from other schools seldom fit local needs.

(vi) Clarity: The duties and responsibilities of the council must be clear, specific and understood by all. A clearly written statement should be developed about the obligations and policies of the council to leave no scope for any estrangement on any side.

(vii) Authority: Sufficient authority should be granted to the council to formulate rules and regulations governing the chartering and supervision of other co-curricular activities: One of the major responsibilities of the council should be that of general supervision and coordination of the entire co-curricular programme. It would include : (a) Forming clubs (b) Recommending the elimination of activities that have outlived their usefulness, (c) Suggesting modification of any activities that seem to be ineffective, (d) Assisting with the establishment and co-ordination of the financial structure of the curricular activities and (e) Helping to determine and administer school policies for the co-curricular field.

(viii) Constructive programme of activities: The council should concentrate on constructive projects designed to improve the school. Council programmes should be challenging to students and result in successful achievement.

(ix) **Supervision Council activities must be supervised:** The co-curricular programme is a part of the total instructional programme of the school. The council is primarily an organisation in which learning takes place through the planning and completion of projects. An adviser should be present at all council meetings to serve as a consultant or guide.

The Organisation

School councils are composed of members elected by different houses, classes and clubs. The council should be representative in scope. It should be thoroughly democratic in its method of election. It should be the voice of all the people. It should be the legislative branch of total school Government in which all school citizens participate actively. The council should have powers and privileges. Its limitations should be defined as clearly as its powers and privileges. Each school should evolve the constitution of its own council. Limitations of jurisdictions should be carefully states in the constitution and not continually used as a threat by faculty. The veto power should be seldom used and never emphasised. Regular and adequate time should be provided during the school days for elections, discussions, reporting and evaluation. The organisation plan should be simple and* workable. It should be developed and conducted on a basis of clearly defined constitutional areas of responsibility.

Election of Members

In some schools, there is the practice of representation by clubs. In others grade level of school class is the basis. There are the automatic, the exofficio council plans under which the class officersor the school administrative officers or the honorary society, are the members of school's student council. Provision should be made for representation of the faculty and other adult citizens of the schools.

Activities of the Council

(i) Co-curricular regulatory activities.

(ii) Assembly activities.

(iii) Orientation of new students.

(iv) Recreational activities.

(v) Welfare activities.

(vi) Income producing activities.

6.6.5 The School Assembly

The school assembly can serve as the focussing centre of all forms of co-curricular life of a school.

Objectives

(i) **To unify school:** The assembly affords an opportunity for the entire school personnel to work, think and even plan together as a unit. The members of the school family need to stand and appreciate those with whom they come in contact in the school. By working together as a unit, each feels that there is a common bond.

(ii) **To interpret the work of the school:** One of the most important talks of the assembly programmes is to share what is going on in the school both in and out of the class-room. Every departmental should be urged to assume responsibility for at least one assembly each year to stimulate new interests, suggest vocational choice and improve the activities themselves by spotlighting them on assembly programmes.

(iii) **To develop desirable attitudes and appreciations:** Through assemblies such desirable attitudes may be strengthened as respect for property, consideration for people of all religions and races, responsibility for one's actions, obedience to constituted authority and a willingness and ability to co- operate. Appreciations are best developed by frequent exposure to activities in a setting to which the learner reacts with some favourable emotional responses. Students can be stimulated to do their best in studies also.

(iv) **To assist in the selection of a vocation:** Assembly programmes can assist the student as he chooses a vocation. Activities such as lectures by successful individuals, a dramatic description by thecommercial department of the vocational requirements of workers in the field, carefully selected motion pictures etc. can prove quite useful.

(v) **To develop a better understanding of critical issues and problems in our contemporary culture:** In order to enable the youth of today to adjust to the mores of his environment, he must be informed about religion and politics, social and economic set- up, service in the armed forces. School assembly is a good forum for

the purpose.

(vi) **To furnish opportunities to appear before an audience:** The school assembly may well serve as a laboratory for learning how to become an effective leader. Participation in plays, reciting a song, making a speech all help to "break the ice" and give assurance and competence to the participants.

(vii) **To learn more about the community and how it functions:** Members of the community can be invited to participate in the life of the school . The school can emerge from its "ivory tower."

(viii) **The recognise superior achievement:** The assembly can be utilised to give public recognition to superior achievement such as athletic prowess, special music talent, high scholastic attainment, superior citizenship, commendable honesty.

(ix) **To encourage the development of good audience behaviour:** Good audience behaviour is essential for good citizenship. A lot of time and intelligent supervision will enable us to achieve the goal.

(x) **To furnish wholesome entertainment as well as to educate:** There can be assembly programmes which have entertainment as well as educational value.

(xi) **To provide an opportunity to present certain administrative problems and to seek solutions of them:** The principal may well point out certain undesirable acts leading to undesirable consequences. He might as well suggest some desirable courses of action. He can stress how one could co-operate to make their school a better school avoiding criticism of overt acts.

Guidelines for Making Assembly Programmes

(i) Every pupil and teacher should actively participate in at least one assembly programme each year.

(ii) Assemblies should include a wide variety of activities.

(iii) Important speakers and entertainers should be invited to participate in assembly programme.

(iv) Programmes should be well-planned and should be conducted by both teachers and students.

(v) If the problem of the Assembly is to the "Clearing House" of the school corporate

life, careful preparation is very necessary. Programmes should be reviewed and rehearsed before they are actually staged.

(vi) Reasonable order must be maintained.

(vii) Assembly programmes must be supervised.

(viii) Programmes should be evaluated.

(ix) Class assemblies should not take more time than that allotted to a regular class period.

(x) Assembly programmes should be regularly scheduled at the same time of day and on the same day of each week.

(xi) Meetings of the assembly should be held frequently. One good programme a week is better than daily routine affairs consisting of formal talks and necessary announcements.

(xii) School assemblies should be open to all students.

(xiii) Reprimanding or pious sermonising and heavy subjects should be avoided. Talks in the assemblies should be interesting,instructive and inspiring.

Duties of the Principal

(i) He must understand what specific contributions the school assembly can make to the total educational programme of his school.

(ii) He should see that effective student and faculty leadership are selected.

(iii) He should assist in the determination of policies governing school assemblies and should approve all those policies that are consistent with the general policies of the school system.

(iv) He should delegate authority commensurate with responsibility to those selected to implement all approved policies and should back Up those in charge.

(v) He should see that sufficient time for school assemblies is located within the school day.

(vi) He should do everything within his power to guarantee that the maximum potential of school assemblies is reached in his school.

(vii) He should not point out the faults and shortcomings of the pupils frequently at the

school assemblies.

6.6.6 Field Trips

The school excursion may be so simple as the first trip of the five year old to explore the school plant or so ambitious as the week's visit to the nation's capital taken by the senior high school class.

While things which can be learnt best in school should be learnt there, things which can be learnt best outdoors should be learnt out-doors. These range from the discovery of the smallest forms of life to a study of heavenly bodies; from an enjoyment of constructive purposeful work to interest in natural beauty; from having fun 'to' learning how to work together.

Objectives of Excursions

(i) To capitalize educationally the migratory instinct of the child.

The school excursion properly initiated, organized, conducted, completed and evaluated represents an excellent capitalization of his migratory urge.

(ii) To acquaint the pupil with his environment: When the pupil visits a fir department, court or council in session, post office, historical monuments, he acquires information correlated with the idea or relationship that is being presented in his school work.

(iii) To interpret, supplement and enrich curricular experiences:

Excursions may be undertaken for securing information, changing attitudes, awakening interests, developing appreciations, promoting ideals, enjoying new experiences. They can initiate a unit of study. They are a very good means of getting knowledge first hand, of confirming and supplementing second-hand knowledge.

Types of Excursions

1. Some complex undertaking requiring elaborate transportation, full day planning and additional adult helpers. These longer journeys/trips to historical sites and special events beyond the local community offer valuable opportunities for observation of the environment along the way.
2. Some trips are shorter and more easily planned as visits to factories, radio stations,

newspaper plants, wholesale and retail establishments, libraries and the like.

3. Still others are simple to undertake and may be embarked on almost at the moment of conceiving the idea-the walk around the block to see nature and man getting ready for winter, the journey to the neighboring farm, the walk through the park to gather some needed specimens.

Planning

Before an excursion is actually taken up, every pupil as well asthe teacher, should be fully aware of just why this particular trip isbeing planned and if it is related to his own classroom experiencesand activities. Children also need to be directed while they areobserving. It is always advisable to test the success of the observationswhile they are still being made. The teacher and pupils may togetherwork out the details and handle the event. A committee may beformed to gather material, formulate questions, and increase the interestof the group, not merely in seeing, but in seeing the 'how' and 'why' of the thing. The teacher should only be a guide. A few sub-committeesmay be appointed by the teacher or selected by the pupils.

Evaluations

Excursions should be evaluated in terms of the originally established purposes, mistakes and difficulties should be diagnosed, conduct of the group should be discussed, letters of thanks should be written to the persons concerned and highlights of the trip should be recorded in some permanent form future use.

6.6.7 The School Magazine

Objectives

1. To unify the school spirit.
2. To mould and influence school opinion.
3. To encourage desirable school activities and enterprises.
4. To give authentic information regarding the school to students, parents, patrons, old students and other schools.
5. To serve as a medium of expression of student opinion.
6. To provide opportunity for creative work and self-expression.
7. Qualities of co-operation, tact, accuracy, tolerance, responsibility, initiative,

leadership and cordial relations among different schools.

8. To record the history of the school and help to advertise the institutions.

Magazine production is a laboratory experience in creative journalism. The very existence of a good magazine in the school will prove a spur to creative efforts of students in all fields.

The magazine should reflect the best work, students can produce; but what is "best" should be subject to constant scrutiny in terms of the interests of the readers. This means continuous exploration of the interests of the reader and planning of future issues in accordance with the findings of such evaluation.

The interest of the student will -be increased. The magazine will convey a monthly message home. In this way, it can prove very helpful to the pupils, parents and the school.

6.6.8 The School Handbook

Every high and higher secondary school must have a hand-book to orientate the newcomer about the school. The following information may be included in the school handbook.

1. A picture of the school
2. Brief history of the school
3. Location of the school and how to reach it
4 Plan of the building showing various facilities.
5. Names and assignments of the staff.
6. School mottos, emblems and songs.
7. Subject offerings.
8. Rules of attendance, classification, promotion etc.
9. Calendar of the school year.
10. Examinations.
11. Progress reports.
12. Time-table.
13. School celebrations.

14. Clubs and society with rules and regulations.
15. Medical and Health Services.
16. School Guidance Service.
17. School uniform.
18. Stipend and scholarships.
19. Alumni Association.
20. Home work.
21. School canteen.
22. Manners and courtesy.
23. P.T.A
24. Fees and other costs. UN
25. School publications.
26. Student council.
27. Awards and prizes.

6.6.9 Athletics And Games

Objectives

1. Young people in their adolescence possess an exuberance of energy which if not properly utilised, often leads their over- stepping the bounds of reason and control. Physical exercise provides a healthy outlet for surplus energy.
2. It secures organic development to the limit of inherited possibilities and makes for feeling of well-being.
3. It also promotes the development of that control of the muscular system which gives skill, resourcefulness and fundamental basis for a broad manual.
4. It provides an opportunity for securing mental and moral discipline-the alertness, precision, determination, self-control, courage, team work, self-denial, loyalty, leadership and sportsman-tike magnanimity.

Organisation and Supervision

The teaching staff should control such things as time and places for training,

competitive games with outside teams, the method of raising and spending money and the making of such rules as well prohibit those who are negligent in their school from playing in the several teams. But this guidance should not be over-done.

Following points may be noted to make the athletic programmeeffective:- ,

1. It should be a well co-ordinated part of secondary school curriculum.
2. It should be based on the spirit of amateurism.
3. Opportunities should be provided for many students to participate in a wide variety of sports in every sport season.
4. Training in conduct, game ethics and sportsmanship should given for participants.
5. It should include a well-balanced programme of intra-mural sports.
6. All athletic competitions should grow out of and form an integral part of the physical and health education programme of the school.
7. Proper facilities should be provided for the girls.

6.6.10 Boy Scouting

Objectives

1. To teach youth to be good by given them lessons in doing good.
2. To give the boys a useful and enjoyable time in the open air,outside school hours.
3. To train them in habits of self-control, self-help, self- reliance and self-sacrifice.
4. To help them towards character-building, with a view to making them better men and citizens, not only of their motherland but of the whole world.
5. To create a healthy environment through clubs, camps and sports where boys learn to play the games for the team, where they are trained in social service and civic sense and are definitely encouraged to live purer, nobler and healthier lives.
6. To develop in boys honour, loyalty, obedience, resourcefulness and a desire to serve.
7. To train them to accept responsibility not only for the assigned tasks but also for the unexpected emergency.

Although Scouting is not a subject for examination, it must receive adequate encouragement. The scout-master should be a real leader, with plenty of energy and

cheerfulness, ripe knowledge and wide experience of the world, and capacity to organise, instruct and inspire the young people placed in his charge. He should give practical training in scout games and handicrafts that are appealing and useful to pupils. He should live up the scout law himself. He should guide and inspire his followers. The training must be extended to two or three years.

6.6.11 Girl Guides

Objective

1. To teach her through play the elements of home making, 01 building a strong body and of becoming a good citizen.
2. To train healthy, cheerful, serviceable and good.
3. To open up great opportunities for the development of character and the encouragement of social service.
4. To promote proper use of leisure.

Organization

This movement has three branches : The Blue-Bird Flock for girls below 1.1. Girl Guides Company for those from 11 to 16, and Ranger Company for Girls 16 years. old or over.

6.6.12 Speech Activities

1. **Debates:** Debates have important educational values. They emphasise clear, forceful and persuasive delivery, the ability to analyse the facts which bear upon an issue and to organise those facts into well-organized and convincing whole. The topics for debates should be chosen from the present real life of the students, problems of national and international importance. Opportunities for public speaking should be given to as many students as possible.
2. **Dramatization:** Dramatization has a universal appeal to old and young alike. The fascination is of universal human appeal, whether it be playing apart oneself or seeing some phase of life made real as the characters materialise before our eyes. This characteristic attitude of youth has not been sufficiently capitalised for educational purposes in most schools. As a method of teaching. It has important use inthe class-room as well as for club meeting and assembly programmes. The fields of literature and history naturally lend themselves to this type of activity. But

dramatization may be used effectively in any subject, a science class re-enacting circumstances of some famous scientific discovery; a mathematics group showing the application of mathematics in daily life. The opportunities are varied and many. It all depends upon the teacher how he utilizes them. The alert teacher will think of many adaptations which can be made in his own teaching field.

3. **Music:** The singing school is a happy school. Tasks and problems do not loom so large or life so vexing, after a lively session of song with one's fellow.

6.7 LET US SUM UP

co curricular activities are utmost needed to fulfill the aims and objectives of life. In co-curricular activities, students participate in various cultural programmes, which help them in socialization, self-identification and self-assessment. The participation in drama, play enables in developing balanced personality. People get acquainted with culture, customs, and activities of other places due to co-curricular activities such as field trips, tours and excursion. It inculcates the feelings of harmony, thus develop unity and togetherness in the society. In community work, students require to meet with many people and develop the capability of adjustment. Since, in many co-curricular activities, children have to perform in groups, and performing as a team develops the sense of belongingness.

6.8 UNIT END EXERCISES

1. "Co-curricular activities add to the appeal of the school and realise the creative talents and social aptitude of students." Discuss.
2. "What children most require is an abundance of opportunities for wholesome activities wisely directed? If these can be made sufficiently stimulating varied and rewardful, educative growth is inevitable." Discuss and suggest ways to derive the proper results.
3. "Co-curricular activities as organised in our schools at present fail to achieve the desired aims." What suggestions will you offer toorganise the activities properly?
4. "The play-ground is an open-air school." Discuss.
5. Discuss the importance and place of co-curricular activities in a Secondary School.
6. Describe any three co-curricular activities which you would like to organise in a rural high school.

7. Discuss the principles that should guide the heads in assigning responsibilities to staff member for organising various school activities.

6.9 REFERENCES

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6.10 ANSWERS TO CHECK YOUR PROGRESS

1.1 Opportunities to exercise creative capacities.

1. Improvement of curriculum.
2. New learning experiences
3. Individual and group guidance.
4. Class-room instruction.
5. Effective school administration.
6. Utilization of spare time.
7. Teachers to understand the pupils better.

2. 1 Democracy of opportunity.

1. Diversity.
2. Few restrictions.
3. Wide distribution of participation.
4. Accounting for special needs
5. Motivation for class instruction.

LESSON NO. 7 **UNIT-III**

LESSON PLANNING

STRUCTURE

1.1 Introduction

1.2 Objectives

1.3 Lesson Plan: An Introduction

1.3.1 Lesson Plan: Definitions

1.3.2 Lesson Plan: Components

1.4 Criteria of a Good Lesson Plan

1.5 Need and Importance/Advantage of Lesson Planning

1.6 Types of Lessons

1.7 Pre-Requisites of Lesson Planning

1.8 Principles of writing lesson plan in teaching of physical science

1.9 Preparation of lesson Plan

1.10 Let Us Sum Up

1.11 Lesson End Exercise

1.12 Suggested Further Readings

1.13 Answer to Check Your Progress

7.1 INTRODUCTION

It is necessary for science teachers to plan their lessons in advance for several reasons. Practice in planning, teaching and then reviewing the lessons will help teachers achieve success in their teaching. This chapter begins with a few standard definitions of a lesson plan, followed by criteria of a good lesson plan, need and importance/advantage of lesson planning. Types of lessons and pre-requisites of lesson planning are next discussed. Before planning a lesson, a teacher should look into a few essential points, the

major principles of writing lesson plan in teaching of physical science are elaborated. Experienced teachers as well as prospective teachers should follow the principles for planning a lesson.

In this lesson reader is given an overview of the following aspects:

- Lesson Plan: An Introduction
- Lesson Plan: Definitions
- Lesson Plan: Components
- Criteria of a Good Lesson Plan
- Need and Importance/Advantage of Lesson Planning
- Types of Lessons
- Pre-Requisites of Lesson Planning
- Principles of writing lesson plan in teaching of physical science
- Preparation of lesson Plan

7.2 OBJECTIVES

After studying this chapter, the reader will be able to:

- Define a lesson plan.
- List the advantages of lesson planning.
- Enumerate the criteria of a good lesson plan.
- Describe the steps involved in lesson planning.
- Apply the principles of writing lesson plan in teaching of physical science

7.3 LESSON PLAN: AN INTRODUCTION

The origin of lesson plan is from Gestalt psychology. Gestalt theory of learning has a great influence on human learning. According to this theory, the learner perceives a concept or a problem or a situation in totality or as a whole. A unit plays an important role in learning of student, because he usually takes the unit in understanding the whole concept. Thus, the whole is perceived part by part Meaningful activities are related to one another within a unit. These activities provide, purposeful learning experiences and the learner understands the whole concept.

There are two approaches of teaching plan. The first approach is propounded by Herbart. He stresses on the content and information's in a plan. The second approach is given by John Dewey and Kilpatrick. They have emphasized on the experiences of learner rather than information.

B.F. Skinner has provided a recent approach to the teaching-learning plan. He stresses on the modification of behavior. His assumption is that the student learnsGood lesson planning is the key to successful teaching. Lesson planning in advance has a futuristic implication which permits a teacher to anticipate pupils' reactions, and by using these reactions to prepare adequately in order to avoid foreseeable difficulties. It helps a teacher to manage her time effectively better if the content is presented in small sequential units. Thus, the teaching plan is the crucial aspect of lesson-plan.

7.3.1 Lesson Plan: Definitions

Good defines a lesson plan as an "Outline of the important points of a lesson arranged in the order in which they are to be presented to students by the teacher".

Lester B. Stands defines a lesson plan as "A Plan of Action".

Biglands: A lesson plan is actually a plan of action

Binning & Binning: Daily lesson planning involves defining the objectives, selecting and arranging subject matter and determining the method or procedure.

Carter V. Good: A lesson plan is of lesson arranged in order in which they are to be presented. It may include objectives, points to be made, questions to be asked, references to materials, assignments, etc.

Bossing: A lesson plan is an organized statement of general and specific goals together with the specific means by which these goals are to be attained by learner under the guidance of the teacher on a given day.

Kant: Lesson plan is the teacher's mental and intellectual visualization of the class room experience as he plans it to occur

Lesson plan is a sort of action plan that the teacher carries out in teaching-learning process in the class room situation.

Types of lesson Planning

1. Planning of work of year in proper and definite manner.

2. Planning of each unit.

3. Daily lesson planning.

4. Planning shared and discussed with pupils.

7.3.2 Lesson Plan: Components

Lesson plan is that small unit of subject matter which teacher plans has in a definite period of time. This duration of teaching varies from school to school and depend upon teacher. Minimum duration of lesson-plan should be of 30-35 to 50 minutes. Teacher must keep in mind the presentation of lesson plan while teaching. Method, Questioning, student participation should involve in this part. All teachers have to give explanation of:

- General aims
- Specific aim
- Previous knowledge of students
- Appropriate teaching strategies
- Method of teaching
- Teaching-resources to be used

7.4 CRITERIA OF A GOOD LESSON PLAN

1. Lesson plan should be written and well prepared. It must cover all the aspects of teaching.
2. Objectives of lesson plan general and specific should be clear.
3. Teaching and should be used at proper time.
4. Previous knowledge testing should be there for teaching.
5. Lesson should be correlated with the previous lesson.
6. It must reveal different activities of students.
7. Students must be actively participated in lesson.
8. Black-board work to be done should be readable and clear.
9. Developing questions should be planned in lesson.
10. Sectional recapitulation should be done in order to know the retention of the students.

11. It should be flexible in order to make attraction and interest of class.
12. Teacher is free to make changes.
13. Individual differences should kept in knowledge while planning.
14. Teacher must prepare it by keeping time in view. It should not t much lengthy or short.

7.5 NEED AND IMPORTANCE OF LESSON PLANNING

1. It makes definite and regular work to do in systematic and organized manner.
2. It helps the teacher to understand the objectives clearly.
3. It provides self-confidence to teacher as she has beforehand knowledge and can solve the problems.
4. It saves the time for students to have better understanding of the subject and is beneficial for teacher that he can do his work and teach in time properly.
5. Pre-planning of lessons helps the teacher to cover the syllabus in time.
6. It provides guidance to the teacher as to what and how he should teach.
7. It ensures suitable use of teaching resources.
8. Proper lesson planning help in establishing co-relation and connection between different lessons.
9. It helps the teacher in choosing best pedagogy.
10. It stimulate the teacher to introduce developing questions with examples.
11. It helps the teacher to understand the individual difference.
12. It helps the teacher to evaluate teaching-learning process.
13. It helps in developing the specific teaching skills.
14. It inspires teachers to improve the further lessons.
15. It lays stress on instructional material.
16. It helps in developing interest of the students.
17. Lesson-plan develops the possibilities of adjustment in the class room situations.
18. It makes teaching effective.

19. It helps in improving discipline in class.

7.6 TYPES OF LESSONS

On the basis of learning objectives, the lesson plans may be classified info three categories:

I. Knowledge Lesson (Cognitive Centric)

ii. Skill lessons (Psychomotor Centric)

iii. Appreciation lessons (Aesthetic Centric)

(i) Knowledge Lesson: (Cognitive Centric)

Knowledge lesson has emphasis on the acquisition of information or content and cognation. The purpose of such type of lesson is to provide the factual information regarding the content or subject matter and building knowledge schemes. Here, main emphasis is given on the presentation of the content formation. These types of lessons are useful in all the subjects as basic foundation.

(ii) Skill lessons: (Psychomotor Centric)

The skill lessons are designed to achieve the psychomotor learning. The purpose of skill lesson is to help the child to do and learn the competencies. Skill lessons may vary from learning elementary skills, such as speaking, reading and writing to. Complex skill, music, dancing, gymnastic exercises further leading higher level competencies.

Learner always love activity and they look forward for a skill lesson. The child is full of creative energy which must be fully utilized. Skill exercises, which are divided from creative expression, create a vacuum in his experiences, and motivation for learning process. The teacher should not only be concerned with the teaching of the techniques of the skill, but also with its creative aspects.

Skills are acquired through the method of trial and error. It means that repetition is carried on by a learning who is eager to succeed. This method suits to the nature of young Learner. The psychological 'Law of Effect' has a great bearing on the learning of any skill. So, in the preparation of skill lessons, the above mentioned principles should be followed.

(iii) Appreciation Lesson: (Aesthetic Centric)

The aim of appreciation lesson is to develop the affective aspects of students. It aims to enable the children to appreciate or observe. The chief objective of such types of

lessons is to give inputs for well-balanced emotional life. The appreciation lessons are prepared for developing attitudes feelings and values among students. These types of lessons are used in teaching-learning of poetry, music and dancing etc. The appreciation lessons are also possible in science and mathematics while appreciating nature, symmetric etc.

Usually the social studies, science and mathematics lessons are highly loaded by cognitive objectives (knowledge), the language lessons by affective objectives (appreciation), the craft, and scientific technology lessons by psychomotor objectives (skill). But it is very difficult to prepare a lesson plan exclusively for achieving only one type of learning dimension. Virtually each type of lesson includes the cognitive, affective and psychomotor objectives and in virtue of nature of the subject-matter any one of these objectives dominates the lesson-plan. Thus, any lesson-plan will have more than one of learning domains.

7.7 PRE-REQUISITES OF LESSON PLANNING

I. Knowledge of Subject Matter. Teacher must have vast knowledge of his subject. He should have thorough knowledge of subject matter, materials and activities which are to be used.

II. Knowledge of child psychology. Teacher must know the individual differences among students. He must teach them accordingly.

III. Knowledge of Methods and Techniques. Teacher should be conversant with new methods and techniques of teaching this will enable him to improve teaching-learning and arousing interest in pupil.

IV. Knowledge of Aims. Teacher should have basic knowledge of aims and objectives of education. He should have ability and skill of teaching and writing.

Other than that teacher need to consider underneath prerequisites:

i. The teacher should have ability to select and make use of required procedures and support device.

ii. The teacher must have the competency in relating teaching activities to learning structures by using appropriate teaching and communicating strategies.

iii. The teacher should be competent in planning and organizing the teaching activities. He should also be able in reinforcing the pupils' activities and

monitoring their behaviour.

iv. He should have the skill for the effective use of black board visuals in presenting the content.

v. A teacher should have good knowledge and skill of developing working questions, explanations for the lesson plan.

vi. The teacher should be able to construct criterion test for evaluating the learning outcomes of pupils.

7.8 PRINCIPLES OF WRITING LESSON PLAN IN TEACHING OF PHYSICAL SCIENCE

Principles of writing lesson plan in teaching of physical science which should be kept in mind. These principles will keep the lesson on track and will be helpful in achieving the objectives. Some of the principles to be followed are

1. **Principle of Clarity of objective:** In a lesson plan, there should be clarity of objectives. Well defined objectives will make teacher and pupil active to achieve the goal.

2. **Principle of Knowledge of the subject:** Teacher must have clarity about the subject. Teacher should not only read new text-books but also refer supplementary books and material concerning the topic.

3. **Principle of Clarity about previous knowledge:** Teacher should know previous knowledge of the pupils while planning and preparing les because without knowing it lie cannot impart new knowledge to them.

4. **Principle of use of instructional material:** It should be decided before hand at what step the material aids/teaching aid should be used. What is to be clarified with that aid? Aids should be used when needed. It makes the les interesting for pupil.

5. **Principle of Flexibility:** Teacher should be free to make changes in lesson plan is a slave of the teacher, not the master. So in order to interest and attraction in lesson teacher should make it flexible.

6. **Principle of Time plan:** Teacher should have time sense while preparing lesson. Teacher should know it very well that how much time it will take to present before the pupil. How many activities can be performed in that duration?

7. **Principle of knowledge of various approaches to Lesson Planning:** Teacher should have knowledge of approaches to Lesson Planning as various educationists have stressed on different points to prepare a lesson plan. Various approaches are used in preparing the lesson like.

- Herbartian Approach or Herbartian Five-step Approach,
- Unit approach or Morrison's Approach.,
- The Evaluation Approach
- RCEM Approach
- American Approach,
- British Approach etc.

7.9 PREPARATION OF LESSON PLAN

Following points should be kept in mind while preparing a lesson plan:

1) Lesson number
   - Date
   - Time
   - Class
   - Subject
   - Average age of children
2) Topic of the lesson
3) Aims of the lesson
   a) Specific aim
   b) General aim
4) Material aids
5) Previous knowledge
6) Introduction
7) Statement of the aim
8) Presentation

9) Comprehensive question

10) Black-board summary

11) Application or Recapitulation

12) Home-work

2. Topic of the lesson

For effective teaching the reading material is divided into various topics. If a topic is small in size, then it works as a lesson for the day. But if it is lengthy, then it is divided into sub topics, according to our ideas and accordingly each heading is also determined.

3. Aims of the lesson

Before lesson is taught, it is necessary to decide its aim or objectives. Every lesson has following two types of aims:

a) General aims: By general aims we mean aims related to the subject. In these aims, no change is made as they are definite and have direct relation with the full subject.

b) Specific aims: Those aims which are not related to the full subject, instead, they are related to a part of the lesson and with a particular context. These are changed in accordance with the changes in lesson and context.

4. Material aids

In order to make the teaching successful, effective and interesting, a teacher uses material aids or devices and techniques. The time and manner of which should be included in the lesson plan.

5. Previous knowledge

Previous knowledge is the knowledge, which the students already possess before teaching them a new lesson. In previous knowledge not only the previous reading material, but all the experiences of the child, which he has achieved till now is included. By taking into consideration the previous knowledge, this will also be kept in mind, but previous knowledge of the students should be in accordance to the selected lesson.

6. Introduction

Before starting a new lesson, a teacher should prepare his students to acquire new knowledge. Here a question arises, how a teacher can may ask 3 or 4 questions based on the students' previous knowledge, in order to inculcate interest, enthusiasm and curiosity

among his students for accepting the new lesson. In order to make the student accept and adopt a new lesson, following methods can be used:

a) Asking questions based on the lesson

b) Narrating a story

c) Showing a picture

d) Explaining the subject

e) Narrating poems

g) Presenting any example or incident etc.

7. Statement of the aim

After completing the introduction of the lesson, students get a picture of the objectives of that lesson. After giving the introduction, teacher should tell the specific aims. While students are acquainted with the specific aims of lesson, enthusiasm is generated among them. Secondly, they choose the correct way for the study of the lesson. Their attention is centralized towards the reading subject and the teacher will feel comfortable while teaching.

8. Presentation

After statement of aim, when the attention of both, the teacher and the students are centralized towards the lesson, the teacher should use the principle of selection and division. For the development of the units, a teacher is required to use various educational techniques like questions, examples, explanation, narration and exhibition.

9. Comprehensive questions

Comprehensive questions are those questions, which are asked by the teacher from his students after teaching every unit of the lesson, in order to ascertain, whether the children have properly understood the lesson or not. Comprehensive questions are usually of two types – first related to the teaching matter and second related to the language.

10. Black – board summary

The black board summary should always be formed with the help of students, but not much time should be devoted to this purpose. Black –board summary consists of important sentences which should be small, clear, relevant and written in a serial form so

that students can adopt lesson matter easily and comfortably.

11. Recapitulation

Recapitulation exercise should be done so that whatever has been taught to the students till now, can be retain in their brains. The teacher comes to know about the success or failure in achieving his aim.

12. Home – work

Home assignment should be given to the students related to that lesson.

7.10 LET US SUM UP

Lesson planning is the first and foremost step in teaching. A good planning for lesson results

In good teaching and better results. In this lesson, we have discussed criteria of a good lesson plan need and importance/advantage of lesson planning, types of lesson, pre-requisites of lesson planning, principles of writing lesson plan in teaching of physical science and preparation of lesson plan it will help pupil teacher to plan his lesson in orderly manner. Lesson plan may help the teacher to construct the lesson plan and exploring more opportunities for integration of alternative resources in classroom. Teaching is a purposeful activity. It has been repeatedly emphasized, that good and effective teaching stimulates the learner to think and motivates them to learn further. The teacher is to create learning situations and organize them in such a way that the child feels the inner urge to know, to think and to do. It is not as simple as it seems. However, just as in all other spheres of human activity, planning and scheming it out makes even difficult task easier. Therefore, for successful and effective teaching, planning is the first and most important step. For the effective classroom instruction, intelligent planning and creativity of a teacher are the key stones.

7.11 LESSON END EXERCISE

Note: a) Write your answer in the space provided after each item.

b) Compare your answers with those given at the end of the unit.

a) 1. Why should physical science teacher plan a lesson?

---

a) 2. Why material aids are useful in teaching?

---

b). 1. What are the benefits of lesson planning?

b). 2. Explain the principles of writing a lesson in teaching of physical science.

b). 3. In your opinion what should be included in a lesson plan. Discuss.

7.12 SUGGESTED FURTHER READING

Kumar, Amit (2002): Teaching of Physical Sciences. Anmol Publications, New Delhi.

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Bhandula, N. (1989). Teaching of Science . Ludhiana: Parkash Brothers.

Das , R.C. (1992). Science Teaching in School . New Delhi: Sterling Publishing.

Gupta, V.K. (1995). Teaching and Learning of Science and Technology, Delhi, Vikas Publishing House.

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7.13 ANSWERS TO CHECK YOUR PROGRESS

a. 1) It is necessary for a physical science teachers to plan their lessons in advance for several reasons. Practice in planning, teaching and then reviewing the lessons will help teachers achieve success in their teaching.

a. 2) In order to make the teaching successful, effective and interesting, a teacher uses material aids or devices and techniques. The time and manner of which should be included in the lesson plan.

b). 1. Benefits of lesson planning

1. It makes definite and regular work to do in systematic and organized manner.
2. It helps the teacher to understand the objectives clearly.
3. It provides self-confidence to teacher as she has beforehand knowledge and can solve the problems.
4. It saves the time for students to have better understanding of the subject and is beneficial for teacher that he can do his work and teach in time properly.
5. Pre-planning of lessons helps the teacher to cover the syllabus in time.
6. It provides guidance to the teacher as to what and how he should teach.
7. It ensures suitable use of teaching resources.
8. Proper lesson planning help in establishing co-relation and connection between different lessons.
9. It helps the teacher in choosing best pedagogy.
10. It stimulate the teacher to introduce developing questions with examples.
11. It helps the teacher to understand the individual difference.

b). 2. Principles of writing a lesson in teaching of physical science.

Principles of writing lesson plan in teaching of physical science which should be kept in mind. These principles will keep the lesson on track and will be helpful in achieving the objectives. Some of the principles to be followed are

1. **Principle of Clarity of objective:** In a lesson plan, there should be clarity of objectives. Well defined objectives will make teacher and pupil active to achieve the goal.
2. **Principle of Knowledge of the subject:** Teacher must have clarity about the subject. Teacher should not only read new text-books but also refer supplementary books and material concerning the topic.
3. **Principle of Clarity about previous knowledge:** Teacher should know previous

knowledge of the pupils while planning and preparing les because without knowing it lie cannot impart new knowledge to them.

4. **Principle of use of instructional material:** It should be decided before hand at what step the material aids/teaching aid should be used. What is to be clarified with that aid? Aids should be used when needed. It makes the les interesting for pupil.

5. **Principle of Flexibility:** Teacher should be free to make changes in lesson plan is a slave of the teacher, not the master. So in order to interest and attraction in lesson teacher should make it flexible.

6. **Principle of Time plan:** Teacher should have time sense while preparing lesson. Teacher should know it very well that how much time it will take to present before the pupil. How many activities can be performed in that duration?

7. **Principle of knowledge of various approaches to Lesson Planning:** Teacher should have knowledge of approaches to Lesson Planning as various educationists have stressed on different points to prepare a lesson plan. Various approaches are used in preparing the lesson like.

- Herbartian Approach or Herbartian Five-step Approach,
- Unit approach or Morrison's Approach.,
- The Evaluation Approach
- RCEM Approach
- American Approach,
- British Approach etc.

b) Lesson plan should include:

Subject, time, class, average age of the students should be mentioned in the lesson Plan, the Topic of the lesson, Aims of the lesson, Material aids, Comprehensive questions, Home – work followed by important examples and activities should be included in lesson planning.

LESSON NO. 8 UNIT-III

STEPS FOR PREPARING A LESSON PLANNING THROUGH HERBARTIAN AND RCEM APPROACH

STRUCTURE

8.1 Introduction

8.2 Objectives

8.3 Herbartian approach: An Introduction

8.3.1 Herbart's Educational Ideology

8.3.2 Steps of teaching approach

8.4 Elements/Steps for Preparing Herbartian Lesson-Plan

8.5 Herbartian Five Steps / Revised Herbartian Model

8.6 Herbartian Lesson Plan Model

8.7 Advantages of Herbartian Model

8.8 Disadvantages of Herbartian Model

8.9 Check Your Progress

8.10 Regional College of Education Mysore (RCEM)Approach

8.11 Design of Lesson Plan According To RCEM Approach

8.12 Merits of RCEM Approach

8.13 Demerits of RCEM Approach

8.14 Let Us Sum Up

8.15 Lesson End Exercise

8.16 Suggested Further Readings

8.17 Answer to Check Your Progress

8.1 INTRODUCTION

Learning to plan is just like any other skill. It takes time and practice. At first lesson, planning may seem like a time consuming process but by creating detailed lesson plans, as a beginner teacher one is able to develop routines that can become more automatic over

time.

- Lesson planning should be in a written form.
- In lesson planning, the general and specific objectives should be clearly defined.
- The lesson plan should relate to suitable teaching method and its use.
- A continuity component reviews and reflects on content from the previous lesson.
- Subject, time, class, average age of the students should be mentioned in the lesson plan.
- Important examples should be included in lesson planning.
- Inspirational or motivational methods should be experimented in lesson planning.
- In lesson planning, the time for each topic should appropriately be pre-determined.
- In lesson planning, the techniques and supportive materials of education like charts, maps and other audio-visual materials and its utilization should be written.

It has been realized that when we start teaching it is 90% planning and 10% management. Nevertheless, for an experienced teacher, it is 10% planning and 90% management. If, having developed a set of effective management skills and teaching routines, having experienced how to be resourceful with very little, and above all having learned to trust your learners, you are ready to fly on your own. It is then that you will experience the (almost) unbearable lightness of teaching.

8.2 OBJECTIVES

After going through this unit, you will be able to:

i. Know the essential elements of Herbartian approach.

ii. Understand the process followed for making lesson plan using Herbartian approach.

iii. Create a well-organized lesson plan using Herbartian approach.

iv. Apply the RCEM approach for lesson planning.

v. Understand the advantages and disadvantages of using RCEM 1 for lesson Planning

8.3 HERBARTIAN APPROACH: AN INTRODUCTION

John Fredric Herbart was a great European educationist and philosopher of 19th century. He advocated that teaching should be planned actively if we intend to make it efficient He applied the knowledge of psychology regarding the Learning process.

Herbartian approach is based on APPERCEPTIVE MASS THEORY OF LEARNING. The main thing in that theory is that the learner is like a clean slate and all the knowledge is given to him from outside. If new knowledge is imparted by linking with old knowledge of the student it is acquired easily and is retained for a longer period. The contents should be presented into units and those units should be arranged in a logical sequence.

8.3.1 HERBART'S EDUCATIONAL IDEOLOGY

Based upon Educational psychology Herbart's educational ideology advocated the following four elements for a successful teaching.

1. **INTEREST:** The teaching process should be interesting. When the interest of pupils is created in some subject, their attention is attracted towards it. They acquire the new knowledge very easily.

2. **APPERCEPTION:** The entire knowledge is provided to the pupils from outside. Apperception of this external knowledge occurs in the unconscious mind of the pupils. By relating new knowledge to the previous knowledge of the pupils, their learning is simplified. Hence, in order to make the learning process effective, the teacher should move from known to unknown.

3. **GENERAL METHOD:** Learning activity occurs in a definite sequence. Hence, the activities of the unit should be edited in a definite sequence and in a logical order.

4. **CORRELATION.** Knowledge is one unit. All the subjects should be studied after correlating each other in the form of one unit. All the subject of the curriculum should be taught by correlating them with History.

8.3.2 STEPS OF TEACHING APPROACH

1. **CLARITY:** The teacher should present the subject-matter with clarity. The subject-matter to be taught is broken into various facts so that pupils pay attention to each fact or element.

2. **ASSOCIATION:** The new knowledge of the pupils is related to their previous knowledge.

3. **SYSTEM:** New knowledge or thought should be organized in sequence on the basis of logic. The specific are separated from the generals which may enable the pupils to view the mutual relations between various fact or elements so that they may gain the knowledge of 'whole'.

4. **METHOD.** The pupils apply the gained knowledge to the new situations.

8.4. ELEMENTS/STEPS FOR PREPARING HERBARTIAN LESSON-PLAN:

Herbartian approach is also known as Herbartian five steps approach In most of teacher's training institutions the Herbartian five steps approach of lesson planning is used. This lesson planning is an ancient concept. So, in earlier periods too, attempts have been made to formulate a general procedure for the conduct of various types of lessons. The credit of significant contribution in this field is to Herbart. John Fredrik Herbart (1776-1841 AD), a German philosopher and great educationist and his followers adopted and evolved the most famous procedure known as the 'Herbartain Formal Steps'. These are called formula steps, because these deal with the content of lesson. Initially there were four steps as given by Herbart. But later on his followers divided the activities of a teaching unit into five steps. According to the Herbartian School of Pedagogy, the five formal steps are as follows:

1. Preparation
2. Presentation
3. Association or comparison
4. Generalization
5. Application

A. KNOWLEDGE:

1. Preparation:

The first step of lesson-planning is preparation of the lesson. At this step the teacher plans for what is to be taught in the class? What teaching-aid/material would be used for teaching? Which method would be used for teaching? Etc. There are certain classroom activities which are to be done before starting the classroom teaching. These are:

(i) Formation of Objectives

a. General Objectives

These objectives are formulated by the teacher in his subject keeping in view the entering behaviours of the learners. For example: 1. to develop the knowledge of grammar among the Students.

b. Specific Objectives

These objectives are formulated on the basis of general objectives and considering the nature of the topic and level of students. These are specified in terms of knowledge, skill or appreciation. These objectives are written in behavioural terms. For Example :(I) Students will be able to recall the definition of noun. (ii) Students will be able to enumerate the examples of noun

(ii) Previous Knowledge Testing/ Entry Behaviour: In this, the teacher asks various questions from the students for checking their previous knowledge. Some questions are asked from the pupils in order to test their previous knowledge so that curiosity may arouse in them for learning of new knowledge. By testing their previous experiences the pupils are prepared for acquiring new knowledge.

a) Announcement of the Topic/ Statement of Aim: After checking the previous knowledge, here, the topic becomes clear to the pupils and the teacher himself is supposed to write the topic on the black-board in clear words

2. Presentation: It is the central part of teaching-process. At this step, the teacher teaches the student certain topic or lesson. He uses various teaching-methods and teaching material/aid for this. He keeps into mind the principles of psychology such as going from concrete to abstract, from general to specific etc. He comes to the level of the students for explaining different concepts, topics and lessons. The lesson is developed with the cooperation of the pupils. Opportunities are provided to pupils to learn themselves by stimulating their mental activity. The teacher tries to receive most of the points from the pupils by questioning so that the new knowledge may get related to the previous knowledge

B. UNDERSTANDING:

3. Association or comparison: At this step the teacher associates and relates the previous knowledge of the students with the topic which is being taught in the class. The teacher also relates his subject and topic with topics of other subjects. Thus the students

get a thorough knowledge and understanding of the topic which is being taught. He learns to identify the subjects, lessons and concepts not in isolated form but as interrelated and integrated identities. In this, the facts, events and application taught are related mutually by comparison to enable the pupils to understand the taught material. The teacher establishes a relationship between two subjects and also between the facts and events of one subject and the facts and events of the other subject. He compares them so that the new knowledge may get stabilized and clarified in the minds of the pupils.

4. Generalization (System): Generalization means 'to view a similarity in same kinds of activities and concepts'. At this level of teaching process, the teacher explains and excites the students to generalize the concepts, examples and activities and arrive at concluding statement. For example, while teaching law of demand the teacher shows the students that different objects of which demand falls when price rises. The students generalize these activities and arrive at the conclusion that demand of the commodity has reverse relationship with the price. Herbart termed this step as 'system'. After explaining the main lesson, the pupils are provided with opportunities to think. They formulate such principles and rules which may be used in various situations of the future life.

C. APPLICATION

5(a). Application: At this step the teacher tells the students about the use or application of topic/concept which is taught in the class. At this step, the students learn to apply the concept/topic in everyday life. For this, the teacher can suggest such activities, actions and questions in which the concept or the topic would be practically implemented. In Application it is observed whether the acquired knowledge may be applied to the new situations. The teacher verifies this by asking recapitulate questions or by providing opportunities to apply the acquired knowledge in the new saturations. This stabilizes the new knowledge and validity of the rules may also be proved.

5(b). Recapitulation: This is the last but very important step of lesson-planning. In this, the teacher asks questions from the students in order to evaluate his own teaching work. Teacher also provides appropriate reinforcement to the students at this step. This step and teaching-process both end with assigning home-work to the students.

8.5 HERBARTIAN 5 STEPS/ REVISED HERBARTIAN MODEL:

While Herbart emphasized only four steps his followers modified the above four steps. Ziller, a disciple of Herbart, divided the first step i.e., clarity into two introduction

and presentation. Ryan incorporated one more step termed as 'Statement of Aims' in between these two. Still other disciples of Herbart changed the names of other three steps. The term comparison was used in place of association, generalization in place of system and application in place of method. Thus, resulted five steps in place of four. These five steps are termed as Herbartian 5 steps of teaching.

Original Steps of Herbartian Approach	Modifier	Revised Steps
1. Clarity	**Ziller** Modified in two	**1. Introduction** **2. Presentation**
Nil	**Ryan** incorporated **one more step**	**1.a. 'Statement of Aims'**
2. Comparison **3. System** **4. Method**	Other **Disciples of Herbart** changed other three step	**3. Comparison** was used in place of **association** **4. Generalization** in place of **system** **5. Application** in place of **Method**

8.6 HERBARTIAN LESSON PLAN MODEL

(For Teaching of Physical Sciences)

Writing a Lesson Plan

Every teacher must write his lesson plan well in advance. The method of writing the lesson must reflect the modern trends of science teaching. There is no one money order form like Proforma for writing up the lesson plans. The lesson plan is written in four columns.

1. Specifications - Deciding 'Why to teach?'
   (Stating G.I.Os & S.I.Os)
2. Content - 'Analyzing 'What to teach?'
   (Analysis of content area)
3. Learning Experience - Deciding 'How to teach?'
   (Methods and learning activities)
4. Evaluation - Measuring 'How far it is taught?'
   (Evidence of achievement)

Learning experiences depend on specifications. Content is given through appropriate learning experiences to realize the specification. Evaluation is directed towards assessing the extent to which the specification has been realized. The teacher should have thorough idea about the content area of the lesson before he makes an attempt to write the lesson plan. Usually the following is commonly used, with little modifications, in a majority of the teacher training institutions.

The Format of a Lesson Plan

Preliminary information: (such as class, subject, topic, etc.,)

1. General Instructional objectives: The pupil,

a) Acquires knowledge ……..

b) Understands ……

c) Application ……..……

2. Specifications: The pupil,

1. Recalls …….
2. Recognizes …….
3. Explains …….
4. …….

I. Teaching Aids:

List of apparatus / chemicals / charts

II. Introduction:

(Motivation)

III. Presentation:

Specification	Content	Learning Experience	Evaluation

IV. Recapitulation: (2 or 5 Short answer type questions)

V. Assignment: (1or 2 Essay type questions)

Signature of the Guide Teacher **Signature of the Trainee**

Lesson Plan (Model)

Name of the Trainee :

Name of the School :

Class :

Strength :

Roll Nos. :

Present :

Date :

Lecture No. :

Subject : Science

Unit No. : 7

Unit Name : Magnetism

Topic : Magnetic field - Mapping

I. General Instructional Objectives : The pupil,

1. Acquires knowledge about
   a) Magnetic field,
   b) Magnetic lines of force.
2. Understands the magnetic lines of forces around a magnet.
3. Applies his knowledge in identifying earth's magnetic lines.
4. Develops skills in a) observation and b) drawing and labelling.
5. Appreciates the nature of Earth's magnetic field.

II. Specific Instructional Objectives: The pupil,

1. Recalls the definition of "magnetic - field".
2. Recognizes the magnetic lines of force.
3. Recognizes the magnetic lines around bar magnet.
4. Interprets the earth's magnetic lines.
5. Interprets the observed phenomena.

6. Compares earth's magnetic lines with the magnetic lines of a bar magnet.

7. Reason for the appearance of earth's magnetic lines.

8. Draws the magnetic lines of

   a) a bar magnet,

   b) the earth.

9. Enjoys the activities related to magnetism.

III. Teaching Aids:

1. Bar magnet
2. Iron fillings
3. Glass plate
4. White papers
5. Pencil
6. Compass needle
7. Chart-magnetic lines of a bar magnet

IV. Introduction:

1. This lesson may be introduced just by testing the previous knowledge of the pupils.

   Tr. : What is the name of the substance that attracts iron fillings?

   Pupil : Magnet

   Tr. : What are the two poles in a magnet?

   Pupil : North pole and south pole.

2. The Teacher brings the north pole of a Bar Magnet near the north pole of a compass needle.

   Tr. : What do you observe?

   Pupil : Like poles repel each other.

V. Presentation: So, well students, today we shall discuss the properties of a magnet.

VI. Recapitulation:

1. Define magnetic field.
2. What is the experiment to know the magnetic forces around a magnet?
3. Define magnetic lines of forces.
4. State the properties of earth's magnetic lines.

VI. Presentation: So, well students, today we shall discuss the properties of a magnet.

Specifications	Content	Learning Experience	Evaluation
Recalls	Magnetic energy	Teacher states magnetic energy with reference to light energy. Tr. Demonstrates the following activities: Activity (1): Placing a glass plate over a bar magnet keeps white-paper on it. Sprinkle iron filings & taps the glass plate.	Define magnetic energy.
Observes	Iron fillings arrange themselves and present a pattern of lines.	1. What do you observe?	
Recalls Interprets	Magnetic field	Tr. Defines the magnetic field.	Define magnetic field.
Interprets	The lines around the magnet indicates the magnetic lines of forces	Tr. States the magnetic lines of forces.	
Recognizes	The lines around the magnet indicates the magnetic lines of forces	Tr. States the magnetic lines of forces	How do they know that magnetic forces exist around the magnet?
Observes	Magnetic lines of forces	Activity (2): Keep a bar magnet on a white paper and draws the magnetic lines using compass needle.	
Draws Infers	Diagram	Tr. Allows the pupil to draw the same.	
Infers	Lines of force start from the north pole of a magnet and ends at the south pole.	Tr. Explains the direction of the lines using a chart.	What is the direction of the lines of force of a bar magnet?
Observes	Earth's magnetic lines	Activity (3): Tr. Draws the earth's magnetic lines using compass needle and the following Observations are made.	
Interprets	Earth's magnetic lines are parallel to each other	2. Examine these lines, how are they?	
Draws	Drawing the magnetic lines of earth	Tr. Allows the pupil to draw earth's magnetic lines.	
Compares	North pole of the magnetic poles of earth is found at geographical south.	Tr. Explains the magnetic poles of earth with reference to Geographical poles.	Which magnetic pole is found at the geographical north of earth?
Infers	For small distance, the field is uniform.	Tr. Explains the property of the earth's magnetic lines.	
Reasons	For long distance the field is uniform	Tr. Gives the reason for its appearance in terms of magnitude and direction.	Why the magnetic lines of force of earth are straight and parallel?

VII. Assignment:

1. Describe the process of drawing the magnetic lines of a bar magnet.
2. Explain (with a diagram) the process of drawing the magnetic lines of force due to earth's magnetic field.

Signature of the Guide Teacher **Signature of the Trainee**

With the knowledge that we have gained so far, let us attempt to prepare the objectives in terms of behavioural terms for a topic in Physics.

Preparing G.I.Os and Specifications for the lesson 'Floattion' (VIII standard):

General Instructional Objectives: The pupil,

1. Acquires the knowledge of the principle of floatation.

Specific Instructional Objectives: The pupil,

1. Recalls the names of floating bodies.
2. Recalls the depravities of familiar solids and liquids.
3. Recognizes the cause of floatation
4. Recognizes the first and second laws of flotation.2. Understands
   a) The laws of floatation
   b) The method of working hydrometer.
5. Sees relationship between the densities of floating bodies and the liquids in which they float.
6. Interprets the first and second laws of flotation.
7. Explains the method of working of hydrometer.3. Applies the laws of flotation in hydrometer.
8. Reasons for various bodies floating in various liquids.
9. Verifies the first and second laws of flotation.
4. Develops skill in observation and interpretation in scientific experiments.
5. Develops interest in floating bodies in their study.

10. Use hydrometer to find out the density of a given liquid.

11. Records relevant readings accurately.

12. Enjoys in reading books on flotation.

Preparing General Instructional Objectives	
General Instructional Objectives: The pupil	**Specific Instructional Objectives: The pupil**
1. Acquires knowledge of ammonia	1. Recalls the names of ammonium salts. 2. Recognizes a few names of fertilizers.
2. Understands, a). The methods of preparation of Ammonia.	3. Explains the laboratory preparation of Ammonia 4. Explains the Haber process of preparing Ammonia.
b). Properties of Ammonia.	5. Identifies the physical and chemical properties of Ammonia.
3. Applies the knowledge of Ammonia in identifying the Uses.	6. Verifies the use of Ammonia in daily life.
4. Develops skill in observation, experimentation and drawing.	7. Observes the laboratory preparation of Ammonia. 8. Performs the experiment related to physical & chemical properties of Ammonia. 9. Draws the experimental set up for the preparation of Ammonia.
5. Appreciates the use of Ammonia.	10. Visits local industries where Ammonia is prepared.

8.7 ADVANTAGES OF HERBARTIAN MODEL

1. Organized Teaching

Each step has been organized in a logical order, which provides an opportunity to the fresh teacher to become aware of future mistakes. Originality is never affected and the teaching goes on in a very organized way.

2. Acquiring thoughts as apperception.

Herbart believed that when the new thought related to the thoughts lying in unconscious mind of the pupils are presented, the thoughts of unconscious mind come to the conscious mind, establish relationship with the new thought and again go to the unconscious mind. Herbart termed this material process of acquiring thoughts as apperception.

3. Use of Inductive and Deductive Methods

While presenting the new knowledge, help of various examples is sought through generalization and rules are derived. It is an inductive method. In the step application, these rules are to be executed, this is a deductive method. Thus, both indicative and deductive methods are used in this five steps approach.

4. Recapitulation

Such question is asked while recapitulating which, on answering, result in the learning and application of the acquired knowledge in new situations.

5. Correlation Possible

Herbart considered entire knowledge as a single unit. The knowledge of the pupils is acquired in a single unit. This allows to establishing a correlation between previous and new knowledge and between all subjects of the curriculum.

8.8 DISADVANTAGES OF HERBARTIAN MODEL

1. Mechanical Method of Teaching

The use of these steps takes away the freedom of the teacher as he cannot incorporate his independent thought in any step. This reduces his originality. Hence, Herbartian approach is a mechanical method of teaching.

2. No Place for Individual Differences

While using Herbartian approach. Similar questions are asked to the entire. This overlooks individual differences.

3. Useful in Knowledge

Lesson only Herbartian approach is useful in the knowledge lesson only, not in appreciation and skill lessons.

4. Teacher More Active

In Herbartian approach, the teacher has to be more active. It is more desirable if the pupils remain more active than the teachers. As this teaching method is not activity-centered, pupils don't get any motivation for learning.

5. No need of Generalization

Generalization is not needed while teaching language, geography, history, music and arts etc. Thus, all the five steps are not needed while teaching.

6. Uninteresting

This approach stresses upon the teaching of all the subjects of curriculum in a similar sequence overlooking the interests, attitudes, abilities, and capacities of the pupils according to their mental development. The entire teaching becomes monotonous. The

pupil does not show any interest in acquiring new knowledge. Thus, Herbart's teaching method is not interesting

7. Difficulty of Correlation.

Considering the knowledge as a complete unit, Herbart emphasized correlation between different subjects for the unity in the mental life of the pupils, but following these five steps teachers impart the knowledge of different subjects to the pupils differently. They seek to establish a correlation between various subjects in order to bring integration in the mental life of the pupils, which is essentially difficult, if not impossible. Therefore, in nutshell it can be concluded that Herbartain Five-Step Approach, is an impressive and psychological teaching method. It includes both inductive and deductive methods. A correlation among all the subjects of the curriculum is possible by its use. There is a provision of recapitulation in the step under application.

However, some educationists point out that this method is useful only for knowledge lessons. Generalization is not needed in every lesson. Herbart's method is mechanical. There is no place for individual differences. It does not motivate the pupils to learn by doing. The correlation between the different subjects is essentially difficult. Glower points out that in Herbartian approach, emphasis is laid on teaching only instead of learning. This reduces the freedom of the teacher. Pupils also become passive. Neither is their character formed nor do they reach their desired goals. However, the pupil-teachers should follow this approach with necessary changes keeping its merits in view.

So, in nutshell it can be concluded that Herbartain Five-Step Approach, is an impressive and psychological teaching method. It includes both inductive and deductive methods. A correlation among all the subjects of the curriculum is possible by its use. There is a provision of recapitulation in the step under 'application'. However, some educationists point out that this method is useful only for knowledge lessons. Generalization is not needed in every lesson. Herbart's method is mechanical. There is no place for individual differences. It does not motivate the pupils to learn by doing. The correlation between the different subjects is essentially difficult. Glower points out that in Herbartian approach; emphasis is laid on teaching only instead of learning. This reduces the freedom of the teacher. Pupils also become passive. Neither is their character formed nor do they reach their desired goals. However, the pupils-teachers should follow this approach with necessary changes keeping its merits in view.

8.9 CHECK YOUR PROGRESS

Note: a) Write your answer in the space provided after each item.

b) Compare your answers with those given at the end of the unit.

1. Write a brief note on Educational Ideology of Herbartian Model.

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2. Why some educationists consider "Herbart's" method is mechanical.

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3. Write a advantages of Herbartian Model of lesson planning.

8.10 RCEM APPROACH TO LESSON PLANNING:

The Indian educationists developed a new approach to lesson planning which is an improvement over the earlier approaches. This approach was developed in Regional College of Education Mysore. So, it is known as RCEM method of lesson planning. It also considers the Bloom's taxonomy of educational objectives in identifying the

teaching objectives with some modifications. It involves 17 mental abilities for writing the objectives in behavioural or functional form. In this approach of lesson planning, the design plan consists of three aspects:

I Input

ii Process

iii Output

Input— This aspect is concerned with the identification of objectives. Input may also be termed as 'expected behavioural outcomes' (EBOs). These objectives are broadly classified into four categories viz. knowledge, understanding, application and creativity. These objectives are written in behavioural by employing seventeen mental abilities. The entering behaviours of the students are also identified. The sequence of instructional procedure is determined with the help of these objectives.

Process —this aspect is concerned with the presentation of content and learning experiences. The main focus of process aspect is to create the learning situations for providing appropriate learning experiences to the learners. Therefore, the teaching strategies and tactics are selected for achieving the specified objectives. The communications strategy and audio-visual aids are employed for the effective presentation of the content. The process also includes the technique of motivation, so that student's behaviour can be reinforced for the desirable responses. The process implies the interaction of teacher and students.

Output —This aspect of instructional procedure is concerned with the 'Real Learning Outcomes' (RLOs). In the process aspect learning experiences are provided for the desirable change in students behaviours. The change in behaviours is known as the 'Real Learning Outcomes' (RLOs). The various measuring devices are employed to measure the RLOs. The evaluation devices are specified for measuring the criterion behaviours. The theoretical of RCEM lesson plan has been illustrated with help of table given on proceeding page.

8.11. DESIGN OF LESSON PLAN ACCORDING TO RCEM APPROACH

Input	Process		Output
Instruction Expected Behavior Outcomes (EBOs)	**Communication Strategy Learning Experiences (LE)**		**Evaluation**
	Teacher Activities	**Student Activities**	
1. Knowledge Objectives	Lecture, demonstration, use of chart and maps, explanation, question and answer methods.	Listening, observation, taking notes, interaction	Review, define, state describe, name list, questions.
2. Understanding Objectives	Discussion, problem,-solving demonstration, question-answer method.	Listening, observation, initiation, participation in group discussion.	Explain, interpret, translate, discriminate solving of the Problems.
3. Application Objectives	Question-answer, group discussion, laboratory work, problem-solving methods.	Experiments, use of knowledge in solving the problems.	Observation, practical tests situational test, essay type test etc.
4. Creativity Objectives	Individual work, group discussion, problem-solving.	Analysis and synthesis of elements, establish new relationships.	Oral test, essay type test, situational test, problem-solving, observation.

8.12 MERITS OF RCEM APPROACH

1. It is more suitable to Indian schools.
2. Objectives are stated in terms of measurable abilities and mental process.
3. Teaching-learning situations, strategies, aids and materials are properly stated.
4. Evaluation aspect is properly taken care of.

8.13 DEMERITS OF RCEM APPROACH

1. It is very tedious to write lesson plan of this type.
2. It is time consuming.

8.14 LET US SUM UP

German Philosopher and educationist John Fedrick Herbart (1746-1841) developed a psychological procedure in the field of lesson planning. His approach

indicates more towards teacher's presentation rather than the student's behaviour. Herbart proposed four steps: a) Clearness b) Association c) System d) Method These steps were further modified by Herbart as: a) Preparation: in this step previous knowledge is explored so that the students become motivated to gain new knowledge. b) In Presentation step, the content is presented in an effective manner. Active participation of the students is an essential part of presentation.

c) Association or Comparison step is related with the task of strengthening the content presented in the second step. Teacher compares the previous knowledge with new knowledge and thus the students establish a link between them. d) Generalisation is done after comparison, students learn to simplify the content. Rules, principles, characteristics, objectives, importance and limitations etc. are drawn in this step. e) Application in this students learn to apply the knowledge in similar situations. f) Recapitulation in this teacher asks questions related to the content to check how much the students have understood

RCEM approach to lesson planning has been developed at Regional College of Education, Mysore. It is named as RCEM approach. This approach makes use of Systems Approach to education. The main steps involved in this approach are: a) Input in this step, the entry level behaviour of the students is examined. Instructional objectives are specified in behavioural terms. b) Process step is concerned with the presentation of content matter. It corresponds to interaction process of the classroom. Activities of teacher and students are involved in this process. c) Output step is the evaluation phase of the lesson. Teacher uses various evaluation techniques to know the extent of achievement of instructional objectives.

8.15 LESSON END EXERCISE

Note: a) Write your answer in the space provided after each item.

b) Compare your answers with those given at the end of the unit.

4). Write the steps involved in lesson planning using RCEM approach?

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5). Inscribe the merits of RCEM Approach.

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6). Inscribe the demerits of RCEM Approach?

8.16 SUGGESTED FURTHER READING

Kumar, Amit (2002): Teaching of Physical Sciences. Anmol Publications, New Delhi.

Mangal, S.K.(1997): Teaching of Science, Arya Book Depot, New Delhi.

V.K. (1998): How to Teach Science. Vivek Publishers, Ambala.

Sharma, R.C. (1998): Modern Science Teaching. Dhanpat Rai and Sons, New Delhi.

Serdyukov, Peter, and Ryan, Mark. Writing Effective Lesson Plans: The 5-Star Approach. Boston: Allyn & Bacon, 2008.

Bhandula, N. (1989). Teaching of Science . Ludhiana: Parkash Brothers.

Das, R.C. (1992). Science Teaching in School . New Delhi: Sterling Publishing.

Gupta, V.K. (1995). Teaching and Learning of Science and Technology, Delhi, Vikas Publishing House.

Kalra, R.M. (2010). : Science Education for Teacher Trainees, New Delhi, PHI Learning

8.17 ANSWERS TO CHECK YOUR PROGRESS

Q1. Write a brief note on Educational Ideology of Herbartian Model.

Based upon Educational psychology Herbart's educational ideology advocated the following four elements for a successful teaching.

- **INTEREST:** The teaching process should be interesting. When the interest of pupils is created in some subject, their attention is attracted towards it. They acquire the new knowledge very easily.
- **APPERCEPTION:** The entire knowledge is provided to the pupils from outside. Apperception of this external knowledge occurs in the unconscious mind of the

pupils. By relating new knowledge to the previous knowledge of the pupils, their learning is simplified. Hence, in order to make the learning process effective, the teacher should move from known to unknown.

- **GENERAL METHOD:** Learning activity occurs in a definite sequence. Hence, the activities of the unit should be edited in a definite sequence and in a logical order.
- **CORRELATION.** Knowledge is one unit. All the subjects should be studied after correlating each other in the form of one unit. All the subject of the curriculum should be taught by correlating them with History.

Q2. Why some educationists consider "Herbart's" method is mechanical

However, some educationists point out that this method is useful only for knowledge lessons. Generalization is not needed in every lesson. Herbart's method is mechanical. There is no place for individual differences. It does not motivate the pupils to learn by doing. The correlation between the different subjects is essentially difficult. Glower points out that in Herbartian approach, emphasis is laid on teaching only instead of learning. This reduces the freedom of the teacher. Pupils also become passive. Neither is their character formed nor do they reach their desired goals. However, the pupil-teachers should follow this approach with necessary changes keeping its merits in view.

Q3. Write a advantages of Herbartian Model of lesson planning.

1. Organized Teaching

Each step has been organized in a logical order, which provides an opportunity to the fresh teacher to become aware of future mistakes. Originality is never affected and the teaching goes on in a very organized way.

2. Acquiring thoughts as apperception.

Herbart believed that when the new thought related to the thoughts lying in unconscious mind of the pupils are presented, the thoughts of unconscious mind come to the conscious mind, establish relationship with the new thought and again go to the unconscious mind. Herbart termed this material process of acquiring thoughts as apperception.

3. Use of Inductive and Deductive Methods

While presenting the new knowledge, help of various examples is sought through

generalization and rules are derived. It is an inductive method. In the step application, these rules are to be executed, this is a deductive method. Thus, both indicative and deductive methods are used in this five steps approach.

4. Recapitulation

Such question is asked while recapitulating which, on answering, result in the learning and application of the acquired knowledge in new situations.

5. Correlation Possible

Herbart considered entire knowledge as a single unit. The knowledge of the pupils is acquired in a single unit. This allows to establishing a correlation between previous and new knowledge and between all subjects of the curriculum.

Q4. Write the steps involved in lesson planning using RCEM approach.

RCEM approach of lesson planning has been developed at Regional College of Education, Mysore. It is named as RCEM approach. This approach makes use of Systems Approach to education. The main steps involved in this approach are: a) Input in this step, the entry level behaviour of the students is examined. Instructional objectives are specified in behavioural terms. b) Process step is concerned with the presentation of content matter. It corresponds to interaction process of the classroom. Activities of teacher and students are involved in this process. c) Output step is the evaluation phase of the lesson. Teacher uses various evaluation techniques to know the extent of achievement of instructional objectives.

Q5. Inscribe the merits of RCEM Approach.

1. It is more suitable to Indian schools.
2. Objectives are stated in terms of measurable abilities and mental process.
3. Teaching-learning situations, strategies, aids and materials are properly stated.
4. Evaluation aspect is properly taken care of.

Q6. Inscribe the demerits of RCEM Approach.

1. It is very tedious to write lesson plan of this type.
2. It is time consuming.

LESSON NO. 9 UNIT-III

RCEM AND CONSTRUCTIVISM APPROACH

STRUCTURE

9.1 Introduction

9.2 Types of Constructivism

9.2.1 Cognitive constructivism

9.2.2 Radical constructivism

9.2.3 Social constructivism

9.3 The 5 E Instructional Model

9.3.1 Engagement: Engage Phase

9.3.2 Exploration

9.3.3 Elaboration

9.3.4 Explanation

9.3.5 Evaluation

9.4 Reasons for using 5E Model

9.5 Constructivism model lesson plan

9.6 RCEM Approach

9.7 RCEM model lesson plan

9.8 Let us sum up

9.9 Lesson End Exercise

9.10 Suggested Further Readings

9.11 Answer to Check Your Progress

9.1 INTRODUCTION

Constructivism is an approach to construct a new knowledge from the individuals prior knowledge, prior experiences, believes, environmental factors both extraneous and intrinsic, economic background, socio cultural background, developmental level, etc. So

above cited factors play a crucial role in new knowledge construction.

To construct new knowledge first step required for the same is to get answer of how and why of information and second is to relate pre and existing knowledge. Construction of knowledge is very active phenomenon, which gets constructed in the mind of the learner. Driscoll (1994) articulated a clear framework of five principles of constructivist learning, such as:

i. Integration of appropriate learning activities

ii. Inculcation of collaborative learning environment

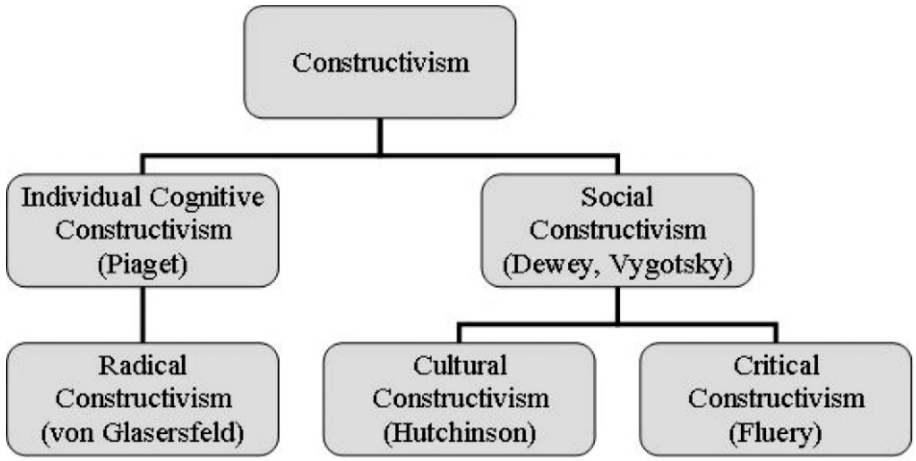
iii. Emphasis on representation of content in multiple forms

iv. Instructions as per students‟ interest and need

Is constructivism an instructional approach? It is a:

- ➢ Philosophy to practice
- ➢ Psychology to apply/implement
- — Constructivism draws on students' existing knowledge, beliefs, and skills.
- — With a constructivist approach, students synthesize new understanding from prior learning and new information.
- — Constructivism draws on the developmental work of Dewey (1938), Hegel (1807/1949), Kant (1781/1946), and Vico (1725/1968).
- — Von Glasersfeld (1984, 1990) proposed three essential epistemological tenets of constructivism ;
  - — Knowledge is not passively accumulated, but rather, is the result of active cognizing by the individual;
  - — Cognition is an adaptive process that functions to make an individual's behavior more viable given a particular environment;
  - — Cognition organizes and makes sense of one's experience, and is not a process to render an accurate representation of reality; and
  - — Knowing has roots in both biological/neurological construction, and social, cultural, and language based interactions (Dewey, 1916/1980; Garrison, 1997, 1998; Gergen, 1995; Maturana & Varela, 1992).

9.2 TYPES OF CONSTRUCTIVISM



9.1.1. Cognitive constructivism

— The process of internalization and (re)construction of external reality is learning. That is, learning is the process of building accurate internal models or representations that mirror or reflect external structures that exist in the "real" world. This perspective on learning focuses on (a) the procedures or processes of learning, (b) how what is learned is represented or symbolized in the mind, and (c) how these representations are organized within the mind.

— It is often considered a "weak" form of constructivism, within the constructivist community

— It remains the "black sheep" of the constructivist community since its focus does not include the subjective nature of knowledge.

9.1.2. Radical constructivism

— The adaptive nature of knowledge underscores that knowledge is not objective "truth," that is, internal knowledge does not match external reality, but rather is a viable model of experience (von Glasersfeld, 1995). These viable models are created within an individual, influenced by the context within which an activity was experienced, and relative to the accomplishment of a particular goal.

— Thus, according to Staver (1995), "knowledge is knowledge of the knower, not knowledge of the external world; improving knowledge means improving its

viability or fit in, but not match with, an external world“

— It is considered as a "strong" form of constructivism, as it fully embraces three of the constructivist epistemological tenets and at least partially embraces the fourth. That is, radical constructivism is concerned with both the construction of mental structures, the position of cognitive constructivists, and the construction of personal meaning. In this sense, radical constructivism involves a greater degree of construction than does cognitive constructivism, involving two planes of construction, structure and meaning, rather than only one, structure.

9.1.3. Social constructivism

— Social constructivism, unlike cognitive and radical constructivism, emphasizes all four of the previously mentioned epistemological tenets.

— It maintains the social nature of knowledge, and the belief that knowledge is the result of social interaction and language usage, and thus is a shared, rather than an individual, experience (Prawatt & Floden, 1994).

— In addition, this social interaction always occurs within a socio-cultural context, resulting in knowledge that is bound to a specific time and place (Gergen, 1995; Vygotsky, 1978).

— This position is exemplified by Bakhtin (1984), "truth is not to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of their dialogic interaction". Truth, in this case, is neither the objective reality of the cognitive constructivists nor the experiential reality of the radical constructivist, but rather is a socially constructed and agreed upon truth resulting from "co-participation in cultural practices" (Cobb & Yackel, 1996, p. 37).

— A constructivist learning intervention is thus an intervention where contextualised activities (tasks) are used to provide learners with an opportunity to discover and collaboratively construct meaning.

— Learners are respected as unique individuals, and instructors act as facilitators rather than as teachers

9.3 THE 5 E INSTRUCTIONAL MODEL

— Constructivism model of 5E learning is very much effective, operative and

functional for science education as it is blended with the existing theories of learning. Moreover 5E Model is based on the Constructivist Approach so very much useful for teaching of science subject. This model was developed during the BSCS (Biological Science Curriculum Study) Project. For secondary science teaching this model was initially constructed by the science educators. Trowbridge and Bybee (1990) envisioned five-phase model in which learners begin to investigate phenomenon and eventually complete the learning cycle by creating conceptions, theories and generalizations based on their work. This model provides opportunities to learner to learn science easily and quickly. The five phases, of which titles capture the essence of the students' actions, are listed as follows:

1 Engagement 2 Exploration 3 Explanation 4 Elaboration 5 Evaluation given in Fig.9.2:

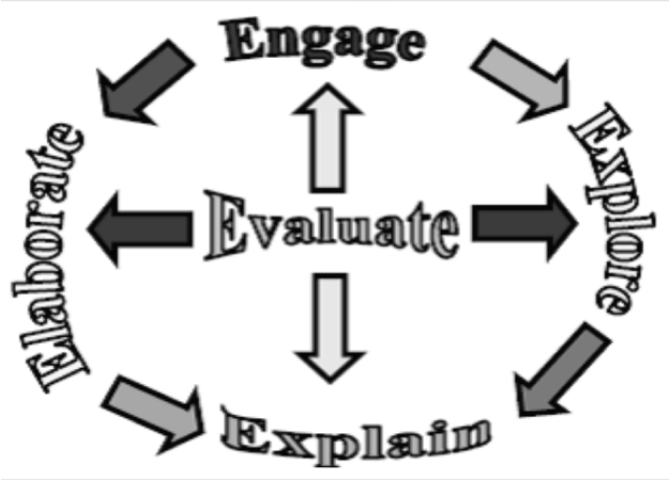


FIG. 9.2: 5E MODEL AND ITS PHASES

— The 5 E's is an instructional model based on the theory of constructivism of learning, it explores that when learners build or construct new ideas they always make the base of their old ideas. The 5 E's model is applicable for the students of all ages, including adults. The philosophy about learning, proposes that, learners need to construct their own understanding of new ideas, this is what we call is constructivism. Much has been researched and inscribed by varied eminent scholars in the fields of learning theory and cognition. Scholars such as Jean Piaget, Eleanor Duckworth, George Hein, and Howard Gardener have explored these ideas in-depth. Each of the 5 E's describes a phase of learning, and each phase begins with the letter "E": Engage, Explore, Explain, Elaborate, and Evaluate. The

5 E's allows students and teachers to experience common activities, to use and build on prior knowledge and experience, to construct meaning, and to continually assess their knowledge and understanding of a concept.

— The Five Es is a teaching model, based on Piagetian theory, which can be used to implement constructivism in teaching and learning process. Teacher must use constructivist approach while designing a lesson to make it interesting, motivating and encourage the students for developing higher-order thinking. Use of 5E approach is helpful for teacher as well as it promote experiential learning.

9.3.1. Engagement: Engage Phase

The Engagement phase is the attempt to activate prior knowledge to discover student preconceptions. Prior knowledge is the major factor in understanding in any subject. The lesson mentally engages with question and activities, construction of new things through their previous knowledge as the base. It will lead to have more concentrated student's attention, access their prior knowledge and stimulate their thinking. The activities under this stage should enable learners to make connection between past and present learning experiences and organize their experiences.

Engagement of the students in the class can be done via conducting some activity, asking questions, demonstration etc. Instructor establishes rules and regulations as well as the activities to be performed to engage he students. The engagement of the students should be like that through which they should feel motivated, interested, excited and actively engaged physically as well as mentally. The successful learning will take place only if the teacher gives hands on experience to the students.It is synthesized by educators and educational researchers, that when students are highly engaged in performing science pertaining activities or learning science then they build new knowledge in an excellent way.

9.3.2. Exploration

When the students are engaged or had shown the interest in ideas, the next phase which starts is exploration. For exploration that activities should be designed which are common and those experiences should be given which are concrete. Basically, those activities, which initiate the construction of concept. The activities and tasks which are lending the time to students to think and investigate, test, make decisions, resolve problem, perform, investigate, collect information from authentic resources, construct a

model etc. should be assigned. The teacher acts as a facilitator in the exploration phase.

To get involved with the material, process and phenomenon students need to be given an opportunity to work together in teams, share the ideas for the process, share common experiences to explore. Teacher should act as a facilitator and guide and should supply the material and resources. Student's inquiry should be tackled carefully to nurture their hidden talent.

9.3.3. Explanation:

In explanation stage the learners communicates the idea or concept i.e. abstract experiences are communicated step by step with some logics or interlinks. The experiences are shared and explained with the facilitator, peers etc. When the task is assigned to the group, the learners support each other's explained experiences, ideas and motivate each other to explain further to reach a particular ideas, hypotheses, questions or observation or conclusion.

There are some activities which allow learners to examine the exploration regarding task performed by them. Understanding of students' is clarified only, when they reflect. Students also analyze and explain during exploration phase.

In the explanation phase the ideas or experiences for explanation are gathered from both printed and non printed media and also from teacher. The varied ways via which explanation can be done are oral presentation, video mode, film, animation, reading and with the help of demonstration.

In science when the students construct their knowledge they use some scientific words for explanation and at the end they will use some scientific terms to explain experiences and will develop and expand the concepts, processes and skills.

9.3.4. Elaboration

In this stage the students will develop the concepts based on which they have taught. They will make associations with other concepts, and apply their understandings to their general surroundings. Applications to real world occasions, for example, where to plant blossoms so they get daylight the vast majority of the day, or how to prop up a shoreline umbrella for shade from the Sun, are both expansions and applications of the idea that light goes in a straight way. These associations frequently prompt further request and new understandings.

Exercises for elaboration can grow and solidify students' thinking as they apply it to a certifiable circumstance, critical thinking, choice making, exploratory request, thinking ability exercises look at, arrange/apply etc. Once students start creating a clarification of their remaining assignments, it is vital to include students in further encounters that amplify or clear up the ideas, techniques, or abilities. The word clarification implies the demonstration in which ideas, methods, or abilities become simple, conceivable and clear. The methodology of clarification gives the understudies and instructor with a typical utilization of terms in respect to the learning errand. At times, understudies may at present have confusions, or they might just comprehend an idea regarding the exploratory experience. Elaboration exercises give students further time and encounters that help learning.

9.3.5. Evaluation:

Evaluate phase comprises an on-going diagnostic process that permits the instructor to figure out whether the learner has achieved understanding of ideas and learning. Evaluation and assessment can happen at all focuses along the continuum of the instructional methodology. A portion of the apparatuses that support in this demonstrative procedure are: rubrics (evaluated and prioritized conclusion desires) decided as an inseparable unit with the lesson plan, instructor perception organized by agendas, understudy meetings, portfolios composed with particular purposes, task and issue based learning items, and inserted evaluations. Solidify proof of the learning move ahead is most important in correspondences between students, instructors, parents and administrators.

Showcases of fulfillment and advancement upgrade, understanding for all gatherings included in the instructive process, further it can get to be bouncing off focuses for extra perfection of the students' instruction. These confirmations of learning serve to guide the educator in further lesson arranging and may flag the requirement for change and alter. Case in point, if an educator sees clear proof of misinterpretation, then he/she can return to the idea to upgrade clearer understanding. On the off chance that the understudies show significant enthusiasm toward an expanding bearing of request, the instructor can consider refocusing the examination to exploit this abnormal state of investment. Exercises which permit the educator to survey student execution and/or understandings of ideas, aptitudes, procedures, and applications, any of the past exercises, create a scoring guide or rubric, performance assessment, produce a product,

journal entry, portfolio etc.

The 5e instructional model is adjusted to numerous procedures included in investigative request. In science, the techniques for scientific inquiry are a phenomenal means for students to assess their clarifications. These routines are, when its all said and done, harmonious with science. At the point when the subject is taught as per 5e Model, understudies use mechanical supplies all the more viably. Utilizing machine, web and other innovative gears of understudies expands the adequacy of this methodology. In the execution of 5e Model, Computers and machine supported projects have been utilized. It is presumed that utilizing machine is extremely compelling for helping understudies to comprehend the subject all the more impeccably. Uses of computer in the learning environment help the students to achieve their objectives all the more early and effortlessly.

Scientific inquiry is an excellent method to evaluate explanation made by science students and when 5E instructional model is used, the scientific inquiry method gets most suitably fixed in it as this method is, after all, congruent with science. ICT based tools and services can be utilized most effectively in 5E Model based approach.

9.4. REASONS FOR USING 5E MODEL:

The 5E encompasses the principles of engagement, which tap student's prior knowledge about a science concepts, exploration gives students the chance to work with science concepts in a “hands-on” format. Following the exploration Phase is the Explanation phase, where the teacher and/or students explain the concept in detail, introducing students to relevant science vocabulary. In the elaboration phase of the science lesson, the teacher facilitates deeper or broader understanding of the lesson. Often this phase involves activities that direct students for applying their knowledge to the new situations. Finally, the teachers can assess student understanding of the science lesson through some type of assessment or Evaluation. 5E model used is given below

9.5. CONSTRUCTIVISM MODEL LESSON PLAN

LESSON PLAN ON SOUND: PRODUCTION AND PROPAGATION

Class/Grade Level	IX
Unit of Study	**SOUND**

Lesson Title : SOUND: PRODUCTION AND PROPAGATION

Unit Summary

Sound is produced due to vibration of different objects. Sound travels as a longitudinal wave through a material medium. In sound propagation, it is the en ergy of the sound that travels and not the particles of the medium.

Subject Area: Science, Math and Arts

Approximate Time Needed: 45-minute

Targeted Content Standards and Benchmarks : Sound Production and Propagation

21st Century Student Objectives/Learning Outcomes

Objectives: : Enable the students to :

1. know about the sound ,its production and propagation.
2. understand about the sound, its production and propagation.
3. appreciate the uniqueness of sound.
4. increase their inquiry skills.

Learning Outcomes: The students will be able to:

1. recall about sound and its sources.
2. write the meaning of term sound.
3. illustrate the sound production phenomenon.
4. analyze the propagation of sound.
5. differentiate between production and propagation of sound.

Prerequisite Skills

Conceptual knowledge:-

Students should have the knowledge of the sound and its sources.

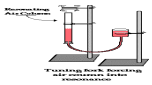
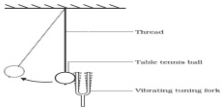
Language skills:

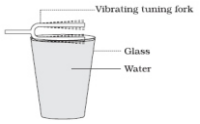
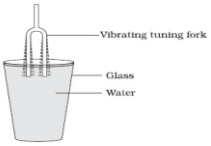
Students should have the basic reading and writing skills like making notes, comprehending and organizing the matter.

Materials and Resources Required For Lesson	
Printed Materials	Textbook, curriculum guides, lab manuals, reference material etc.
Supplies	Tuning Fork, Thread, Table Tennis ball, Beaker or glass, Rubber band etc.

Instructional Procedure

Learning links and Points	Engagement	Exploration	Explanation	Elaboration	Evaluation
SET INDUCTION	Teacher will furnish an activity on production of sound to differentiate between different sounds. When a bird flaps its wings, do you hear any sound? Think how the buzzing sound accompanying a bee is produced. In continuance with the introduction of the topic, teacher will figure out the general idea about different types of sound and ask students to point out the things from the session. Teacher will show activities in which she will ask the questions side by side.	Students will give close watch to the activity and will write their observations on the observation sheet provided by the teacher.	Everyday we hear sounds from various sources like humans, birds, bells, machines, vehicles, televisio ns, radios etc. Sound is a form of energy which produces a sensation of hearing in our ears. There are also other forms of energy like mechanical energy, heat energy, light energy etc. We have talked about mechanical energy in the previous chapters. You ha ve been taught about conservation of energy, which states that we can neither create nor destroy energy. We can just change it from one form to another. When you clap, a sound is produced. In this chapter we are going to learn how sound is produced and how it is transmitted through a medium and received by our ear.	Students will give more examples of production of sound like chirping of birds, vehicle horns etc.	Students will be evaluated on the basis of their previous knowledge.

PRODUCTION OF SOUND	Teacher will perform more activities in which she will ask the questions side by side like From these activities what do you conclude? Can you produce sound without a vibrating object? As per these activities what do we do to the objects?   Fig.1: Vibrat ing tuning fork Teacher will show a figure of "a vibrating object creating a series of compressions and rarefactions in the medium" with the help of windows photo viewer.  Fig. 2: Vibrating tuning fork just touching the suspended table tennis ball.	After watching the activities students will answer the questions made by the teacher.	Take a tunin g fork and set it vibrating by striking its prong on a rubber pad. Bring it near your ear.Fig.1 • Do you hear any sound? • Touch one of the prongs of the vibrating tuning fork with your finger and share your experience with your friends. • Now, suspend a table tennis ball or a small plastic ball by a thread from a support [Take a big needle and a thread, put a knot at one end of the thread, and then with the help of the needle pass the thread through the ball]. Touch the ball gently with the prong of a vib rating tuning fork (Fig. 2) • Observe what happens and discuss with your friends. Fill water in a beaker or a glass up to the brim. Gently touch the water surface with one of the prongs of the vibrating tuning fork, as shown in Fig. 3. • Next dip the pr ongs of the vibrating tuning fork in water, as shown in Fig. 4. • Observe what happens in both the cases.	Students will intricate that the sound of the human voice is produced due to vibrations in the vocal cords.	What is sound? How does the sound produced by a vibrating object in a medium reach your ear?

	 Fig. 3.: Vibrating tuning fork just touching the Suspended table tennis ball.  Fig. 4: Both the prongs of the vibrating tuning fork dipped in water.		• Discuss with your friends why this happens. In these activities we have produced sound by striking the tuning fork. We set the objects vibrating and produce sound. Vibration means a kind of rapid to and fro motion of an object.		
PROPAGATION OF SOUND	Teacher will show an activity based on propagation of sound.	After watching the activity students will answer the questions made by the teacher.	Sound is produced by vibrating objects. The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Sound moves through a medium from the point of generation to the listener. When an object vibrates, it sets the particles of the medium around it vibrating. The particles do not travel all the way from the vibrating object to the ear. A particle of the medium in contact with the vibrating object is first displaced from its equilibrium position. It then exerts a force on the adjacent particle. As a result of which the adjacent particle gets displaced from its position of rest. After displacing the adjacent	Students elaborate that we can also produce sound by plucking, scratching, rubbing, blowing or shaking different objects. The medium is very necessary for propagation of sound. Without medium sound can not propagate and how does density of particles play an important role in propagation of sound.	Cite an experiment to show that sou nd needs a material medium for its propagation . Can you communicate with your friend on moon? If yes/no, why?

			particle the first particle comes back to its original position. This process continues in the medium till the sound reaches your ear. The disturbance created by a source of sound in the medium travels through the medium and not the particles of the medium. A wave is a disturbance that moves through a medium when the particles of the medium set neighbouring particles into motion. They in turn produce similar motion in others. The particles of the medium do not move forward themselves, but the disturbance is carried forward. This is what happens during propagation of sound in a medium, hence sound can be visualised as a wave. Sound waves are characterized by the motion of particles in the medium and are called mechanical waves.	1.why sound is called as mechanical wave? 2.why the medium play an important role in traveling of sound?	.

Assessment Plan

Formative Evaluation: Time line: 10 minutes

- Multiple choice Questions will be given on worksheet by the teacher on the cove red topics and will ask the students to write the answers on the provided response sheet. After completion of the test teacher will ask the students to exchange the response sheets. Then answer key will be projected and students will check the response she et and submit the same.

Home assignment: Time line: 1Day

- Make a list of different types of musical instruments and discuss with your friends which part of the instrument vibrates to produce sound.
- Can sound make a light spot dance?
- Take a tin can. Remove both ends to make it a hollow cylinder. Take a balloon and stretch

it over the can, then wrap a rubber band around the balloon. Take a small piece of mirror. Use a drop of glue to stick the piece of mirror to the balloon. Allow the light through a slit to fall on the mirror. After reflection the light spot is seen on the wall, as shown in Fig. 6. Talk or shout directly into the open end of the can and observe the dancing light spot on the wall. Discuss with your friends what makes the light spot dance.

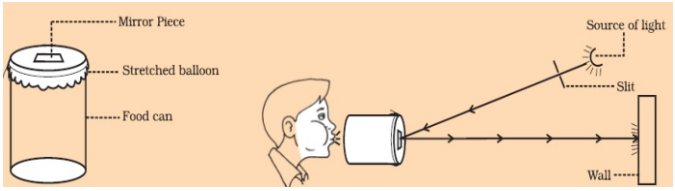


Fig: *A beam of light from a light source is made to fall on a mirror.The reflected light is falling on the wall*

1. Write the above-prescribed tasks and submit the same.
2. Read the study material from the textbook.

9.6 RCEM APPROACH

The Indian educationists developed a new approach to lesson planning which is an improvement over the earlier approaches. This approach was developed in Regional College of Education Mysore. So, it is known as RCEM method of lesson planning. It also considers the Bloom's taxonomy of educational objectives in identifying the teaching objectives with some modifications. It involves 17 mental abilities for writing the objectives in behavioural or functional form. In this approach of lesson planning, the design plan consists of three aspects:

I. Input

II. Process

III. Output

(I). Input— This aspect is concerned with the identification of objectives. Input may also be termed as 'expected behavioural outcomes' (EBOs). These objectives are broadly classified into four categories viz. knowledge, understanding, application and creativity. These objectives are written in behavioural by employing seventeen mental abilities. The entering behaviours of the students are also identified. The sequence of instructional procedure is determined with the help of these objectives.

II. Process —this aspect is concerned with the presentation of content and learning experiences. The main focus of process aspect is to create the learning situations for providing appropriate learning experiences to the learners. Therefore, the teaching strategies and tactics are selected for achieving the specified objectives. The

communications strategy and audio-visual aids are employed for the effective presentation of the content. The process also includes the technique of motivation, so that student's behaviour can be reinforced for the desirable responses. The process implies the interaction of teacher and students.

III. Output —This aspect of instructional procedure is concerned with the 'Real Learning Outcomes' (RLOs). In the process aspect learning experiences are provided for the desirable change in students behaviours. The change in behaviours is known as the 'Real Learning Outcomes' (RLOs). The various measuring devices are employed to measure the RLOs. The evaluation devices are specified for measuring the criterion behaviours.

9.7 MODEL LESSON OF RCEM APPROACH **SOUND: COMPRESSION AND RAREFACTION; TRANSVERSE AND LONGITUDINAL WAVES**	
Class/Grade Level	IX
Unit of Study	**SOUND:** COMPRESSION AND RAREFACTION; TRANSVERSE AND LONGITUDINAL WAVES
Lesson Overview	
Lesson Title : SOUND : COMPRESSION AND RAREFACTION; TRANSVERSE AND LONGITUDINAL WAVES	
Unit Summary Sound is produced due to vibration of different objects. Sound travels as a longitudinal wave through a material medium. Sound travels as successive compressions and rarefactions in the medium. In sound propagation, it is the energy of the sound that travels and not the particles of the medium.	
Subject Area: Science, Math and Arts	
Approximate Time Needed: 45-minute	
Targeted Content Standards and Benchmarks : Compression and Rarefaction, Transverse and longitudinal waves	
21st Century Student Objectives/Learning Outcomes	
Objectives: : Enable the students to : 1. know about the compressions and rarefaction. 2. understand why sound waves are called longitudinal waves. 3. appreciate how transverse waves are helpful in producing sound. 4. analyze that the sound needs a medium to travel and.	

5. increase their inquiry skills.

Learning Outcomes: The students will be able to:

1. recall about the sound production and propagation.
2. state how sound is produced and refracted.
3. differentiate between compression and rarefaction of sound.
4. describe with the help of diagram, how compression and rarefaction are produced.
5. Illustrate with the help of experiment that the sound needs a medium to travel.
6. depict that sound waves are of two types that is longitudinal and transverse.

Prerequisite Skills

Conceptual knowledge:-

Students should have the knowledge of the sound production and propagation.

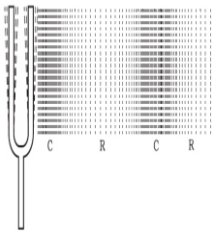
Language skills:

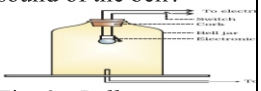
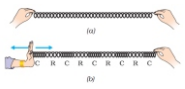
Students should have the basic reading and writing skills like making notes, comprehending and organizing the matter.

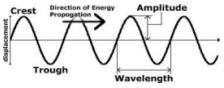
Materials and Resources Required For Lesson

Printed Materials	Textbook, curriculum guides, lab manuals, reference material etc.
Supplies	Tuning Fork, bell jar experiment apparatus, slinky etc.

Instructional Procedure

INPUT		**PROCESS**		**OUTPUT**
LEARNING LINKS AND POINTS	**CONTENT**	**TEACHING ACTIVITY**	**LEARNING ACTIVITY**	**EVALUATION**
COMPRESSION AND RAREFACTION	Air is the most common medium through which sound travels. When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure. This region is called a compression (C), as shown in Fig. 1. This compression starts to move away from the vibrating object. When the vibrating object moves backwards, it creates a region of low pressure called rarefaction (R), as shown in Fig. 1. As the object moves back and forth rapidly, a series of compressions and rarefactions is created in the air. These make the sound wave that propagates through the medium. Compression is the region of high pressure and rarefaction is the region of low pressure. Pressure is related to the number of particles of a medium in a given volume. More density of the particles in the medium gives more pressure and vice versa. Thus, propagation of sound can be visualised as	Teacher will show the flash card depicting compression and rarefaction.  Fig.1: A vibrating object creating a series of compressions (C) and rarefactions (R) in the medium	After watching the flashcards students will answer the questions made by the teacher.	Describe with the help of diagram, how compression and rarefaction are produced in air near a source of sound.

	propagation of density variations or pressure variations in the medium.			
SOUND NEEDS A MEDIUM TO TRAVEL	Sound is a mechanical wave and needs a material medium like air, water, steel etc. for its propagation. It cannot travel through vacuum, which can be demonstrated by the following experiment. Take an electric bell and an airtight glass bell jar. The electric bell is suspended inside the airtight bell jar. The bell ja711`2r. Now start the vacuum pump. When the air in the jar is pumped out gradually, the sound becomes fainter, although the same current is passing through the bell. After some time when less air is left inside the bell jar you will hear a very feeble sound.	To make the students understand the sound needs a medium to travel teacher will perform a experiment and will ask few questions pertaining to the experiment. What will happen if the air is removed completely? Will you still be able to hear the sound of the bell?  Fig. 2 *Bell jar experiment showing sound cannot travel in vacuum.*	Students will observe the activity session to understand the sound needs a medium to travel and will answer the questions asked by the teacher.	What is the difference between compression and rarefaction? Explain how sound is produced by your school bell. Why are sound waves called Mechanical waves?
SOUND WAVES ARE LONGITUDINAL WAVES AND TRANSVERSE WAVES	Take a slinky. Ask your friend to hold one end. You hold the other end. Now stretch the slinky as shown in Fig. 2. (a). Then give it a sharp push towards your friend. • If you mark a dot on the slinky, you will observe that the dot on the slinky will move back and forth parallel to the direction of the propagation of the disturbance. The regions where the coils become closer are called compressions (C) and the regions where the coils are further apart are called rarefactions (R). As we already know, sound propagates in the medium as a series of compressions and rarefactions. Now, we can compare the propagation of disturbance in a slinky with the sound propagation in the medium. These waves are called longitudinal waves. In these waves the individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance. The particles do not move from one place to another but they simply oscillate back and forth about their position of rest. This is exactly how a sound wave propagates; hence sound waves are longitudinal waves.	Teacher will perform an activity on longitudinal wave. Afterward teacher will make a group of 5 to 8 students and provides slinky (long elastic iron coils) and will instruct them to stretch the slinky as shown in Fig. 3. (a). (while projecting on the screen)  Fig.: 3 *Longitudinal waves in a slinky.* Then give it a sharp push towards your friend. Ask them What do you notice? If you move your hand pushing and pulling the slinky alternatively, what will you observe?	Students keenly observe the activity shown and afterward will engage them in the activity	How can a longitudinal waves can be represented graphically Why sound wave is called a longitudinal wave?

TRANSVERSE WAVE	There is also another type of wave, called a transverse wave. In a transverse wave particles do not oscillate along the line of wave propagation but oscillate up and down about their mean position as the wave travels.Fig.3 Thus a transverse wave is the one in which the individual particles of the medium move about their mean positions in a direction perpendicular to the direction of wave propagation. Light is a transverse wave but for light, the oscillations are not of the medium particles or their pressure or density. It is not a mechanical wave.	Teacher will perform an activity on Transverse waves.  Fig.3 : *Transverse Wave*	Students will keenly observe the activity and afterward will engage them in the activity	Define transverse wave.

Assessment Summary

Formative Evaluation: Time line: 10 minutes

Multiple choice Questions will be given on worksheet by the teacher on the covered topics and will ask the students to write the answers on the provided response sheet. After completion of the test teacher will ask the students to exchange the response sheets. Then answer key will be projected and students will check the response sheet and submit the same.

Home assignment: Time line: 1Day

Solve the following:

i. How transverse and longitudinal waves can be represented graphically?
ii. List the two differences between transverse and longitudinal?
iii. Give examples of waves which are combination of both transverse and longitudinal wave motion.
Write the above prescribed tasks submit the same by tomorrow

iv. Read the study material from the text book.

9.8 LET US SUM UP

Constructivism is an epistemology, a learning or meaning-making theory that offers an explanation of the nature of knowledge and how human beings learn. It maintains that individuals create or construct their own new understandings or knowledge through the interaction of what they already know and believe and the ideas, events, and activities with which they come in contact (Cannella and Reiff, 1994; Richardson, 1997).

The 5E learning cycle is a method for planning lessons, teaching-learning process, and developing curricula. The BSCS (Biological Science Curriculum Study) 5E Instructional Model developed in 1980s by Roger Bybee, which describes a teaching sequence was used for an individual lesson plan. It comprises 5 phases namely engagement, exploration, explanation, elaboration, and evaluation. Format of the lesson plan was adapted from the lesson plan builder offline template of Intel Education teach Programme and Intel Learning Connections.

RCEM approach to lesson planning has been developed at Regional College of Education, Mysore. It is named as RCEM approach. This approach makes use of Systems Approach to education. The main steps involved in this approach are: a) Input in this step, the entry level behaviour of the students is examined. Instructional objectives are specified in behavioural terms. b) Process step is concerned with the presentation of content matter. It corresponds to interaction process of the classroom. Activities of teacher and students are involved in this process. c) Output step is the evaluation phase of the lesson. Teacher uses various evaluation techniques to know the extent of achievement of instructional objectives.

9.9 LESSON END EXERCISE

Note: a) Write your answer in the space provided after each item.

b) Compare your answers with those given at the end of the unit.

1). Write in brief the reasons for using 5E model of lesson planning.

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2). Diagrammatically represent the phases of 5E model of lesson planning.

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3). Write the steps involved in lesson planning using RCEM approach?

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4). Inscribe the merits of RCEM Approach.

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5). Inscribe the demerits of RCEM Approach?

9.10 SUGGESTED FURTHER READING

Kumar, Amit (2002): Teaching of Physical Sciences. Anmol Publications, New Delhi.

Mangal, S.K.(1997): Teaching of Science, Arya Book Depot, New Delhi.

V.K. (1998): How to Teach Science. Vivek Publishers, Ambala.

Sharma, R.C. (1998): Modern Science Teaching. Dhanpat Rai and Sons, New Delhi.

Serdyukov, Peter, and Ryan, Mark. Writing Effective Lesson Plans: The 5-Star Approach. Boston: Allyn & Bacon, 2008.

Bhandula, N. (1989). Teaching of Science . Ludhiana: Parkash Brothers.

Das, R.C. (1992). Science Teaching in School . New Delhi: Sterling Publishing.

Gupta, V.K. (1995). Teaching and Learning of Science and Technology, Delhi, Vikas Publishing House.

Kalra, R.M. (2010). : Science Education for Teacher Trainees, New Delhi, PHI Learning

9.11 ANSWERS TO CHECK YOUR PROGRESS

Q1. Write in brief the reasons for using 5E model of lesson planning.

The 5E encompasses the principles of engagement, which tap student's prior knowledge about a science concepts, exploration gives students the chance to work with science concepts in a "hands-on" format. Following the exploration Phase is the Explanation phase, where the teacher and/or students explain the concept in detail, introducing students to relevant science vocabulary. In the elaboration phase of the science lesson, the teacher facilitates deeper or broader understanding of the lesson. Often this phase involves activities that direct students for applying their knowledge to the new situations. Finally, the teachers can assess student understanding of the science lesson through some type of assessment or Evaluation.

Q.2. Diagrammatically represent the phases of 5E model of lesson planning.

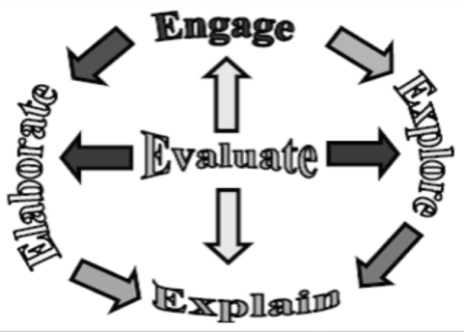


FIG. 1.2: 5E MODEL AND ITS PHASES

Q3. Write the steps involved in lesson planning using RCEM approach.

RCEM approach of lesson planning has been developed at Regional College of Education, Mysore. It is named as RCEM approach. This approach makes use of Systems Approach to education. The main steps involved in this approach are: a) Input in this step, the entry level behaviour of the students is examined. Instructional objectives are specified in behavioural terms. b) Process step is concerned with the presentation of content matter. It corresponds to interaction process of the classroom. Activities of teacher and students are involved in this process. c) Output step is the evaluation phase of the lesson. Teacher uses various evaluation techniques to know the extent of achievement of instructional objectives.

Q4. Inscribe the merits of RCEM Approach.

1. It is more suitable to Indian schools.
2. Objectives are stated in terms of measurable abilities and mental process.
3. Teaching-learning situations, strategies, aids and materials are properly stated.
4. Evaluation aspect is properly taken care of.

Q5. Inscribe the demerits of RCEM Approach.

1. It is very tedious to write lesson plan of this type.
2. It is time consuming.

ELECTRIC CURRENT

STRUCTURE

10.1 Introduction

10.2 Objectives

10.3 Electric Current

10.4 Potential Difference

10.5 Effects of Electric Current

10.6 Let Us Sum Up

10.7 Lesson End Exercise

10.8 Suggested Further Readings

10.9 Answers To Check Your Progress

10.1 INTRODUCTION

Electricity has an important place in modern society. It is a controllable and convenient form of energy for a variety of uses in homes, schools, hospitals, industries and so on. What constitutes electricity? How does it flow in an electric circuit? What are the factors that control or regulate the current through an electric circuit?

In this lesson, we shall attempt to answer such questions. We shall also discuss various effects of electric current like heating effect, magnetic effect and chemical effect.

10.2 OBJECTIVES

1. To study electric current.
2. To study potential difference.
3. To study various effects of electric current.

10.3 ELECTRIC CURRENT

We are familiar with air current and water current. We know that flowing water constitute water current in rivers. Similarly, if the electric charge flows through a conductor (for example, through a metallic wire), we say that there is an electric current in the conductor. In a torch, we know that the cells (or a battery, when placed in proper order) provide flow of charges or an electric current through the torch bulb to glow. We have also seen that torch gives light only when its switch is on. What does a switch do? A switch makes a conducting link between the cell and the bulb. A continuous and closed path of an electric current is called an electric circuit. Now, if the circuit is broken anywhere (or the switch of the torch is turned off), the current stops flowing and the bulb does not glow.

How do we express electric current?

Electric current is expressed by the amount of charge flowing through a particular area in unit time. In other words, it is the rate of flow of electric charges. In circuits using metallic wires, electrons constitute the flow of charges. However, electrons were not known at the time when the phenomenon of electricity was first observed. So, electric current was considered to be the flow of positive charges and the direction of flow of positive charges was taken to be the direction of electric current. Conventionally, in an electric circuit the direction of electric current is taken as opposite to the direction of flow of electrons (Figure 1 and 2), which are negative charges.

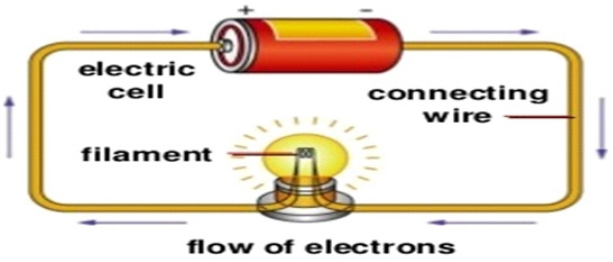


Figure 1: Diagram of Electric circuit

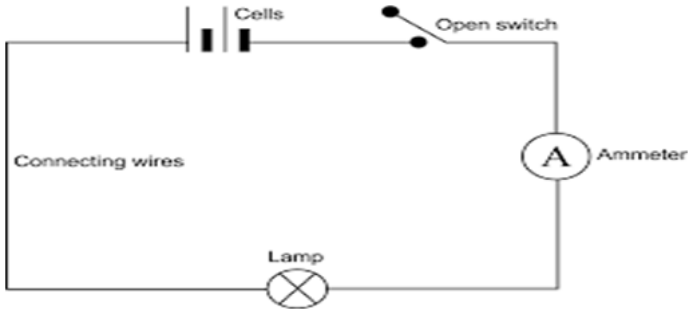


Figure 2: Schematic Diagram of electric circuit

If a net charge Q, flows across any cross-section of a conductor in time t, then the current I, through the cross-section is:

$$I = Q/t$$

The SI unit of electric charge is coulomb (C), which is equivalent to the charge contained in nearly 6×10^{18} electrons. (We know that an electron possesses a negative charge of 1.6×10^{-19} C.) The electric current is expressed by a unit called ampere (A), named after the French scientist, Andre-Marie Ampere (1775–1836). One ampere is constituted by the flow of one coulomb of charge per second, that is, 1 A = 1 C/1 s. Small quantities of current are expressed in milliampere (1 mA = 10^{-3} A) or in microampere (1 μA = 10^{-6} A). An instrument called ammeter measures electric current in a circuit. It is always connected in series in a circuit through which the current is to be measured. Note that the electric current flows in the circuit from the positive terminal of the cell to the negative terminal of the cell

through the bulb and ammeter.

Check your Progress

Q. No. 1. Choose the correct option for the following questions:

1. Electrical current does not flow in

(a) An open circuit

(b) A closed circuit

(c) An electromagnet

(d) A complete circuit

2. Look at the electric circuit below (Figure 3):

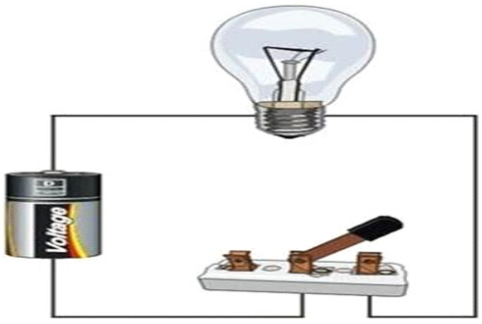


Figure 3: Electric Circuit

(a) The circuit is closed.

(b) It doesn't include a load.

(c) The circuit is open.

(d) It does not include an electrical source.

3. What is the SI unit of electric charge?

(a) Ampere

(b) Coulomb

(c) Volt

(d) milliampere

4. A continuous and closed path of an electric current is called a/an_____.

(a) terminal

(b) ammeter

(c) conductor

(d) electric circuit

10.4 POTENTIAL DIFFERENCE

Electric potential is a location-dependent quantity that expresses the amount of potential energy per unit of charge at a specified location. When a Coulomb of charge (or any given amount of charge) possesses a relatively large quantity of potential energy at a given location, then that location is said to be a location of high electric potential. And similarly, if a Coulomb of charge (or any given amount of charge) possesses a relatively small quantity of potential energy at a given location, then that location is said to be a location of low electric potential. As we begin to apply our concepts of potential energy and electric potential to circuits, we will begin to refer to the difference in electric potential between two points.

Consider the task of moving a positive test charge within a uniform electric field from location A to location B as shown in the diagram at the right. In moving the charge against the electric field from location A to location B, work will have to be done on the charge by an external force. The work done on the charge changes its potential energy to a higher value; and the amount of work that is done is equal to the change in the potential energy. As a result of this change in potential energy, there is also a difference in electric potential between locations A and B. This difference in electric potential is represented by the symbol ΔV and is formally referred to as the electric potential difference. By definition, the electric potential difference is the difference in electric potential (V) between the final and the initial location when work is done upon a charge to change its potential energy. In equation form, the electric potential difference is

$$\Delta V = V_B - V_A = \frac{\text{Work}}{\text{Charge}} = \frac{\Delta PE}{\text{Charge}}$$

The standard metric unit of electric potential difference is the volt, abbreviated V and named in honor of Alessandro Volta. One Volt is equivalent to one Joule per Coulomb. If the electric potential difference between two locations is 1 volt, then one Coulomb of charge will gain 1 joule of potential energy when moved between those two locations. Because electric potential difference is expressed in units of volts, it is sometimes referred to as the voltage.

So, one can arrive at following definitions:

Electric Potential: The amount of electric potential energy at a point is called electric potential.

Electric Potential difference: The difference in the amount of electric potential energy between two points in an electric circuit is called electric potential difference.

Electric potential difference is known as voltage, which is equal to the work done per unit charge to move the charge between two points against static electric field.

Therefore;

$$Voltage = \frac{Work\ done}{Charge}$$

Voltage or electric potential difference is denoted by 'V'. Therefore;

$$V = \frac{W}{Q} \quad ------(1)$$

Where, W = work done and Q = Charge

SI Unit of Electric Potential Difference (Voltage)

SI unit of electric potential difference is volt and denoted by 'V'. This is named in honour of Italian Physicist Alessandro Volta.

$$V = \frac{Joule}{Coulomb} = \frac{J}{C}$$

$$or, V = J\,C^{-1}$$

Since joule is the unit of work and coulomb is the unit of charge; 1 volt of electric potential difference is equal to the 1 joule of work to be done to move a charge of 1 coulomb from one point to another in an electric circuit. Therefore,

$$1V = \frac{1\,joule}{1coulomb} = \frac{1J}{1C}$$

$$or, 1V = 1\,JC^{-1}$$

Voltmeter: An apparatus to measure the potential difference or electric potential difference between two points in an electric circuit. The voltmeter is always connected in parallel across the

points between which the potential difference is to be measured.

Example 1: Calculate the work done if a charge of 5 C moving across two point having potential difference equal to 15 V.

Solution: Given, potential difference (V) = 15 V

Charge (Q) = 5 C

Work done (W) =?

We know that; V = W/Q

Or, W = V x Q

Or, W = 15 V x 5 C = 75 J

Example 2: Calculate the work done to carry a charge of 3 C, if the potential difference between two points is 10 V.

Solution: Given, charge = 3 C

Potential difference between two points = 10V

Work done (W) =?

We know that; V = W/Q

Or, W = V x Q

Or, W = 10 V x 3 C = 30 J

Example 3: What potential difference is required to do 100 J of work to carry a charge of 10 C between two points?

Solution: Given, work done (W) = 100J

Charge (Q) = 10C

Potential difference (V) =?

We know that; V = W/Q

Or, V = 100 J ÷ 10 C = 10 V

Example 4: Calculate the potential difference between two points, if 1500 J of work is done to carry a charge of 50C from one point to other?

Solution: Given, work done (W) = 1500J

Charge (Q) = 50C

Potential difference (V) =?

We know that; V = W/Q

Or, V = 1500 J ÷ 50 C = 30 V

Example 5: **5000 J of work would is done to carry how much charge between two points having potential difference of 100 V?**

Solution: Given, potential difference (V) = 100V

Work done (W) = 5000 J

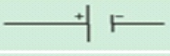
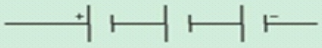
Charge (Q) =?

We know that; V = W/Q

Or, Q = W/V

Or, Q = 5000 J ÷ 100 V = 50 C

Symbols used in a Circuit diagram (Figure 4)

Sl. No.	Components	Symbols
1	An electric cell	
2	A battery or a combination of cells	

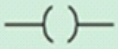
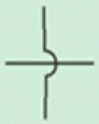
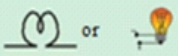
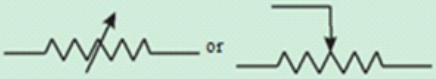
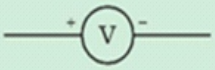
3	Plug key or switch (open)	
4	Plug key or switch (closed)	
5	A wire joint	
6	Wires crossing without joining	
7	Electric bulb	
8	A resistor of resistance *R*	
9	Variable resistance or rheostat	
10	Ammeter	
11	Voltmeter	

Figure 4: Symbols of some commonly used components in circuit diagrams

Check your Progress

Q. No. 2. Choose the correct option for the following questions:

1. Voltage is measured in __.

(a) volts

(b) watts

(c) coulombs

(d) ampere

2. The difference in electrical potential energy between two places is called

(a) resistance

(b) friction

(c) induction

(d) voltage

3. The standard metric unit on electric potential difference is the volt, abbreviated V and named in honor of _____.

(a) Armstrong Volta

(b) Alessandro Volta

(c) Voltas Aless

(d) Volta Armstrong

4. One Volt is equivalent to _____.

(a) one Coulomb per Joule

(b) one Joule per Newton

(c) one Joule per Coulomb

(d) one Newton per Coulomb

10.5 EFFECTS OF ELECTRIC CURRENT

1. HEATING EFFECT OF ELECTRIC CURRENT

We know that a battery or a cell is a source of electrical energy. The chemical reaction within the cell generates the potential difference between its two terminals that sets the electrons in motion to flow the current through a resistor or a system of resistors connected to the battery.

To maintain the current, the source has to keep expending its energy. Where does this energy go? A part of the source energy in maintaining the current may be consumed into useful work (like in rotating the blades of an electric fan). Rest of the source energy may be expended in heat to raise the temperature of gadget.

We often observe this in our everyday life. For example, an electric fan becomes warm if used continuously for longer time etc. On the other hand, if the electric circuit is purely resistive, that is, a configuration of resistors only connected to a battery; the source energy continually gets dissipated entirely in the form of heat. This is known as the heating effect of electric current. This effect is utilised in devices such as electric heater, electric iron etc.

Consider a current I flowing through a resistor of resistance R. Let the potential difference across it be V (Fig. 5). Let t be the time during which a charge Q flows across. The work done in moving the charge Q through a potential difference V is VQ. Therefore, the source must supply energy equal to VQ in time t. Hence the power input to the circuit by the source is

$$P = V\,Q/t = VI$$

Or the energy supplied to the circuit by the source in time t is $P \times t$, that is, VIt.

What happens to this energy expended by the source? This energy gets dissipated in the resistor as heat. Thus for a steady current I, the amount of heat H produced in time t is

$$H = VI\,t$$

Applying Ohm's law (V= IR), we get

$$H = I^2 Rt$$

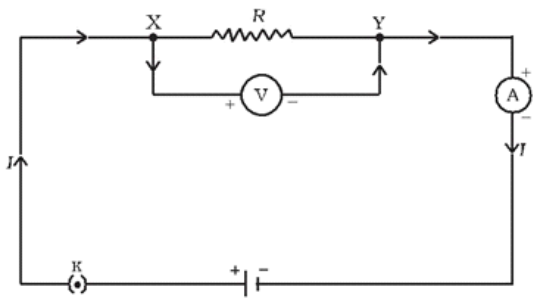


Figure 5: A steady current in a purely resistive electric circuit

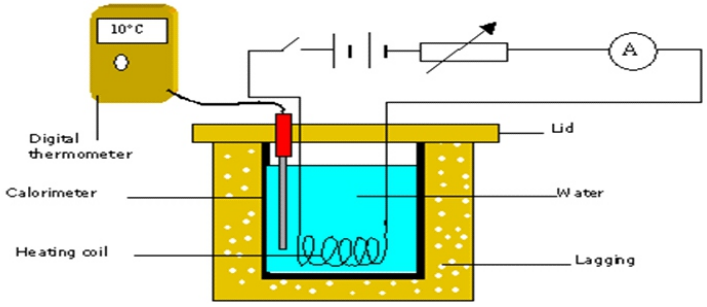


Figure 6: Diagram of Joule's Law of Heating

This is known as Joule's law of heating (Figure 6). The law implies that heat produced in a resistor is

1. directly proportional to the square of current for a given resistance,
2. directly proportional to resistance for a given current, and
3. directly proportional to the time for which the current flows through the resistor.

In practical situations, when an electric appliance is connected to a known voltage source, is used after calculating the current through it, using the relation I = V/R.

The electric laundry iron, electric toaster, electric oven, electric kettle and electric heater are some of the familiar devices based on Joule's heating.

The electric heating is also used to produce light, as in an electric bulb. Here, the filament must retain as much of the heat generated as is possible, so that it gets very hot and emits light. It must not melt at such high temperature. A strong metal with high melting point such as tungsten (melting point 3380°C) is used for making bulb filaments. The filament should be thermally isolated as much as possible, using insulating support, etc. The bulbs are usually filled with chemically inactive nitrogen and argon gases to prolong the life of filament. Most of the power consumed by the filament appears as heat, but a small part of it is in the form of light radiated.

Another common application of Joule's heating is the fuse used in electric circuits. It protects circuits and appliances by stopping the flow of any unduly high electric current. The fuse is placed in series with the device. It consists of a piece of wire made of a metal or an alloy of appropriate melting point, for example aluminium, copper, iron, lead etc. If a current larger than the specified value flows through the circuit, the temperature of the fuse wire increases. This melts the fuse wire and breaks the circuit. The fuse wire is usually encased in a cartridge of porcelain or similar material with metal ends.

1. MAGNETIC EFFECTS OF CURRENT

We are familiar with the fact that a compass needle gets deflected when brought near a bar magnet. A compass needle is, in fact, a small bar magnet. The ends of the compass needle point approximately towards north and south directions. The end pointing towards north is called north seeking or north pole. The other end that points towards south is called south seeking or south pole. Through various activities we have observed that like poles repel, while unlike poles of magnets attract each other.

Magnetic field is a quantity that has both direction and magnitude. The direction of the magnetic field is taken to be the direction in which a north pole of the compass needle moves inside it. Therefore, it is taken by convention that the field lines emerge from north pole and merge at the south pole (Figure 7).

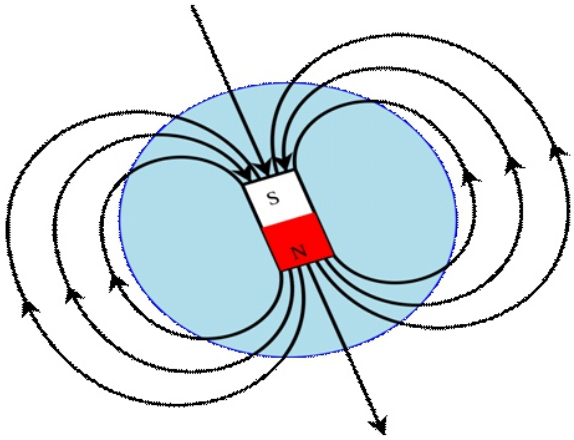


Figure 7: Direction of Magnetic Field Lines

Inside the magnet, the direction of field lines is from its south pole to its north pole. Thus the magnetic field lines are closed curves.

The relative strength of the magnetic field is shown by the degree of closeness of the field lines. The field is stronger, that is, the force acting on the pole of another magnet placed is greater where the field lines are crowded.

No two field-lines are found to cross each other. If they did, it would mean that at the point of intersection, the compass needle would point towards two directions, which is not possible.

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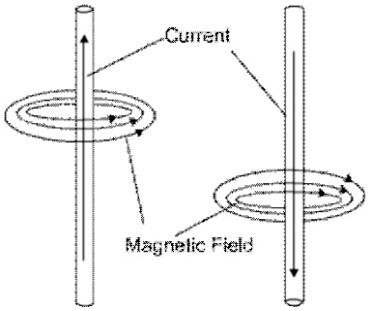
Magnetic field due to current through a straight conductor:

A current carrying straight conductor has magnetic field in the form of concentric circles; around it. Magnetic field of current carrying straight conductor can be shown by magnetic field lines.

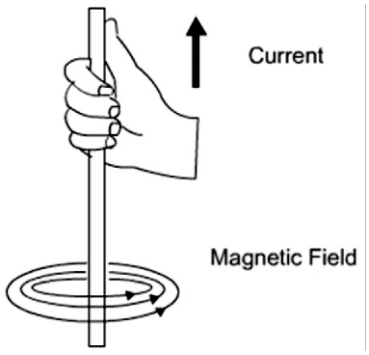
The direction of magnetic field through a current carrying conductor depends upon the direction of flow of electric current. The direction of magnetic field gets reversed in case of a change in the direction of electric current.

Let a current carrying conductor be suspended vertically and the electric current is flowing from south to north. In this case, the direction of magnetic field will be anticlockwise. If the current is flowing from north to south, the direction of magnetic field will be clockwise.

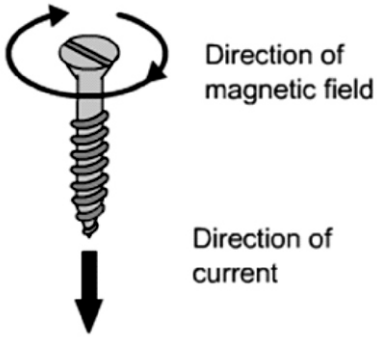
Right Hand Thumb Rule:



The direction of magnetic field; in relation to direction of electric current through a straight conductor can be depicted by using the Right Hand Thumb Rule. It is also known as Maxwell's Corkscrew Rule.



If a current carrying conductor is held by right hand; keeping the thumb straight and if the direction of electric current is in the direction of thumb, then the direction of wrapping of other fingers will show the direction of magnetic field.



As per Maxwell's corkscrew rule, if the direction of forward movement of screw shows the direction of current, then the direction of rotation of screw shows the direction of magnetic field.

Properties of Magnetic Field:

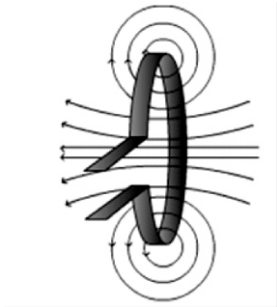
· The magnitude of magnetic field increases with increase in electric current and decreases with decrease in electric current.

· The magnitude of magnetic field; produced by electric current; decreases with increase in distance and vice-versa. The size of concentric circles of magnetic field lines increases with distance from the conductor, which shows that magnetic field decreases with distance.

· Magnetic field lines are always parallel to each other.

· No two field lines cross each other.

Magnetic field due to current through a circular loop:



In case of a circular current carrying conductor, the magnetic field is produced in the same manner as it is in case of a straight current carrying conductor.

In case of a circular current carrying conductor, the magnetic field lines would be in the form of concentric circles around every part of the periphery of the conductor. Since, magnetic field lines tend to remain closer when near the conductor, so the magnetic field would be stronger near the periphery of the loop. On the other hand, the magnetic field lines would be distant from each other when we move towards the centre of the current carrying loop. Finally; at the centre, the arcs of big circles would appear as a straight lines.

The direction of magnetic field can be identified using Right Hand Thumb's Rule. Let us assume that the current is moving in anti-clockwise direction in the loop. In that case, the magnetic field would be in clockwise direction; at the top of the loop. Moreover, it would be in anticlockwise direction at the bottom of the loop.

Clock Face Rule: A current carrying loop works like a disc magnet. The polarity of this magnet can be easily understood with the help of clock face rule. If the current is flowing in anti-clockwise direction, then the face of the loop shows north pole. On the other hand, if the current is flowing in clockwise direction, then the face of the loop shows south pole.

Magnetic field and number of turns of coil: Magnitude of magnetic field gets summed up with increase in the number of turns of coil. If there are 'n' turns of coil, magnitude of magnetic field will be 'n'

times of magnetic field.

Magnetic Field due to a current in a Solenoid:

Solenoid is the coil with many circular turns of insulated copper wire wrapped closely in the shape of cylinder.

A current carrying solenoid produces similar pattern of magnetic field as a bar magnet. One end of solenoid behaves as the north pole and another end behaves as the south pole. Magnetic field lines are parallel inside the solenoid; similar to a bar magnet; which shows that magnetic field is same at all points inside the solenoid.

By producing a strong magnetic field inside the solenoid, magnetic materials can be magnetized. Magnet formed by producing magnetic field inside a solenoid is called electromagnet.

Devices that use current-carrying conductors and magnetic fields include electric motor, electric generator, loudspeakers, microphones and measuring instruments.

An electric current always produces a magnetic field. Even weak ion currents that travel along the nerve cells in our body produce magnetic fields. When we touch something, our nerves carry an electric impulse to the muscles we need to use. This impulse produces a temporary magnetic field. These fields are very weak and are about one-billionth of the earth's magnetic field. Two main organs in the human body where the magnetic field produced is significant, are the heart and the brain. The magnetic field inside the body forms the basis of obtaining the images of different body parts. This is done using a technique called Magnetic Resonance Imaging (MRI). Analysis of these images helps in medical diagnosis. Magnetism has, thus, got important uses in medicine.

An electric motor is a rotating device that converts electrical energy to mechanical energy. Electric motor is used as an important component in electric fans, refrigerators, mixers, washing machines, computers, MP3 players etc. Do you know how an electric motor works?

Based on the phenomenon of electromagnetic induction, the experiments studied above generate induced current, which is usually very small. This principle is also employed to produce large currents for use in homes and industry. In an electric generator, mechanical energy is used to rotate a conductor in a magnetic field to produce electricity.

In our homes, we receive supply of electric power through a main supply (also called mains), either supported through overhead electric poles or by underground cables. One of the wires in this supply, usually with red insulation cover, is called live wire (or positive). Another wire, with black insulation, is called neutral wire (or negative). In our country, the potential difference between the two is 220 V.

At the metre-board in the house, these wires pass into an electricity meter through a main fuse. Through the main switch they are connected to the line wires in the house. These wires supply electricity to separate circuits within the house. Often, two separate circuits are used, one of 15 A current rating for appliances with higher power ratings such as geysers, air coolers, etc. The other circuit is of 5 A current rating for bulbs, fans, etc. The earth wire, which has insulation of green colour, is usually connected to a

metal plate deep in the earth near the house. This is used as a safety measure, especially for those appliances that have a metallic body, for example, electric press, toaster, table fan, refrigerator, etc. The metallic body is connected to the earth wire, which provides a low-resistance conducting path for the current. Thus, it ensures that any leakage of current to the metallic body of the appliance keeps its potential to that of the earth, and the user may not get a severe electric shock.

Check your Progress

Q. No. 3. Choose the correct option for the following questions:

1. Surrounding every magnet, there is a _____ _____.

(a) magnetic field

(b) electrical current

(c) another magnet

(d) compass needle

2. According to Joule's Law of heating, heat produced in a resistor is

(a) inversely proportional to the square of current for a given resistance,

(b) inversely proportional to resistance for a given current, and

(c) directly proportional to the time for which the current flows through the resistor.

(d) inversely proportional to the time for which the current flows through the resistor.

3. Inside the magnet, the direction of field lines is from _____.

(a) its north pole to its south pole

(b) its south pole to its south pole

(c) its north pole to its north pole

(d) its south pole to its north pole

4. Magnetic field is a quantity that has _____.

(a) only direction.

(b) both direction and magnitude

(c) only magnitude

(d) neither direction nor magnitude

10.6 LET US SUM UP

· Electric current is expressed by the amount of charge flowing through a particular area in unit time.

· A continuous and closed path of an electric current is called an electric circuit.

· The SI unit of electric charge is coulomb (C), which is equivalent to the charge contained in nearly 6 × 1018 electrons.

· The SI unit of electric current is ampere (A).

· The amount of electric potential energy at a point is called electric potential.

· The difference in the amount of electric potential energy between two points in an electric circuit is called electric potential difference.

· SI unit of electric potential difference is volt and denoted by 'V'.

· The heating effect of electric current is utilised in devices such as electric heater, electric iron etc.

· A compass needle is a small magnet. Its one end, which points towards north, is called a north pole, and the other end, which points towards south, is called a south pole.

· A magnetic field exists in the region surrounding a magnet, in which the force of the magnet can be detected.

· Field lines are used to represent a magnetic field. A field line is the path along which a hypothetical free north pole would tend to move. The direction of the magnetic field at a point is given by the direction that a north pole placed at that point would take. Field lines are shown closer together where the magnetic field is greater.

· A metallic wire carrying an electric current has associated with it a magnetic field. The field lines about the wire consist of a series of concentric circles whose direction is given by the right-hand rule.

· The pattern of the magnetic field around a conductor due to an electric current flowing through it depends on the shape of the conductor. The magnetic field of a solenoid carrying a current is similar to that of a bar magnet.

· An electromagnet consists of a core of soft iron wrapped around with a coil of insulated copper wire.

· A current-carrying conductor when placed in a magnetic field experiences a force. If the direction of the field and that of the current are mutually perpendicular to each other, then the force acting on the conductor will be perpendicular to both and will be given by Fleming's left-hand rule. This is the basis of an electric motor. An electric motor is a device that converts electric energy into mechanical energy.

· The phenomenon of electromagnetic induction is the production of induced current in a coil placed in a region where the magnetic field changes with time. The magnetic field may change due to a relative motion between the coil and a magnet placed near to the coil. If the coil is placed near to a current-carrying conductor, the magnetic field may change either due to a change in the current through the conductor or due to the relative motion between the coil and conductor. The direction of the induced current is given by the Fleming's right-hand rule.

· A generator converts mechanical energy into electrical energy. It works on the basis of electromagnetic induction.

· In our houses we receive AC electric power of 220 V with a frequency of 50 Hz. One of the wires in this supply is with red insulation, called live wire. The other one is of black insulation, which is a neutral wire. The potential difference between the two is 220 V. The third is the earth wire that has green insulation and this is connected to a metallic body deep inside earth. It is used as a safety measure to ensure that any leakage of current to a metallic body does not give any severe shock to a user.

· Fuse is the most important safety device, used for protecting the circuits due to short-circuiting or overloading of the circuits.

10.7 LESSON END EXERCISE

Short-Answer Type Questions:

Q.No.1. What is electric current?

Q.No.2. Define electric potential difference.

Q.No.3. To carry how much charge between two points having potential difference equal to 220 V, 1760 J of work is done?

Long-Answer Type Question:

Q. No.1. Define electric current with the help of a schematic diagram of electric circuit. Discuss the heating and magnetic effects of electric current?

Q. No. 2. Define Joule's Law of heating.

10.8 SUGGESTED FURTHER READINGS

NCERT (2018). Science Handbook for Class X.

NCERT (2018). Science Handbook for Class IX.

http://ncert.nic.in/ncerts/l/jesc112.pdf

https://www.excellup.com/classten/scienceten/electromagnetism.aspx

https://www.khanacademy.org/science/electrical-engineering/introduction-to-ee/intro-to-ee/v/ee-current

https://www.youtube.com/watch?v=PEcPcNMfNks

10.9 ANSWERS TO CHECK YOUR PROGRESS

Q. No.1 correct options

1. (a)

2. (c)

3. (b)

4. (d)

Q. No.2. correct options

1. (a)

2. (d)

3. (b)

4. (c)

Q.No. 3. correct options

1. (a)

2. (c)

3. (d)

4. (b)

FLOW OF HEAT

STRUCTURE

11.1 Introduction

11.2 Objectives

11.3 How Is Heat Transferred

11.3.1 Conduction

11.3.2 Convection

11.3.3 Radiation

11.4 Concept Of Force

11.4.1 Contact Forces

11.4.2 Non-contact Forces

11.5 Concept Of Friction

11.5.1 Types Of Friction

11.5.2 Advantages And Disadvantages

11.5.3 Methods Of Increasing And Decreasing Friction

11.6 Let Us Sum Up

11.7 Lesson End Exercise

11.8 Suggested Further Readings

11.9 Answers To Check Your Progress

11.1 INTRODUCTION

We all have common-sense notions of heat and temperature. Temperature is a measure of 'hotness' of a body. A kettle with boiling water is hotter than a box containing ice. In physics, we need to define the notion of heat, temperature, etc., more carefully. In

this lesson, you will learn what heat is and how it is measured, and study the various proceses by which heat flows from one body to another. Along the way, you will find out why houses made of concrete roofs get very hot during summer days and why the wind at the beach often reverses direction after the sun goes down. You will also learn about the concept and types of force (Contact and Non-Contact). Friction is also a force (Contact force) that resists motion when the surface of one object comes into contact with the surface of another. It is the force resisting the relative motion of not only solid surfaces, but of fluid layers, and material elements too sliding against each other. Methods of increasing and decreasing friction will also be studied in this lesson.

11.2 OBJECTIVES

1. To understand the process of transfer of heat.
2. To study the concept and types of Force.
3. To understand the concept, types and applications of friction.

11.3 HEAT TRANSFER

We know from experience that a glass of ice-cold water left on a table on a hot summer day eventually warms up whereas a cup of hot tea on the same table cools down. It means that when the temperature of body, ice-cold water or hot tea in this case, and its surrounding medium are different, heat transfer takes place between the system and the surrounding medium, until the body and the surrounding medium are at the same temperature. We also know that in the case of glass tumbler of ice cold water, heat flows from the environment to the glass tumbler, whereas in the case of hot tea, it flows from the cup of hot tea to the environment. So, we can say that heat is the form of energy transferred between two (or more) systems or a system and its surroundings by virtue of temperature difference. The SI unit of heat energy transferred is expressed in joule (J) while SI unit of temperature is kelvin (K), and °C is a commonly used unit of temperature. When an object is heated, many changes may take place. Its temperature may rise, it may expand or change state.

Any matter is made up of atoms and molecules, has the ability to transfer Heat. The

atoms are in different types of motion any time. The motion of molecules and atoms is responsible for heat or thermal energy and every matter has this thermal energy. More the motion of molecules more will be the heat energy. If the temperature difference exists between two systems, heat will find a way to transfer from higher to the lower system.

We have seen that heat is energy transfer from one system to another or from one part of a temperature difference. What are the different ways by which this energy transfer takes place?

There are three distinct modes of heat transfer: conduction, convection and radiation (Fig. 11.1).

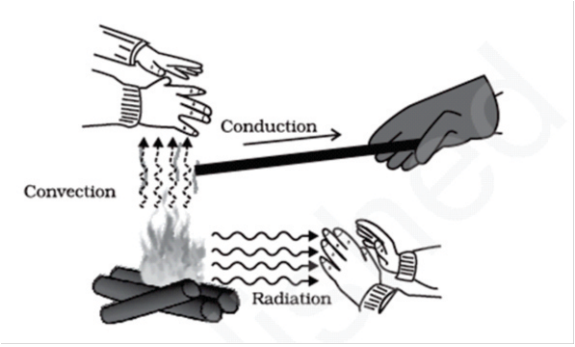


Figure 11.1: Heating by conduction, convection and radiation.

11.3.1 CONDUCTION

Conduction is defined as the heat by the direct collision of molecules. An area of higher kinetic energy transfers thermal energy towards the lower kinetic energy area. High-speed particles clash with particles moving at slow speed, as a result slow speed particles increase their kinetic energy. This is a typical form of heat transfer and takes place by physical contact. For example, place a metal over an open flame.

Conduction is the mechanism of transfer of heat between two adjacent parts of a body because of their temperature difference. Suppose one end of a metallic rod is put in a flame, the other end of the rod will soon be so hot that you cannot hold it by your bare hands. Here heat transfer takes place by conduction from the hot end of the rod through its different parts to the other end. Gases are poor thermal conductors while liquids have

conductivities intermediate between solids and gases.

Heat conduction may be described quantitatively as the time rate of heat flow in a material for a given temperature difference. Consider a metallic bar of length L and uniform cross section A with its two ends maintained at different temperatures. This can be done, for example, by putting the ends in thermal contact with large reservoirs at temperatures, say, T_C and T_D respectively (Fig. 11.2). Let us assume the ideal condition that the sides of the bar are fully insulated so that no heat is exchanged between the sides and the surroundings.

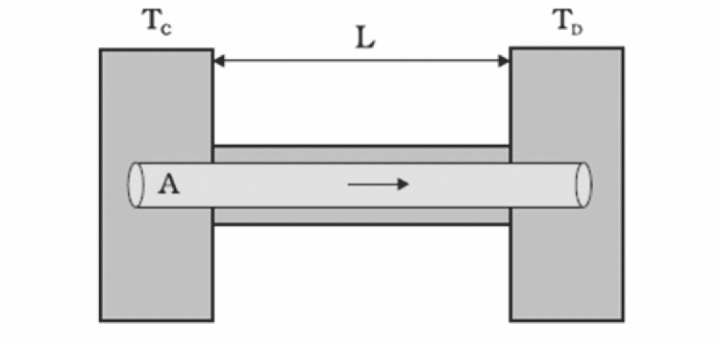


Fig. 11.2: Steady state heat flow by conduction in a bar with its two ends maintained at temperatures T_C and T_D; ($T_C > T_D$).

After sometime, a steady state is reached; the temperature of the bar decreases uniformly with distance from T_C to T_D; ($TC > T_D$). The reservoir at C supplies heat at a constant rate, which transfers through the bar and is given out at the same rate to the reservoir at D. It is found experimentally that in this steady state, the rate of flow of heat (or heat current) H is proportional to the temperature difference ($T_C - T_D$) and the area of cross section A and is inversely proportional to the length L:

$$H = KA \frac{T_C - T_D}{L}$$

The constant of proportionality K is called the thermal conductivity of the material. The greater the value of K for a material, the more rapidly will it conduct heat. The SI unit of K is J S^{-1} m–1 K^{-1} or W m^{-1} K^{-1}. The thermal conductivities of various substances vary slightly with temperature, but can be considered to be constant over a

normal temperature range.

Compare the relatively large thermal conductivities of the good thermal conductors, the metals, with the relatively small thermal conductivities of some good thermal insulators, such as wood and glass wool. You may have noticed that some cooking pots have copper coating on the bottom. Being a good conductor of heat, copper promotes the distribution of heat over the bottom of a pot for uniform cooking.

Plastic foams, on the other hand, are good insulators, mainly because they contain pockets of air. Heat retention and transfer are important in many other applications. Houses made of concrete roofs get very hot during summer days, because thermal conductivity of concrete (though much smaller than that of a metal) is still not small enough. Therefore, people usually prefer to give a layer of earth or foam insulation on the ceiling so that heat transfer is prohibited and keeps the room cooler. In some situations, heat transfer is critical. In a nuclear reactor, for example, elaborate heat transfer systems need to be installed so that the enormous energy produced by nuclear fission in the core transits out sufficiently fast, thus preventing the core from overheating.

11.3.2 CONVECTION

When fluid is heated, it carries thermal energy along with it and moves away from the source. This kind of heat transfer is known as convection. The liquid over the hot surface expands and rises up.

A natural example is in the atmosphere. The earth's surface gets warmed by the sun and the warm air moves up and cool air comes in.

As the temperature of the liquid increases, the liquid's volume also has to increase by the same factor and this effect is known as displacement. The equation to calculate the rate of convection is as follows.

$$Q = Hc \cdot A \cdot (Ts - Tf)$$

Where,

- Q is the heat transferred per unit time.
- Hc is the coefficient of convective heat transfer

- A is the area of heat transfer
- Ts is the surface temperature.
- Tf is the fluid temperature.

Convection is a mode of heat transfer by actual motion of matter. It is possible only in fluids. Convection can be natural or forced. In natural convection, gravity plays an important part.

When a fluid is heated from below, the hot part expands and, therefore, becomes less dense. Because of buoyancy, it rises and the upper colder part replaces it. This again gets heated, rises up and is replaced by the colder part of the fluid. The process goes on. This mode of heat transfer is evidently different from conduction. Convection involves bulk transport of different parts of the fluid. In forced convection, material is forced to move by a pump or by some other physical means. The common examples of forced convection systems are forced-air heating systems in home, the human circulatory system, and the cooling system of an automobile engine. In the human body, the heart acts as the pump that circulates blood through different parts of the body, transferring heat by forced convection and maintaining it at a uniform temperature.

Natural convection is responsible for many familiar phenomena. During the day, the ground heats up more quickly than large bodies of water do. This occurs both because the water has a greater specific heat and because mixing currents disperse the absorbed heat throughout the great volume of water. The air in contact with the warm ground is heated by conduction. It expands, becoming less dense than the surrounding cooler air. As a result, the warm air rises (air currents) and other air moves (winds) to fill the space-creating a sea breeze near a large body of water. Cooler air descends, and a thermal convection cycle is set up, which transfers heat away from the land. At night, the ground loses its heat more quickly, and the water surface is warmer than the land. As a result, the cycle is reversed (Fig. 11.3).

The other example of natural convection is the steady surface wind on the earth blowing in from north-east towards the equator, the so called trade wind. A reasonable

explanation is as follows: the equatorial and polar regions of the earth receive unequal solar heat. Air at the earth's surface near the equator is hot while the air in the upper atmosphere of the poles is cool. In the absence of any other factor, a convection current would be set up, with the air at the equatorial surface rising and moving out towards the poles, descending and streaming in towards the equator. The rotation of the earth, however, modifies this convection current. Because of this, air close to the equator has an eastward speed of 1600 km/h, while it is zero close to the poles. As a result, the air descends not at the poles but at 30° N (North) latitude and returns to the equator. This is called trade wind.

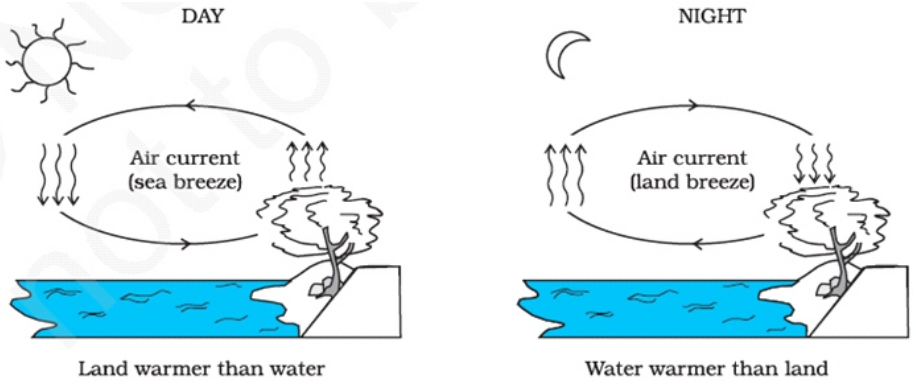


Figure 11.3: Convection Cycles

11.3.3 RADIATION

Conduction and convection require some material as a transport medium. These modes of heat transfer cannot operate between bodies separated by a distance in vacuum. But the earth does receive heat from the sun across a huge distance and we quickly feel the warmth of the fire nearby even though air conducts poorly and before convection can set in. The third mechanism for heat transfer needs no medium; it is called radiation and the energy so radiated by electromagnetic waves is called radiant energy. In an electromagnetic wave electric and magnetic fields oscillate in space and time. Like any wave, electromagnetic waves can have different wavelengths and can travel in vacuum with the same speed, namely the speed of light i.e., 3x108 m s^{-1}. Heat transfer by radiation does not need any medium and it is so fast. This is how heat is transferred to the earth from

the sun through empty space.

All bodies emit radiant energy, whether they are solid, liquid or gases. The electromagnetic radiation emitted by a body by virtue of its temperature like the radiation by a red hot iron or light from a filament lamp is called thermal radiation. When this thermal radiation falls on other bodies, it is partly reflected and partly absorbed. The amount of heat that a body can absorb by radiation depends on the colour of the body. We find that black bodies absorb and emit radiant energy better than bodies of lighter colours. This fact finds many applications in our daily life. We wear white or light coloured clothes in summer so that they absorb the least heat from the sun. However, during winter, we use dark coloured clothes which absorb heat from the sun and keep our body warm. The bottoms of the utensils for cooking food are blackened so that they absorb maximum heat from the fire and give it to the vegetables to be cooked. Similarly, a Dewar flask or thermos bottle is a device to minimise heat transfer between the contents of the bottle and outside. It consists of a double-walled glass vessel with the inner and outer walls coated with silver. Radiation from the inner wall is reflected back into the contents of the bottle. The outer wall similarly reflects back any incoming radiation. The space between the walls is evacuated to reduce conduction and convection losses and the flask is supported on an insulator like cork. The device is, therefore, useful for preventing hot contents (like milk) from getting cold, or alternatively to store cold contents (like ice).

Thermal radiation is generated by the emission of electromagnetic waves. These waves carry away the energy from the emitting body. Radiation takes place through a vacuum or transparent medium which can be either solid or liquid. Thermal radiation is the result of the random motion of molecules in the matter. Movement of charged electrons and protons is responsible for the emission of electromagnetic radiation.

As temperature rises, the wavelengths in the spectra of the radiation emitted decreases and shorter wavelengths radiations are emitted. Thermal radiation can be calculated by Stefan-Boltzmann law:

$$P = e \cdot \sigma \cdot A \cdot (Tr - Tc)4$$

- Where,
- P is the net power of radiation
- A is the area of radiation
- Tr is the radiator temperature
- Tc is the surrounding temperature
- e is emissivity and σ is Stefan's constant.

Check your Progress

Q.1. Choose the correct options for the following questions:

1. What is the definition of conduction?

(a) When heat is transferred from objects like rays of light or electromagnetically.

(b) a hot liquid or air that expands, becomes less dense, and rises or becomes more dense, and sinks.

(c) When heat transfers from objects that are touching.

(d) When heat transfers through the heater or AC in your house.

2. What is the definition of convection?

(a) When heat transfers through waves.

(b) When heat transfers from objects that are touching.

(c) movement in a gas or liquid in which the warmer parts move up and the colder parts move down

(d) Heat traveling from the sun

3. What kind of heat transfer is occurring when the sun warms the sand?

(a) Conduction

(b) Radiation

(c) Convection

(d) Density

4. Which of the following is an example of convection?

(a) A hair dryer is drying up your hair.

(b) When the AC or heater changes the temperature.

(c) When a car engine turns hot after being turned on.

(d) Boiling noodles in water.

11.4 CONCEPT OF FORCE

For many centuries, the problem of motion and its causes had puzzled scientists and philosophers. A ball on the ground, when given a small hit, does not move forever. Such observations suggest that rest is the "natural state" of an object. This remained the belief until Galileo Galilei and Isaac Newton developed an entirely different approach to understand motion.

In our everyday life we observe that some effort is required to put a stationary object into motion or to stop a moving object. We ordinarily experience this as a muscular effort and say that we must push or hit or pull on an object to change its state of motion. The concept of force is based on this push, hit or pull. Let us now ponder about a 'force'. What is it? In fact, no one has seen, tasted or felt a force. However, we always see or feel the effect of a force. It can only be explained by describing what happens when a force is applied to an object. Pushing, hitting and pulling of objects are all ways of bringing objects in motion. They move because we make a force act on them.

Definition of Force

Force is the push or pull the body undergoes when two bodies undergo interaction with each other. Once this interaction stops there would be no more force acting. The force is hence defined as the physical cause that changes or tends to change the dimensions or the state of rest or the state of motion of a body. The Force formula is given by

$F = ma$,

Where 'm' is mass of the body,

and 'a' is the acceleration with which the mass accelerates.

Effects of Force

The effect of force is expressed by the Newton's second law which tells the rate of change of momentum increases as the force applied is increased. Here we can see the two force effects:

· When certain number of forces act on a body in the same direction the effect would be the same in that direction. This is what we call as Resultant force. If a rock is stuck somewhere in between road and some boys push it with enough force the resultant force would be the sum of the forces the boys have applied.

· Balanced forces are said to be acting if we could see the body doesn't change its states of motion even as the forces applied cancel out. Suppose two boys are pushing a table standing in opposite direction applying equal force the forces get balanced and net resultant force is zero.

Types of Forces

There are basically two types of force - **Contact force and Non-contact force.** The forces that act on the bodies that are in physical contact are known as contact forces whereas the forces which act on bodies without being in any physical contact are non-contact forces. Frictional force, spring force, tension force, normal force, air resistance force, applied force are all contact force while gravitational force, electric force, magnetic force are all non-contact forces.

These two broad categories have been explained as under:

11.4.1 CONTACT FORCES

These are those types of forces when two objects interact with each other; they have a physical contact with each other. Types of contact forces are: Frictional force; Tension force; Normal Force; Air Resistance Force, Applied Force, Spring Force.

I. Friction force

As an object moves across a surface it causes friction. Friction force can be sliding

or static. Friction depends upon the nature of the two interacting surfaces. Example: A book sliding on the table, a ball rolling on the floor.

II. Tension force

A force that is transmitted through a string, rope, cable or wire when it is pulled tightly by the object on the opposite end is a tension force. This force flows across the length of the wire or rope. Example- A cable car climbing a mountain using a rope.

III. Normal force

This is the force exerted upon an object that is in contact with another stable object. Usually a normal force is applied horizontally between two objects in contact. Example- A book resting on a table or a person leaning on the wall.

IV. Air Resistance force

This a frictional force applied on objects when they are in air. Often the Air Resistance force opposes the movement of the object. It is noticeable for objects that travel at high speed up in the air. Example- An airplane or a parachute.

V. Applied force

A force with which an object has been pushed or pulled. Here a force is applied to an object by a person or any other object. Example- A person pushing a chair to the other side of the room

VI. Spring force

It is the force which results when a spring is stretched or compressed. A spring is a metal elastic device that returns to its original form when pulled or pressed. If the spring is stretched, spring force is attractive. If it is compressed, spring force is repulsive. Example- Trampoline, diving board etc.

11.4.2 NON-CONTACT FORCES

These are also called as 'Action at a Distance Forces'. These types of forces happen when two interactive objects are not in physical contact with each other; yet they are able

to push or pull. Types of Action at a distance forces are: Gravitational force, Electrical force and Magnetic forces.

I. Gravitational force

This is the force by which the Earth or moon or other massively huge objects attract another object towards them. All objects on the Earth experience the gravitational force, which is directed downwards towards the center of the earth. The force of gravity is always equal to the weight of the object.

II. Electrical force

It is one of the fundamental forces of the Universe. It is a force that exists between all charged particles. It is all around us. It is responsible for making our hair stand on a cold day. When the hair on the head stands and refuses to be brushed, that is static energy. It is this force which allows you to see when you turn on the lamp in a dark room.

III. Magnetic force

This is a push or pull exerted by a magnet. The force of attraction between an object and a magnet is called magnetism. All magnets have north and south poles. This force is the attraction or repulsion that arises between electrically charged particles due to their motion. Example- Iron nails when placed near a magnet.

Check your Progress

Q.2. Choose the correct option for the following questions:

Q.1 What is defined as a push or pull?

(a) force

(b) motion

(c) vector

(d) speed

Q.2. This type of force is when one object pushes or pulls on another object by touching it:

(a) contact

(b) gravity

(c) friction

(d) Non-contact

Q.3. This type of force is an attraction between two objects:

(a) contact

(b) gravity

(c) friction

(d) spring

Q.4 This type of force resist motion between two surfaces that are pressed together:

(a) contact

(b) gravity

(c) friction

(d) Air resistance

11.5 CONCEPT OF FRICTION

Friction is the force that resists motion when the surface of one object comes into contact with the surface of another. In a machine, friction reduces the mechanical advantage, or the ratio of output to input: an automobile, for instance, uses one-quarter of its energy on reducing friction. Yet, it is also friction in the tires that allows the car to stay on the road, and friction in the clutch that makes it possible to drive at all. From matches to machines to molecular structures, friction is one of the most significant phenomena in the physical world.

Friction is the force resisting the relative motion of not only solid surfaces, but of fluid layers, and material elements too sliding against each other.

Measurement

· A tribometer is an instrument that measures friction on a surface.

· A profilograph is a device used to measure pavement surface roughness.

11.5.1 TYPES OF FRICTION

Friction is the force that opposes motion between any surfaces that are in contact. There are four types of friction: static, sliding, rolling, and fluid friction. Static, sliding, and rolling friction occur between solid surfaces. Fluid friction occurs in liquids and gases. All four types of friction are described below:

· Static friction acts on objects when they are resting on a surface. For example, if you are hiking in the woods, there is static friction between your shoes and the trail each time you put down your foot. Without this static friction, your feet would slip out from under you, making it difficult to walk. In fact, that's exactly what happens if you try to walk on ice. That's because ice is very slippery and offers very little friction.

· Sliding friction is friction that acts on objects when they are sliding over a surface. Sliding friction is weaker than static friction. That's why it's easier to slide a piece of furniture over the floor after you start it moving than it is to get it moving in the first place. Sliding friction can be useful. For example, you use sliding friction when you write with a pencil. The pencil “lead” slides easily over the paper, but there's just enough friction between the pencil and paper to leave a mark.

Rolling friction is friction that acts on objects when they are rolling over a surface. Rolling friction is much weaker than sliding friction or static friction. This explains why most forms of ground transportation use wheels, including bicycles, cars, 4-wheelers, roller skates, scooters, and skateboards. Ball bearings are another use of rolling friction. You can see what they look like in the Figure 2. They let parts of a wheel or other machine roll rather than slide over on another.

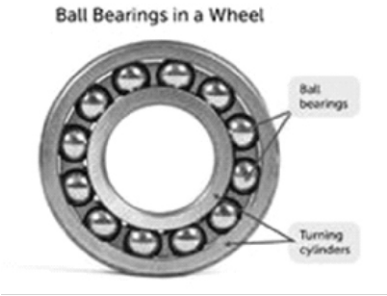


Figure 2: The ball bearings in this wheel reduce friction between the inner and outer cylinders when they turn.

· Fluid friction describes the friction between layers of a viscous fluid that are moving relative to each other. Fluid friction is friction that acts on objects that are moving through a fluid. A fluid is a substance that can flow and take the shape of its container. Fluids include liquids and gases. If you've ever tried to push your open hand through the water in a tub or pool, then you've experienced fluid friction. You can feel the resistance of the water against your hand. When a skydiver falls toward Earth with a parachute. Resistance of the air against the parachute slows his descent. The faster or larger a moving object is, the greater is the fluid friction resisting its motion. That's why there is greater air resistance against the parachute than the skydiver's body.

11.5.2 ADVANTAGES AND DISADVANTAGES

Friction is an important factor in many engineering disciplines. Its applications can be understood in the following paragraphs:

Transportation

Automobile brakes inherently rely on friction, slowing a vehicle by converting its kinetic energy into heat. Incidentally, dispersing this large amount of heat safely is one technical challenge in designing brake systems. Disk brakes rely on friction between a disc and brake pads that are squeezed transversely against the rotating disc. In Drum brakes, brake shoes or pads are pressed outwards against a rotating cylinder (brake drum) to create friction. Since braking discs can be more efficiently cooled than drums, disc brakes have better stopping performance.

Rail adhesion refers to the grip wheels of a train have on the rails.

Road slipperiness is an important design and safety factor for automobiles.

Split friction is a particularly dangerous condition arising due to varying friction on either side of a car.

Road texture affects the interaction of tires and the driving surface.

Household usage

Friction is used to heat and ignite matchsticks (friction between the head of a matchstick and the rubbing surface of the match box).

Sticky pads are used to prevent object from slipping off smooth surfaces by effectively increasing the friction coefficient between the surface and the object.

Advantages of Friction

Friction plays a vital role in our daily life. Without friction we are handicap.

1. It becomes difficult to walk on a slippery road due to low friction. When we move on ice, it becomes difficult to walk due to low friction of ice.

2. We cannot fix nail in the wood or wall if there is no friction. It is friction which holds the nail.

3. A horse cannot pull a cart unless friction furnishes him a secure foothold.

Disadvantages of Friction

Despite the fact that friction is very important in our daily life, it also has some disadvantages like:

1. The main disadvantage of friction is that it produces heat in various parts of machines. In this way some useful energy is wasted as heat energy.

2. Due to friction we have to exert more power in machines.

3. It opposes the motion.

4. Due to friction, noise is also produced in machines.

5. Due to friction, engines of automobiles consume more fuel which is a money loss.

11.5.3 METHODS OF INCREASING AND DECREASING FRICTION

Methods of increasing friction

By making the surface rough, friction can be increased. Examples of increasing friction- the tyres of a motor car and bicycles are made rough to increase the friction. When a ground or surface become slippery after rain or water splashing, it is made rough by spreading sand to increase the friction.

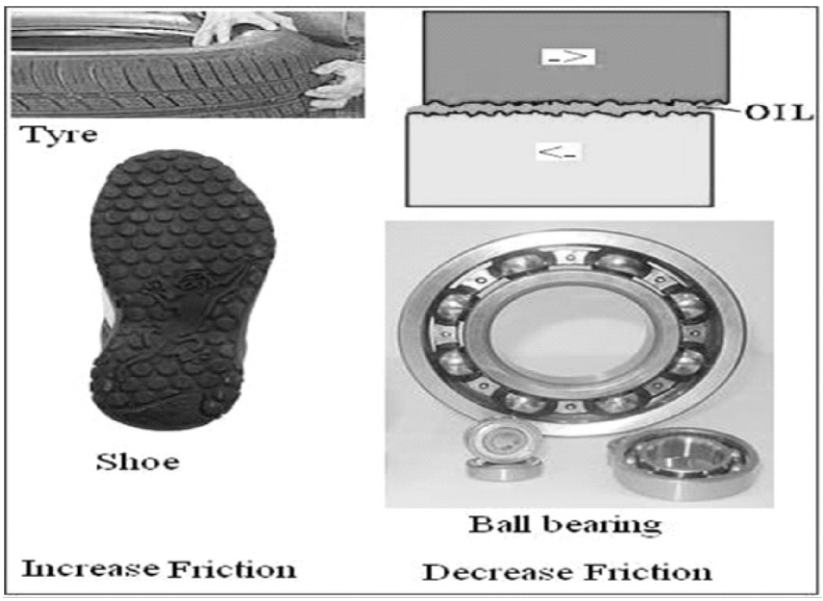


Figure 3: Methods of increasing and decreasing friction

Methods of Decreasing Friction

There are a number of methods to reduce friction, some of them have been discussed as under:

USE OF LUBRICANTS

The parts of machines which are moving over one another must be properly lubricated by using oils and lubricants of suitable viscosity. The interlocking and projections are minimized by this method.

USE OF GREASE

Proper greasing between the sliding parts of machine reduces the friction.

USE OF BALL BEARING

In machines where possible, sliding friction can be replaced by rolling friction by using ball bearings. For example-the free wheel of a cycle, the axle of a motorcar, the shafts of the motor dynamo etc. are provided with ball-bearings.

DESIGN MODIFICATION

Friction can be reduced by changing the design of fast moving objects. The front of vehicles and airplanes made oblong to minimize friction.

It can be concluded from the discussion that, Friction is a force. It is highly applicable in day to day life. It can be a boon or sometimes proves ill. As seen above the function of ball bearing in reducing or decreasing friction plays major role in heating up and loss of machine parts. So, it plays an important role.

Check your Progress

Q.3. Fill in the blanks:

(a) Friction opposes the _____ between the surfaces in contact with each other.

(b) Friction depends upon the _____ of surfaces.

(c) Friction produces _____.

(d) Sprinkling of powder on the carom board _____ friction.

(e) Sliding friction is _____ than the static friction.

11.6 LET US SUM UP

Heat is a form of energy, which is exchanged between two bodies when they are at different temperatures.

Degree of hotness is called temperature and it can be measured in different scales.

The SI unit of heat is joule (J).

Heat can travel shift from one place to another in three manners namely: Radiation,

Convection and Conduction.

Conduction and convection need matter to transfer heat.

Force is the push or pull the body undergoes when two bodies undergo interaction with each other.

Friction is the force that resists motion when the surface of one object comes into contact with the surface of another.

11.7 LESSON END EXERCISE

Short-Answer Type Questions:

Q.No.1 What are contact forces?

Q.No.2 How can we increase or decrease friction?

Q.No.3 How heat is transferred from one place to another?

Long-Answer Type Questions:

Q. No.1. Explain the concept and types of force in detail.

Q. No.2. What is friction? Explain friction as friend and foe to human beings?

11.8 SUGGESTED FURTHER READINGS

NCERT (2018). Science Handbook for Class X.

NCERT (2018). Science Handbook for Class IX.

https://byjus.com/physics/heat-transfer-conduction-convection-and-radiation/

Science Clarified (2018). Friction, Retrieved July 6, 2018 from http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-3-Physics-Vol-1/Friction.html

https://www.ck12.org/physics/types-of-friction/lesson/Types-of-Friction-MS-PS/

11.9 ANSWERS TO CHECK YOUR PROGRESS

Q. No.1. correct options

1. (c)

2. (c)

3. (b)

4. (d)

Q. No.2. correct options

1. (a)

2. (a)

3. (b)

4. (c)

Q.No. 3. Fill in the blanks:

(a) Motion

(b) Nature

(c) Heat

(d) Reduces

(e) Less

ACID, BASES AND SALTS

STRUCTURE

12.1 Introduction

12.2 Objectives

12.3 Acids, Bases And Salts

12.3.1 Types, Properties And Applications In Day To Day Life

12.4 Structure Of Matter

12.4.1 Elements, Compounds, Mixtures And Their Properties

12.5 Atomicity

12.6 Let Us Sum Up

12.7 Lesson End Exercise

12.8 Suggested Further Readings

12.9 Answers To Check Your Progress

12.1 INTRODUCTION

Abhay's mother boiled an egg for him. Since it was very hot she poured some water from a bottle in a bowl and put the egg in it to cool. After a while when she came to pick the egg, she was surprised to find that the shell of the egg was gone! Wonder what happened, she checked the smell of the 'water' and realized that it was actually vinegar! Vinegar is a type of chemical called an acid. There are different ways in which substances can be classified such as solids, liquids, gases or elements, compounds, and mixtures. Similarly, acids and bases is another important classification that we are going to study in this chapter.

In this chapter we will learn:

- What are acids and bases
- Different types of acids and bases.
- Ways of identifying them.
- A process called neutralization.
- The concept of salts
- How are acids and bases used in daily life.

Chemical compounds can be broadly divided into three categories - acids, bases and salts. Acids and bases are strong chemicals and have opposite chemical properties. Acids have a sour taste while bases have a bitter taste. When acids and bases react with each other, they form another class of compounds called salts. Thus, acid, bases and salts form the three main classes of chemicals.

12.2 OBJECTIVES

1. To study about acids, bases and salts

2. To study about structure of matter

3. To study about atomicity

12.3 ACIDS, BASES AND SALTS

Acids

An acid is a chemical species that donates protons or hydrogen ions and/or accepts electrons. Most acids contain a hydrogen atom bonded that can release (dissociate) to yield a cation and anion in water. The higher the concentration of hydrogen ions produced by an acid, the higher its acidity and the lower the pH of the solution.

The word acid from the Latin words acidus or acere, which mean "sour", since one of the characteristics of acids in water is a sour taste (e.g., vinegar or lemon juice).

The term acid was originally used to describe any substance that had a sour taste. Many fruits are sour because they contain acids. This property gave acids their name. Vinegar which is used to preserve food and sulfuric acid which is found in car batteries are examples of acidic substances.

Arrhenius, Brønsted-Lowry and Lewis Acids

There are different ways of defining acids. When a person refers to "an acid", this usually refers to an Arrhenius or Brønsted-Lowry acid. A Lewis acid is typically called a "Lewis acid". The reason is because these definitions don't include the same set of molecules.

- **Arrhenius Acid**

By this definition, an acid is a substance which increases the concentration of hydronium ions (H3O+) when added to water.

You may also consider increasing the concentration of hydrogen ion (H+), as an alternative.

Acids are defined as a compound or element that releases hydrogen (H+) ions into the solution.

$$HNO_3(aq) \xrightarrow{H_2O} H^+(aq) + NO_3^-(aq)$$

In this reaction nitric acid (HNO3) dissociates into hydrogen (H+) and nitrate (NO3-) ions when dissolved in water.

- **Brønsted-Lowry Acid**

By this definition, an acid is a material capable of acting as a proton donor. This is a less restrictive definition because solvents besides water are not excluded. Essentially, any compound that can be deprotonated is a Brønsted-Lowry acid, including typical acids, plus amines and alcohol.

This is the most widely used definition of an acid.

Here, acids are defined as being able to donate protons in the form of hydrogen ions or acids are proton donors.

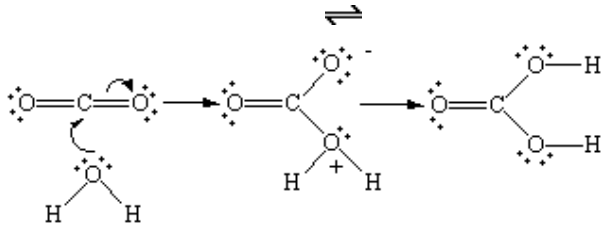
- **Lewis Acid**

A Lewis acid is a compound which can accept an electron pair to form a covalent bond. By this definition, some compounds which don't contain hydrogen qualify as acids, including aluminum trichloride and boron trifluoride.

The Lewis acid-base theory can also be used to explain why non-metal oxides such as CO_2 dissolve in water to form acids, such as carbonic acid H_2CO_3.

$$CO_2(g) + H_2O(l) \quad H_2CO_3(aq)$$

In the course of this reaction, the water molecule acts as an electron-pair donor, or Lewis base. The electron-pair acceptor is the carbon atom in CO_2. When the carbon atom picks up a pair of electrons from the water molecule, it no longer needs to form double bonds with both of the other oxygen atoms as shown in the figure below



One of the oxygen atoms in the intermediate formed when water is added to CO_2 carries a positive charge; another carries a negative charge. After an H+ ion has been transferred from one of these oxygen atoms to the other, all of the oxygen atoms in the compound are electrically neutral. The net result of the reaction between CO_2 and water is therefore, carbonic acid, H_2CO_3.

Strong and Weak Acids

Acids may be identified as either strong or weak acids based on how completely they dissociate into their ions in water. A strong acid, such as hydrochloric acid, completely dissociates into its ions in water. A weak acid only partly dissociates into its ions, so the solution contains water, ions, and the acid (e.g., acetic acid).

Bases

A base is a chemical species that donates electrons or hydroxide ions or that accepts protons.

- **Arrhenius definition**

o acid-base reactions are characterized by acids, which dissociate in aqueous solution to form hydrogen ions (H+) and bases, which form hydroxide (OH−) ions. Acids are defined as a compound or element that releases hydrogen (H+) ions into the solution

Bases are defined as a compound or element that releases hydroxide (OH-) ions into the solution.

o In this reaction lithium hydroxide (LiOH) dissociates into lithium (Li+) and hydroxide (OH-) ions when dissolved in water.

- Bronsted-Lowry Definitions

o definitions of acids and bases based on compounds abilities to either donate or accept protons (H+ ions).

o Here, whereas bases are defined as being able to accept protons.

o basically:

§ acids are proton dono $LiOH(s) \xrightarrow{H_2O} Li^+(aq) + OH^-(aq)$

§ bases are proton acceptors

o In the Brønsted-Lowry system, an acid reacts by donating a proton to a base. In doing so, the acid becomes its conjugate base. The formula of the conjugate base is the formula of the acid less one hydrogen. The reacting base becomes its conjugate acid.

o The formula of the conjugate acid is the formula of the base plus one hydrogen ion.

In the equation for the reaction each acid-base pair has the same subscript. Acid1 is HCl, its conjugate base is base1; hydroxide ion is base 2, and its conjugate acid (water) is acid2.

$$\underset{\text{acid}_1}{HCl} + Na^+ + \underset{\text{base}_2}{OH^-} \longrightarrow \underset{\text{acid}_2}{H_2O} + Na^+ + \underset{\text{base}_1}{Cl^-}$$

o Chloride ion is the conjugate base of hydrochloric acid. Water is the conjugate acid of the hydroxide ion. In this equation the sodium ion is a spectator ion.

The equation for the reaction of hydrochloric acid with ammonia is

$$\underset{\text{acid}_1}{HCl} + \underset{\text{base}_2}{NH_3} \longrightarrow \underset{\text{acid}_2}{NH_4^+} + \underset{\text{base}_1}{Cl^-}$$

When water reacts with ammonia, it is acting as an acid:

$$\underset{\text{acid}_1}{H_2O} + \underset{\text{base}_2}{NH_3} \longrightarrow \underset{\text{acid}_2}{NH_4^+} + \underset{\text{base}_1}{OH^-}$$

Hydroxide ion is the conjugate base of water. When water reacts with an acid, it is acting as a base:

$$\underset{\text{base}_1}{H_2O} + \underset{\text{acid}_2}{HCl} \longrightarrow \underset{\text{acid}_1}{H_3O^+} + \underset{\text{base}_2}{Cl^-}$$

o The conjugate acid of water is the hydronium ion, H3O+, an ion formed by the association of a hydrogen ion with a water molecule

· Lewis Definition of Acid-Bases

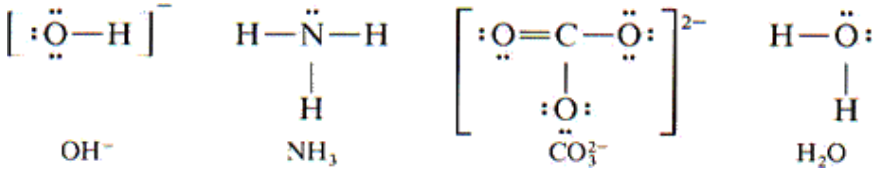
o A Lewis acid is an electron pair acceptor.

o A Lewis base is an electron pair donor.

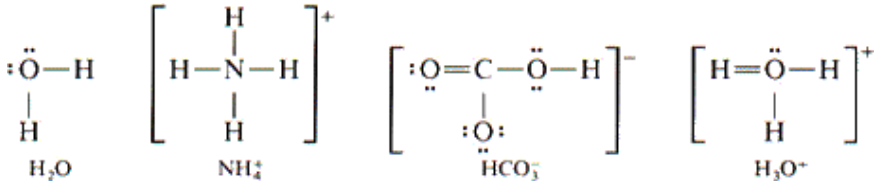
o This definition is more general than those we have seen to this point; any Arrhenius acid or base, or any Bronsted-Lowry acid or base can also be viewed as a Lewis acid or base.

o proposed bases donate unshared electron pairs to acids, regardless of whether the donation is made to a proton or to another atom.

Following are Lewis structures for some bases.



Each of these bases has at least one unshared pair of electrons on a very electronegative atom. When a proton or hydrogen ion is added to these structures, it forms a covalent bond with one of these unshared electron pairs, as shown below:



Bases are substances that taste bitter and feel slippery to the skin. All metal oxides and hydroxides are bases (except ammonium hydroxide, which is not a metallic hydroxide).

Soluble bases are called alkalis. Thus, an alkali is a base which is soluble in water, but not all bases are alkalis. There are other bases which are insoluble.

Strength of Acid or Base Solutions

- A scale for measuring hydrogen ion concentration in a solution (Table 1 and Figure1), called pH scale has been developed. The p in pH stands for 'potenz' in German, meaning power.

p= potential or Power and H = Hydrogen

Table 1: pH values for neutral, basic and acidic solution

pH	**Solution**	Concentration of H_3O^+ and OH^-
pH =7	Neutral Solution	$H_3O^+ = OH^-$
pH>7	Basic Solution	$H_3O^+ < OH^-$
pH<7	Acidic Solution	$H_3O^+ > OH^-$

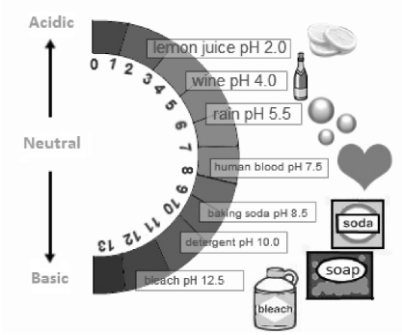


Figure 1: Range of pH

Summary of Acid and Base Properties

This table (Table 2) offers an overview of key properties of acids compared with bases:

Table 2: Properties of acids and bases

Property	Acid	Base
pH	less than 7	greater than 7
litmus paper	blue to red	don't change litmus, but can return acid (red) paper back to blue
taste	sour (e.g. vinegar)	bitter (e.g., baking soda)
odor	burning sensation	often no odor (exception is ammonia)
texture	Sticky	slippery
reactivity	reacts with metals to produce hydrogen gas	reacts with several fats and oils

Salts

Salts are neutral compounds. Salt is ionic compound composed of a metal and a non-metal or polyatomic ion. Solutions of salts in water are called electrolytes. Electrolytes as well as molten salts conduct electricity.

A salt is produced when an acid reacts with a base. The non-metallic ions of the acid and the metal ions of the base form the salt.

Acid + Base —-> Salt + Water

Salts can be of several different colours. Usually, salts are odourless. They are generally neutral i.e. salts have pH = 7. Some common examples of Salts are Toothpaste, Kitchen Salt. Other uses of salts are as fertilisers in agriculture, as food preservatives, photography, etc.

Is Salt an Acid or Base?

When a salt is dissolved in water ions of the salt interact with water to cause acidity or basicity in aqueous solution. A solution of the salt of strong acid and weak base is acidic and for it pH < 7 or $[H^+] > 10^{-7}$, for example $FeCl_3$. Here the solution is acidic and involves cationic hydrolysis.

A solution of the salt of strong base and weak acid is basic and for it, pH > 7 or $[H^+] < 10^{-7}$, for example, KCN (salt of a strong base + weak acid). Here the solution is basic and involves anionic hydrolysis.

12.3.1 TYPES, PROPERTIES AND APPLICATIONS IN DAY TO DAY LIFE

Types

Acids

1. **Organic acids -** Acids derived from plants. For example, citric, oxalic, tartaric and acetic acid.

2. **Inorganic acids** - Acids derived from minerals (mineral acids). For example, HCl, H_2SO_4 and HNO_3.

3. **Hydracids** - Acids containing hydrogen and non-metallic element other than oxygen. For example, HCl, HBr, HI, etc.

4. **Oxyacids** - Acids containing hydrogen, another element and oxygen. For example, HNO_3 and H_2SO_4.

Bases

1. **Strong base** - Strong bases which dissociate completely in solution. For example, NaOH, KOH,etc.

2. **Weak base** - Weak bases do not dissociate completely and so they exist in equilibrium. For example ammonia and amines are weak bases.

Salts

1. **Neutral salts**- formed by reaction between strong acid and strong base. Does not change the colour of litmus (e.g. NaCl)

2. **Acidic salts**- formed by reaction between strong acid and weak base. Solution is acidic. e.g. $CuSO_4$

3. **Acidic salts**- formed by reaction between weak acid and strong base. Solution is basic. e.g. Na_2CO_3

Properties

Properties of acids

1. Acids release a hydrogen ion in aqueous solution.

2. Acids neutralize base in a neutralization reaction.

3. Acids turn blue litmus red.

Properties of bases

1. Bases taste bitter. Tasting of bases is more dangerous than tasting acids due to the property of stronger bases to denature protein.

2. Bases release a hydroxide ion in aqueous solution.

3. Base neutralizes acids in a neutralization reaction. Acid plus base makes water plus salt.

4. Bases denature protein. This accounts for the "slippery" feeling on hands when exposed to base.

5. Bases turn red litmus blue.

Properties of salts

1. Salts are usually solid crystals with a relatively high melting point. Inorganic salts usually have a low hardness and low compressibility similar to edible salt.

2. Salts can be clear and transparent, opaque or metallic and lustrous.

3. Most of the salts are soluble in water. (Except for some like calcium carbonate)

4. Solution of salt in water acts as good conductors of electricity.

5. Some of the salts are white crystals whereas some of them are coloured. (For example, copper sulphate is blue and ferrous sulphate is green)

6. Two or more salts that crystallise to form a single substance are referred to as mixed salts. For example, Alum is a mixed salt.

Applications in Day to Day Life

Acids

1. Sulfuric acid is used in the manufacture of paints, plastics, drugs, detergents and in petrol refining, in lead accumulators and in cleaning of metal surfaces before they are coated with other metals.

2. Nitric acid is used to prepare dyes, drugs, explosives, fertilizers and quick drying paints. It is also used in the purification of gold and silver.

3. Hydrochloric acid is used to remove the impurities from the surface of the articles made of iron and steel before galvanization with zinc.

Bases

1. Sodium hydroxide is used in the manufacture of soap, paper, artificial silk, medicines and organic dyes, in the purification of oil products. It is also used as an electrolyte in alkaline batteries.

2. Calcium hydroxide is used as a material for dressing of acid burns. It is also used as a manufacture of bleaching powder and as an antidote for acid poisoning.

3. Ammonium hydroxide is used as a reagent in the laboratory, and in removing grease from glass panes, ink spots from clothes.

Salts

Without a sprinkle of salt, would you like to have your daily food? From a spot on our dining tables to their use in industries, salt has an important role to play. Let us see how a few salts help us today (Table 3).

Table 3: Common name and uses of different salts

Name of the Salt	Common Name	Uses
Sodium Chloride	Table Salt/Common Salt	Major ingredient in cooking and acts as a food preservative
Sodium Carbonate	Washing Soda	Used in laundry
Sodium Bicarbonate	Baking Soda	Used as a baking agent, in medicines, and as a fire extinguisher
Calcium Carbonate	Limestone	Used in construction of buildings, purification of iron and also as a dietary supplement
Potassium Aluminium Sulphate	Alum	Used in purification of water and in the textile industry
Ammonium chloride	Sal ammoniac	used in dry cell, battery and in the manufacture of medicine
Potassium nitrate	Saltpeter	as meat preservative and in the manufacture of fertilizers and fireworks
Silver nitrate	Lunar caustic	in medicine and photography
Potassium carbonate	Potash	in the manufacture of glass and soap
Sodium hypochlorite	Bleach	in bleaching/laundry
Calcium sulfate	Bassanite	in making moulds and casts

Check your Progress

Q.1. Choose the correct option for the following questions:

1. Which of the following ions or molecules can act as a Lewis base?

(a) Ag+

(b) Nh_3

(c) $AlCl_3$

(d) Bf_3

2. In the reaction, H_2O + HCl H_3O+ + Cl- , which is the conjugate acid of water?

(a) H_2O

(b) Hcl

(c) H_3O+

(d) Cl-

3.According to Bronsted-Lowry definition of acids and bases:

(a) bases are proton acceptors

(b) acids are proton acceptors

(c) bases are proton donors

(d) bases are electron acceptors

4. Which of the following has been used in medicine and photography:

(a) Calcium Carbonate

(b) Potassium carbonate

(c) Potassium nitrate ⟶

(d) Silver nitrate

12.4 STRUCTURE OF MATTER

The term matter refers to anything that occupies space and has mass—in other words, the "stuff" that the universe is made of. All matter is made up of substances called elements, which have specific chemical and physical properties and cannot be broken down into other substances through ordinary chemical reactions. Gold, for instance, is an element, and so is carbon. There are 118 elements, but only 92 occur naturally. The remaining elements have only been made in laboratories and are unstable.

Each element is designated by its chemical symbol, which is a single capital letter or, when the first letter is already "taken" by another element, a combination of two letters. Some elements follow the English term for the element, such as C for carbon and Ca for calcium. Other elements' chemical symbols come from their Latin names; for example, the symbol for sodium is Na, which is a short form of natrium, the Latin word for sodium.

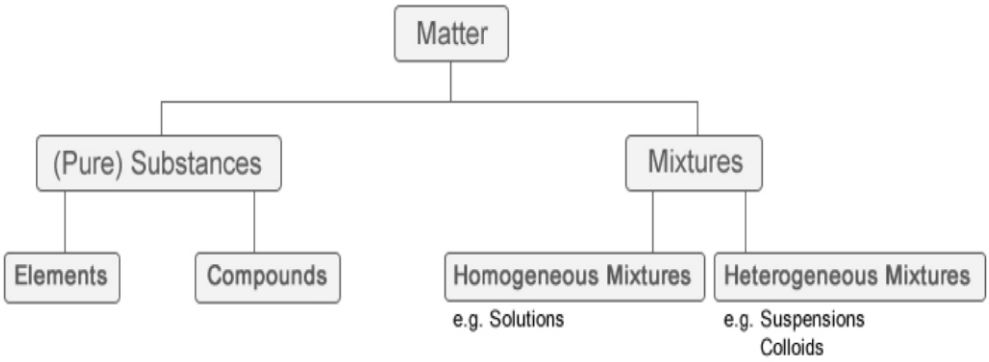
The four elements common to all living organisms are oxygen (O), carbon (C), hydrogen (H), and nitrogen (N), which together make up about 96% of the human body. In the non-living world, elements are found in different proportions, and some elements common to living organisms are relatively rare on the earth as a whole. All elements and the chemical reactions between them obey the same chemical and physical laws, regardless of whether they are a part of the living or nonliving world.

Chemistry is the study of physical matter, which is classified in many different ways, such as state of matter (gas, liquid or solid), chemical form (element, mixture or compound), chemical structure (atoms or molecules, etc.) and so on.

Elements, Compounds and Mixtures their Properties

It is important to understand the terms **"element", "mixture"** and **"compound"**,

because these convey useful information. Another useful term is the word **"substance"**, which can be used to refer to either an element or a compound - but not to a mixture because a **"substance"** always has a definite composition. The most general term is **"matter"** which can be used to refer to any of **"substances"**, **"elements", "mixtures"** or **"compounds"**.



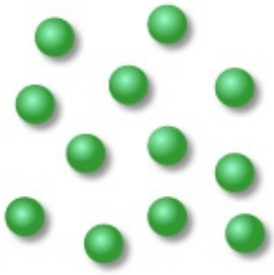
The categories of elements, mixtures and compounds are described in words below:

Elements

1. **consist of only one type of atom** - which may, or may not join together to form molecules or large structures, therefore:

2. can exist as either atoms (e.g. argon) or molecules (e.g., nitrogen)

3. cannot be broken down into a simpler type of matter by either physical or chemical techniques - *though some larger elements break-down spontaneously due to being radioactive.*



Example 1 : Element existing in the form of atoms.



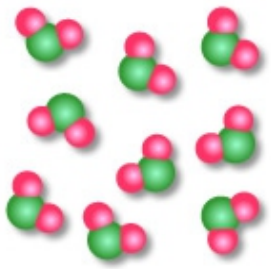
Example 2 : Element existing in the form of diatomic molecules (i.e. molecules formed from two atoms).

Elements are listed in the periodic table.

Many elements are found in nature and so may be called "naturally occurring elements". Other elements have not been found in nature but can be produced in the laboratory. A few more elements are thought to exist but are very rare and even if produced, would only exist for a very short time because they are radioactive and would quickly decompose into other elements whose atoms are smaller.

Compounds

1. **consist of atoms of two or more different elements bound together chemically,**
2. can be broken down into a simpler type of matter (elements) by chemical means; but not by physical means
3. always contains the same ratio of component atoms.
4. have properties different from their component elements (e.g. the compound water (H_2O) is a liquid at room temperature and pressure and has different chemical properties from those of the two elements, hydrogen (H_2) and oxygen (O_2), from which it is formed).



Example 1: Compound whose molecules consist of one atom of one element chemically joined with two atoms of another element.

A **compound** is a pure substance that consists of two or more elements chemically combined in a fixed proportion that can be further subdivided into simpler substances by chemical (not physical) means only.

So, if a quantity of a material consists of atoms of two or more elements joined together, always in the same ratio, then the matter forming that material is a compound.

A **molecule** is the smallest part of a compound whose properties are those of the

compound.

A **compound** can be represented by using a chemical formula.

Mixtures

1. consist of two or more different elements and/or compounds - physically intermingled,

2. can be separated into their constituent parts by physical means (e.g. distilation of liquids or separating magnetic and non-magnetic solids using a magnet), and

3. have many of the properties of their constituent parts (e.g. the element "oxygen" is part of the mixture "air" and some of the properties of air are due to the oxygen, albeit somewhat reduced compared with pure oxygen due to the presence of the other constituents of the mixture called "air").

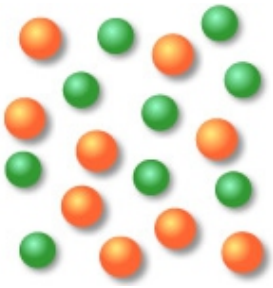
There are many different types of mixtures, some of which have special names. These include:

- **Homogeneous Mixtures -** in which the two or more substances that form the mixture are evenly distributed throughout the mixture, e.g. vinegar is a homogeneous mixture of ethanoic acid and water.
- **Heterogeneous Mixtures -** in which the two or more substances that form the mixture are not evenly distributed throughout the mixture, e.g. oil and water.
- **Solutions -** a special type of homogeneous mixtures in which one substance (called the "solute") is dissolved in another substance (called the "solvent"), e.g. salt water is salt dissolved in water - in such a way that the salt no-longer exists as solid particles within the water.
- **Suspensions -** heterogeneous fluid mixtures containing solid particles large enough for sedimentation, which means that the particles (compare with the "solute" part of a solution) will eventually settle to the bottom of the container (unlike in the case of colloids, below), e.g. particles of sand in water.
- **Colloids -** heterogeneous mixtures in which one is substance microscopically dispersed evenly throughout another substance (for comparison, the size of the

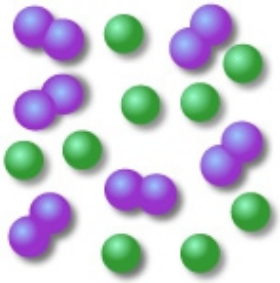
particles of "solute" are greater than in the case of a solution, but much smaller than in the case of a suspension). There are many naturally occuring colloids, e.g. milk. Colloids are very important in biology and medicine.

- **Alloys -** mixtures in which the main elememt (or elements) are metal(s). A more technical definition of an alloy is "a partial or complete solid solution of one or more elements in a metallic matrix". Common examples of alloys include bronze, brass and steels.

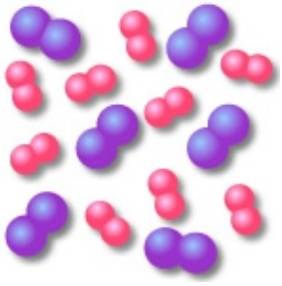
These different types of mixtures are interesting but may not be essential knowledge for GCSE Chemistry. The descriptions are non-technical (omitting details, e.g. particle sizes), but sufficient for comparison of these different types of mixtures.



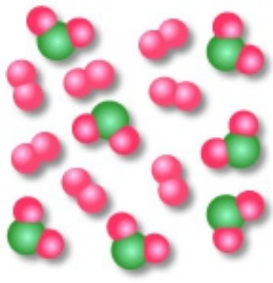
Example 1 : Mixture of two elements, both of which exist as atoms rather than molecules.



Example 2 :Mixture of two elements, one of which exists as atoms, the other as molecules.



Example 3 : Mixture of two elements, both of which exist as molecules rather than atoms.



Example 4 : Mixture of an element (that exists in the form of molecules) and a compound.

Check your Progress

Q.2. State whether the following statements are True or False:

1. Elements consist of only one type of atoms.

2. Compounds consist of atoms of two or more different elements bound together chemically.

3. In a homogeneous mixture, two or more substances that form the mixture are evenly distributed throughout the mixture.

4. Mixture cannot be separated into their constituent parts by physical means.

12.5 ATOMICITY

The molecules of an element are constituted by the same type of atoms. Molecules of many elements, such as argon (Ar), helium (He) etc. are made up of only one atom of that element. But this is not the case with most of the non-metals. For example, a molecule of oxygen consists of two atoms of oxygen and hence it is known as a diatomic molecule, O2. If 3 atoms of oxygen unite into a molecule, instead of the usual 2, we get ozone, O3. The number of atoms constituting a molecule is known as its atomicity.

Metals and some other elements, such as carbon, do not have a simple structure but consist of a very large and indefinite number of atoms bonded together. Let us look at the atomicity of some non-metals (Table 4).

Table 4: Atomicity of some elements

Type of Element	Name	Atomicity
Non-Metal	Argon	Monoatomic
	Helium	Monoatomic
	Oxygen	Diatomic
	Hydrogen	Diatomic
	Nitrogen	Diatomic
	Chlorine	Diatomic
	Phosphorus	Tetra-atomic
	Sulphur	Poly-atomic

12.6 LET US SUM UP

- Acid-base indicators are dyes or mixtures of dyes which are used to indicate the presence of acids and bases.
- Acidic nature of a substance is due to the formation of H+(aq) ions in solution. Formation of OH–(aq) ions in solution is responsible for the basic nature of a substance.
- When an acid reacts with a metal, hydrogen gas is evolved and a corresponding salt is formed.
- When a base reacts with a metal, along with the evolution of hydrogen gas a salt is formed which has a negative ion composed of the metal and oxygen.
- When an acid reacts with a metal carbonate or metal hydrogencarbonate, it gives the corresponding salt, carbon dioxide gas and water.
- Acidic and basic solutions in water conduct electricity because they produce hydrogen and hydroxide ions respectively.
- The strength of an acid or an alkali can be tested by using a scale called the pH scale (0-14) which gives the measure of hydrogen ion concentration in a solution.
- A neutral solution has a pH of exactly 7, while an acidic solution has a pH less than 7 and a basic solution a pH more than 7.
- Living beings carry out their metabolic activities within an optimal pH range.
- Mixing concentrated acids or bases with water is a highly exothermic process.
- Acids and bases neutralise each other to form corresponding salts and water.
- Salts have various uses in everyday life and in industries.
- The number of atoms constituting a molecule is known as its atomicity.

12.7 LESSON END EXERCISE

Short-Answer Type Questions:

Q.No.1 How is strength of acid or base solutions assessed?

Q.No.2 How salts are being used in our daily life?

Q.No.3 Define atomicity.

Long-Answer Type Questions:

Q. No.1. Explain the Arrhenius, Brønsted-Lowry and Lewis Acids and bases in detail.

Q. No.2. What is the structure of matter as per its chemical form?

12.8 SUGGESTED FURTHER READINGS

NCERT (2018). Science Handbook for Class X.

NCERT (2018). Science Handbook for Class IX.

https://www.khanacademy.org/science/biology/water-acids-and-bases/acids-bases-and-ph/a/acids-bases-ph-and-bufffers

https://chem.libretexts.org/Textbook_Maps/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Acids_and_Bases/Acid/Overview_of_Acids_and_Bases

http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch11/acidbase.php

https://www.youtube.com/watch?v=yE8gSY4l0hs

https://www.nobelprize.org/educational/physics/matter/1.html

https://www.youtube.com/watch?v=yjpfievEmpM

12.9 ANSWERS TO CHECK YOUR PROGRESS

Q. No.1. correct options

1. (b)

2. (c)

3. (a)

4. (d)

Q. No.2 State True/False:

1. True

2. True

3. True

4. False