Pedagogy of Physical Sciences Activity – 1

How are substances identified? There are two major ways we can describe a substance: physical properties and chemical properties. Learn about how chemists use properties to classify matter as either a mixture or a pure substance.

Matter

Look around you. What do you see? What kinds of things surround you? Maybe a notebook, or your keyboard, a coin in your pocket or even a pet? Think about how you may describe those things. What do they all have in common? You may be able to come up with some similarities; but one key similarity is that they are all matter. Matter is everything around you! Your pencil, a book; even you are matter. One of the most important things chemists do is describe matter. **Matter** is *anything that has mass and takes up space*. Chemists spend their days working with matter: describing it, making measurements and even changing its form.

Physical and Chemical Properties of Matter

Let's take a closer look at a coin in your pocket. It is made from a metal. You can tell it is made from a metal because it is shiny and maybe has a silvery color. Those two descriptions I gave it are called **physical properties**. A physical property is *a characteristic that can be observed or measured without changing the composition*. If you toss your coin in a fountain, it will sink. This is because your coin is more dense than the water in the fountain. *Density* is another example of a physical property. Your coin may be a little wet, but it is still composed of the same material as it was before you tossed it in the fountain. Other examples of physical properties include *color, mass, smell, boiling point, volume and temperature*.

Rust results when iron reacts with oxygen

Now let's talk about your car. Your car is likely made from a metal as well. How can you tell? It probably has a very similar density to the coin in your pocket. What other properties does a car have? If you have ever seen a 'fender bender' then you would know that metals are quite bendable. When they get hit by something, they dent instead of shattering like glass. This property is known as *malleability*. It is a property that almost all of the metals share and it is a physical property because your car is still composed the same metal after it is dented. It just may look a little different.

But what happens if we fast forward 10 years. Now what does that same car look like? Chances are that it may be starting to form some rust. Unfortunately, the iron that was used to make your car is not the most stable of the metals. When it is exposed to oxygen it transforms into rust. This ability to react to oxygen to form rust is called a **chemical property**. A chemical property is *a characteristic that can only be determined by changing the chemical identity of a substance*. What we started with was iron, but when it reacts with the oxygen in the air, it turns into iron oxide, or rust. What are some of the physical properties of rust? Are they anything like the properties of iron? Are they anything like the properties of oxygen? No. Rust has its own set of properties. First, unlike its metallic counterpart, it is brittle. It's also a dull reddish-brown color. So the *ability to react with oxygen* is a chemical property of iron. Other examples of chemical properties include *reactivity with water, reactivity with acid, pH* and my personal favorite: *flammability*, or the ability to burn.

Mixtures and Pure Substances

The reason properties are so important to a chemist is chemists use them to describe matter and the changes it undergoes. They also use properties to put matter into major categories or classifications. For example, if you have a substance that can be physically separated out into other substances, you have a mixture. A **mixture** is *material made up of two or more substances that are physically mixed but not chemically combined*. Take ocean water as an example. The major components of ocean water are water and salt. They can be separated by allowing the water to evaporate. This is a physical separation because we started with salt water, and we ended with salt and water vapor (which is still water). Solutions and alloys are examples of mixtures.

The ocean water mixture separates when the water evaporates into vapor

Pedagogy of P.S Activity-(2)

4. *Establishes* cause-and-effect relationship.
5. *Gives reasons* for a Physical science phenomenon.
6. *Draws inferences* and conclusions from the observed facts, and
7. *Predicts* Physical science phenomenon from the given data

II. AFFECTIVE DOMAIN:

1. Interest:

The pupil develops *interest* on experiments and science events.

Specifications:

The pupil

1. Actively participates in the activities o f science clubs
2. Contributes science material for school and other magazines
3. Read extra books and journals on science and scientists
4. Visits botanical gardens, zoos, museums and forests for getting additional information
5. Improvises science apparatus and models on his own

2. Scientific Attitudes:

The pupil develops *scientific attitudes* towards science phenomena

Specifications:

The pupil

1. Are Curious to known various science phenomena
2. Shows willingness to consider new interpretation of science data,
3. Develops intellectural honesty in expressing and recording science data
4. Believes in cause-and-effect relationship in science data
5. Does not accept or reject views and conclusions without valid reasons,
6. Suspends judgments in the absence of proper evidence, and
7. Shows perseverance in accomplishing various science tasks,

3. Appreciation:

The pupil *appreciates* the science phenomena in nature and the role of science in human welfare.

Specifications:

The pupil assimilates the knowledge of science , derives pleasure in the pursuit of its study and realises the real significance of the

1. role of science and their importance in daily life,
2. role of science in developing aesthetic sense,
3. Struggle for existence in life

Every one must write only one Teaching Method

4. Contribution of scientists in human welfare,
5. balance of life in nature,
6. Unity underlying diversity exhibited by plants and animals, and
7. Complementarity of structure and function.

III. PSYCHOMOTOR DOMAIN

1. Skills:

The pupil develops skill in

A. Drawing Diagrams,
B. Manipulating apparatus and instruments.
C. Observing Physical science specimens, parts, structures etc.,
D. Scientific Expression.

A) Drawing Skills

Specifications:

The pupil:

1. Draws accurate sketches and diagrams neatly
2. Makes diagrams with sense of proportion
3. Labels diagrams neatly, methodically and correctly, and
4. Draws sketches and diagrams at a reasonable speed

B) Manipulative Skills

The pupil

5. Arrange the apparatus systematically.
6. Handles the apparatus and instruments properly.
7. Reads the instruments with precision.
8. Maintains the apparatus and instruments in order and
9. Improvises apparatus and models

C) Observing Physical science specimens, parts, structures etc.,

The pupil

21. Notices the relevant details in the specimen carefully.
22. Reads the instruments correctly.
23. Discriminates between closely related structures, parts and specimens accurately,
24. Locates the desired parts exactly, and
25. Detects error in experimental set-up and procedures.

D) Skill in Scientific Expression:

The pupil

31. Makes use of correct biological terminology in describing a biological phenomenon,

32. Uses the appropriate terms at the proper place.
33. Puts the ideas in clear, precise and unambiguous terms, and
34. Organizes his thought's systematically

3.3.3 CRITERIA FOR THE SELECTION OF OBJECTIVES

Objectives should be formulated in the light of the needs of the society, the nature of the subject matter and the nature of the learner. In selection the objective Thurber and Collette have suggested the following criteria.

1. Usefulness: The derised learning should have some value in the lives of the puils concerned
2. Practicability: Experiences needed for the development of the learning should be possible.
3. Fitness: The learning should fit into a sequence leading towards broad objectives.
4. Timeliness: Learning should be concerned with material familiar at the present time, not with absolute devices and ideas.
5. Appropriateness: The learning should be appropriate for the maturity and back ground of the pupils.

Besides this there are some other criteria like.

1. **Specificity:** A good objective should be specific.
2. **Unambiguous:** A good objective should not be ambiguous, it should be clear in specifying the desired learning outcome.
3. Feasibility: The objective should be easy to achieve in the classroom.

Review Questions

1. Write the aims and objectives of teaching Physical Sciences?
2. Write the meaning and importance of Objectives?
3. Write the meaning of Instructional Objectives?
4. Explain Blooms Classifications of Educational objectives?
5. Explain Merits and Demerits of Bloom's taxonomy?
6. Write the Instructional objectives and specifications of Teaching Physical Sciences?

UNIT 4

Approaches/Methods and Techniques of Teaching Physical Sciences

Education is an art of all arts and is a developing science. Education all over the world have propounded and designed different approaches and methods of teaching basing on sound philosophical background and universally accepted psychological and educational principles. Teaching is an art and methods of teaching are the ways to understand and practice this art. Effective teaching and learning situations depending upon child centred procedures and active participation of children in the Learning process. These procedures of teaching of mathematics are known as methods of teaching mathematics. Different methods of teaching have been evolved and suggested by different educational thinkers. It is desirable for teacher to learn about all of them so that he can make a rational choice for himself.

4.0 MEANING OF THE TERM METHODS/APPROACH

The word. "Method" in Latin means "Mode" or "ways".

Teaching method is a style of the presentation of content in class-room. M. Verma defined teaching method as "Method is an abstract as logical entities that we can distinguish between manner and methods in reality, they form an organic whole and matter determines method analogously as objective determines means; content and spirit determine style and form of literature."

Gage has defined Teaching method as "Teaching methods are patterns of teacher behaviour that are recurrent, applicable to verse subject – matter, characteristic of more than one teacher and relevant to Learning".

Broudy (1963) has stated that "Method refers to the formal structure of the sequence of acts commonly denoted by instruction. The term method covers both strategies and tactics of teaching and involves the choice of what is to be taught, and in which order is it to be presented".

Importance of Teaching Method and Approaches:

A method or approach is a tool or an instrument in the hands of the teacher to present the content successfully, systematically and satisfactorily.

Good C.V. defines the method / approach as "A standard procedure in the presentation of instructional material and the content of activities, for example, the Herbartian Method, the Morrison Method, etc.

A rational ordering and balancing in the light of knowledge and purpose, of the several elements that enter into the educational process, the nature of the pupil, the materials of instruction, and the total learning situation".

Method or approach is further explained as a procedure for arriving at a destination or goal to attain desired objectives. Characteristics of good method includes.

i) Built on the sound philosophical principles.

ii) Psychological in approach.

iii) Organization of content for effective teaching to avoid waste of time.

iv) Orderly procedure in teaching.

Need and Significance:

Knowledge of these methods may help the children in many ways. Need and significance of the approaches are as follows.

1. Working out a better teaching strategy.
2. Ensure maximum participation of the child
3. Proceeds from concrete to abstract.
4. Provide knowledge at understanding level.
5. To create interest, attitudes and mathematical spirit.
6. To attain the desired objectives at various stages of education.
7. Methods of teaching to learn the content according to help the needs, aptitudes and abilities of the individuals.

Need for Instructional strategies in Teaching:

Strategy is the art of planning the best way to achieve success. These strategies are important because

1. They make the teaching methods easier
2. To make the complicated thing easier
3. To reduce the gap between the teacher and the taught.
4. To reach the desired goals.
5. Individual differences can be met and satisfied.

6. To achieve the objectives.

Principles of Teaching:

Teaching strategies are dependent on

1. Known to unknown
2. Simple to complex
3. Easy to difficult
4. Concrete to abstract
5. Particular to general
6. General to particular

Characteristics of a good teaching method:

1. **Suitable to the level of students:**

   The method adopted should be in accordance with the physical, mental and educational levels of the students.

2. **Interaction:**

   The method should create a good link between the teacher and the student for good teaching atmosphere

3. **Related to Life:**

   It should be related to the problems of life and should show the ways to solve those problems.

4. **Motivation to students:**

   The method should create interest in the teaching learning process.

5. **Opportunities to participate:**

   A good method should provide opportunity for all the students to participate actively in the class room activities.

6. **Guidance:**

   Method should fulfill the objectives of cognitive, affective and psychomotor skills and helps the students to proceed further with their self-help.

CLASSIFICATION OF TEACHING METHODS

Generally the methods of teaching Physical science can be classified into two categories, They are:

1. Teacher-centered methods
2. Pupil-centered methods

1. **Teacher-centered Methods:** In this method, the teacher plays the central and active role. The concentration will be on learning by heart, recalling and memorizing. The students are passive listeners just answering the questions of the teacher. The students ask questions to the teacher rarely. A sort of artificial atmosphere prevails in the classroom.

In this three kinds of methods are included. They are :

a. Lecture Method.
b. Lecture-cum-demonstration.
c. Historical Method

2. **Pupil centered methods:** In these methods, teaching learning process takes place keeping in view the needs, necessities, interests and capacities of the students. There is a natural atmosphere and the students learn in a free atmosphere. The teaching takes place to develop the skills, capabilities of the students and also prepares them to solve the problems. There is a cooperative atmosphere between the teacher and the students. The teacher prepares congenial learning atmosphere and the student uses it to develop his efficiency. In such atmosphere, there is every possibility for the student to learn to the maximum possible extent.

In this following kinds of methods are included. They are :

a. Heuristic Method
b. Project Method.
c. Experimental Method.
d. Inductive, Deductive Method.
e. Problem Solving Method.

4.1 INDUCTIVE AND DEDUCTIVE APPROACHES

4.1.1 INDUCTIVE APPROACH

In the inductive approach the concept/generalization is derived after electing a number of examples from pupils. It is reasoning from "Particular to general". In the teaching of Physical Science we start from every day observations, argue from particular cases to general conclusions, and arrive at laws or principles or theories. This method is known as formula construction method.

Principles of Inductive Approach:

1. Examples to Generalisation.
2. Known to Un-known.
3. Particular to General.

4. Concrete things to abstract things.

Examples:

1. On heating iron expands.
2. On heating copper expands.
3. On heating Aluminum expands.

On heating Iron, Copper, Aluminum expands. All are metals. So, on heating metals expands.

Generalization of the Principle :

On heating all the metals expand.

Joseph says that "We make use of the inductive method of teaching, whenever, we place before children a number of facts, examples or objects, and then endeavour to lead them to draw conclusions". For example in science by heating various metals the student may conclude that metals expand when heated.

Steps in Inductive approach to problem-solving

The various steps in Inductive-approach are:

1. **Sensing the problem:** Here the students define the problem.
2. **Analysing the situation:** Here a detailed analyses of all the aspects of the situation is done.
3. **Collecting the data:** The students collect the relevant data from different sources like books field etc.
4. **Organising the data or information:** The students organize the collected information with the help of teacher.
5. **Framing possible solutions:** After organizing the data, the students frame possible solutions.
6. **Eliminating:** Only possible solutions are retained and the rest are eliminated.
7. **Verification:** The solutions are applied to the problem situations and the results are checked. The procedure is repeated a number of times.

4.1.2 DEDUCTIVE APPROACH

It is opposite to Inductive approach. Deductive approach is "from general to particular". It is sometimes called "going from the known to the unknown", because it involves making logical inferences from general statements that have already been accepted. It is a process of reasoning in which the proposition supplies absolutely conclusive evidences or generalizations. This method also called as a method of verification of formula.

Principles:

1. Generalization / Principles to Examples.
2. Un-known to Known.
3. General to Particular.
4. Abstract things to known things.

Examples: Acids changes blue litmus paper as red and Bases changes red litmus paper as blue.

Take four test tubes containing different liquids in them red-litmus paper was kept. There is no change in colour red-litmus paper of first three test tubes. But in the fourth the test tube red-litmus changed in blue colour. In last tube he took lemon water, he knows that last one is base. So, first three were acids and last one is base. So, he got that acids cannot change the red litmus paper, bases changes it as blue like this he has known by the method of inductive.

Steps in Deductive Approach to problem solving

The various steps in deductive approach are:

1. **Understanding the problem:** The students understand the problem, define it and formulate it.
2. **Collecting Information:** The students collect the information from a number of sources like library, laboratory, field etc.
3. **Reviewing:** Principles, generalizations are reviewed to find facts which may be best applicable to the problem in question.
4. **Drawing inference:** The principles, generalization are applied to particular case and inferences are drawn that the problem falls under the principle.
5. **Verification:** The principle or generalizations is applied to the particular case. If it solves the problem then it is accepted, otherwise the procedure is repeated till a better solution is found.

Difference Between Inductive & Deductive Approaches:

Inductive approach	Deductive approach
1 It proceeds from specific to general	1. It proceeds from general to specific.
2. It is a scientific method, which stimulates method.	2. It is not a discovery but reflective thinking.
3. This approach is based on reasoning.	3. This approach is based on rote memory.
4 It is time consuming approach	4. It is an economical approach in terms of time.
5 Students act as active participants in the teach ing-learning process.	5. In this approach students are rather passive participants.
6. This approach is psychological where the student's nature is mainly considered.	6. In this approach emphasis is on acquisition of facts.
7. It is suitable for primary classes.	7. This approach is better suited for high school classes.
8. In this approach students explore the principles and laws themselves.	8. The principles and laws are made known to the students and their work is only to verify those laws, principles.

4.2 TEACHER CENTERED METHODS

4.2.1 LECTURE METHOD

This method has been used in education from ancient days. At present also this method has occupied on important place in Indian schools. It is also called **'Telling method'** why because the teacher, in it, teaches through telling.

For success the lecture method depends upon two factors:

(a) The selection of the subject matter and

(b) The manner of presenting the subject matter. The mode of presentation depends upon the personality of the teacher.

It is necessary for teacher to have proper preparation and suitable voice. This method is not opposed to the principles of psychology. There takes some mental activity in pupils. With full preparation the teacher can present the subject matter in an interesting way and can ask question to keep them active. If all depends upon the teacher how he makes use of the method. We cure accounts for alertness of auditory faculty. For teaching social studies this method is highly beneficial to the teacher makes use of story telling may to make the lecture interesting.

When to use Lecture Method: The teacher can use lecture narration method, telling method for the following purposes.

1. To Motivate: Before presenting a lesson or a unit of the subject, the pupils can be encouraged to study the same, by explaining first, the important points through lecture method.
2. **To Summarize:** Some pupils are up-set on seeing the extensiveness of the subject matter. They find themselves unsuccessful to come out of the cobweb of the subject matter. In such a case, they do not agree to study the extensive subject matter. Hence it is necessary that this extensive subject matter be presented in such a way so that the whole subject matter be presented in a small form.
3. **To Clarify:** It is to be used to explain the events, terms, concepts and principles involved in the subject. It is necessary to clarify them in simple words.
4. **To Save Time:** It takes form to read and understand the text book. Through lecture, adequate subject matter can be presented in short time.
5. **To Present Additional Material:** At times, the subject matter may be two brief in the book and may be in sufficient. Looking at the level of the pupils, the teacher can give additional matter.
6. **To give Assignment:** While giving home work, the teacher should make use of a lecture.

Advantages:

1. **Individualized Instruction:** It is based on lecture method. The printed words in the book cannot much to the students. Books cannot pay attention to individual differences.
2. **Development of Logical Reasoning:** This method develops reasoning and expression of students.
3. **Classification of Subject Matter:** In this method, the subject matter is made clear to the maximum many points come up in the subject matter which is tough and complicated.
4. **It Saves Time/Labour:** This method will save allot of time and labour.
5. **To Make Subject Matter Interesting and Effective:** By this method, the teacher can make the subject interesting. In it, the teacher can classify the matter through interpretation and gestures.
6. In improves pronunciation among the pupils.
7. In this method pupils and teacher remain active.
8. This method also psychological in nature.

Limitations:

1. Pupils are passive listeners.
2. Stress on theoretical knowledge
3. It is one sided
4. Unstable knowledge
5. Limited time
6. Lack of real knowledge
7. Lack of deep study
8. Efficient lecturer
9. Teaching becomes dull
10. Useful for high classes.

4.2.2 LECTURE-CUM-DEMONSTRATION METHOD

This method includes the merits of lecture method and demonstration method. The teacher performs the experiment in the class and goes on explaining what he does. It takes into account the active participation of the students and is thus not a loop sided process like the lecture method. The students see the actual apparatus and operations and help the teacher in demonstrating the experiment and there by they feel interested in learning. It is difficult to talk about things which the people have to imagine. It is always easy for the students to understand and remember the concrete things and so this method is also in accordance with the maxim of teaching "from concrete to Abstract "'. The students observe the demonstration critically and try to draw inferences. Thus, their power of observation and reasoning are also exercised.

Merits:

The lecture-cum-demonstration method has the following merits.

1. **Psychological Method:** It is a psychological method as it proceeds from the concrete to the abstract.
2. **Economical:** It is an economical method. When the apparatus are not sufficient for the students to do practicals individually, the teacher may perform the experiment for the whole class.
3. **Time-Saving:** It is a time-saving method. Compare to heuristic and project method, it saves much time.
4. **Activity Method:** Students are engaged in various activities like observing, taking notes, answering questions, drawing etc.

5. **Useful to all Students:** This method is suitable to all types of students i.e. average, below average and above students.
6. **Promotes discussion:** This method helps to promote useful and relevant discussion in the classroom.
7. **Safe Method:** If the experiments are dangerous, or if the apparatus are costly, this method is considered as safe.
8. **Develops Skills:** This method can be used to impart manual and manipulative skills to the students.
9. **Brings together theory and practice:** It aids in bringing about a relationship between theory and practicals.
10. **Fosters Thinking:** It fosters good thinking in groups and individuals.
11. **Quick Method:** Quick revision of some principle or project is possible by this method.

Demerits:

Though very useful at the high school stage the lecture-cum-demonstration has the following limitations:

1. Provides no scope for "learning by doing", which is an important principle of learning and the students do not relish the joy of direct personal experiences.
2. Students are not active participants in the process.
3. It ignores the individual differences. Slow learners and the genius are made to sail in the same boat.
4. It is not suitable to develop scientific attitude.
5. It is not suitable to give training in scientific method.
6. Since the teacher is performing the experiment, the students may fail to comprehend the concept clearly.
7. It does not give training in laboratory skills to the students.

While using the demonstration method the teacher can

1. Provide significant, rich and worthwhile experiences to the students.
2. Enhance students power of observation.
3. Illustrate abstract ideas in concrete form.
4. Co-ordinate laboratory work with theory.
5. Provide concrete experiences for the solution of a problem.
6. Add additional demonstrations after its review, if considered necessary.
7. Do those demonstrations which are dangerous for students to perform themselves.

8. Pose a problem to students and gather their hypothesis based on their experiences.

Characteristics of a Good Demonstration:

The following points may be considered as criteria for a good demonstration.

1. **Rehearsal:** The demonstration should be tried out in advance so that everything becomes clear to the teacher. This will give added confidence to the teacher and the teacher can find out the difficulties involved in the experiment before hand.
2. **Arrangement of the Apparatus:** The apparatus for demonstration should be arranged in order. It is always better to keep the apparatus to be used on the left hand side and the used ones on the right hand side.
3. **Visibility:** The demonstration should be visible to all the students. The demonstration table should be a little higher than the pupils tables. Arrangement should be made for adequate lighting.
4. **Apparatus:** The apparatus should be big enough.
5. **Spare Apparatus:** Some spare parts or extra apparatus should be there to fall back in case the apparatus breaks while doing the experiment.
6. **Purpose:** The teacher should be clear of the purpose of demonstration. The teacher should know the aims of the demonstration, the generalizations to be made and the attitude to be developed while demonstrating.
7. **Involvement of Students:** The teacher should involve the students in demonstration. The teacher can take the help of the students in arranging the apparatus, writing summary on the blackboard, taking readings etc.
8. **Simple and speedy:** Demonstration should be simple and speedy. If the demonstration is lengthy, the students have to wait for long for the results. They will loose interest in such demonstrations.
9. **Use of teaching aids:** Demonstration should be supplemented with other teaching aids like charts, pictures, models, films etc.
10. **According to time and season:** Demonstration should be accordance with the time and season otherwise it will be a failure. This is because the climatic conditions affect some apparatus and materials. For example demonstrations on static electricity should be avoided during rainy season while experiments on ice can be done during hot season. The experiments on heat can be done during winter season.

11. **Questions:** Judicious amount of questioning must accompany the demonstration. Questions asked should be reflective to stimulate thinking on the part of the students.
12. **Use of Black board:** A good use of black-board should be made simultaneously. It can be used for writing principles, generalizations arrived at and for drawing diagrams etc.
13. **Take one idea at a time:** Only one major idea should be taken at a time. Too many ideas in one demonstration may confuse the children specially the young ones.
14. **Do demonstration step-by-step:** Break-down the demonstration into simple step-by-step pattern. So that it can be easily understood by the class. Ascertain after each step whether the students have grasped the meaning, contents and explanations. If they have not, the relevant part should be repeated.
15. **Recording the Data:** The students should record the data, observation etc. For this sufficient time should be given to the students.
16. **Training in Scientific method:** Demonstration should create problem for the students and also make provisions for solving it through their own efforts. In this way, the students will find chance to exercise their abilities like observing, analyzing, verifying etc. Thus they will get training in scientific method of solving a problem.
17. **Teacher as "showman":** The teacher should know various methods of arresting the attention of students and creating interest. At times the teacher has to act as a "Showman". To inspire the class with a sense of dramatization and to arouse an atmosphere of suspense just before critical point of an experiment, is an art.
18. **Evaluate:** Give an assignment based on demonstration. This will help evaluate pupils learning.

Steps in Lecture-cum Demonstration:

Lecture-cum-demonstration method is very suitable at the high school stage. It involves the follow steps:

1. **Planning and preparation:** Before the actual conduct of the lecture-cum-demonstration lesson the teacher has to thoroughly prepare and plan for the same.

   While preparing the teacher should keep the following points in mind.

a) **Subject Matter:** The teacher should thoroughly prepare the content by referring the relevant books.

b) **Lesson Planning:** Preparing a lesson-plan is important as it gives confidence to the teacher. The lesson-notes should include how to introduce the lesson, how to present it, list of the principles to be explained, a list of the experiments to be demonstrated, the type of questions to be posed to the students and how to recapitulate the lesson.

c) **Rehearsal of the Experiment:** The demonstration should be rehearsed in advance. Rehearsal will give an idea to the teacher, about the precautions to be taken and the difficulties that are involved in the demonstration. This will ensure the smooth and systematic conduct of the lesson.

d) **Collection and arrangement of apparatus:** The apparatus and the chemicals should be properly arranged on the demonstration table. Some spare apparatus and chemicals will be an added advantage.

2. **Introducing the Lesson:** The lesson should be started by motivating the students. The lesson should be introduced in a problematic way so that students can appreciate and realize the importance of the topic. It can also be introduced by

a) Telling a story

b) A familiar anecdote

c) By performing a simple experiment related to the demonstration etc.

While introducing the lesson the teacher has to keep in mind the student's previous knowledge and their personal experiences also.

3. **Presentation of the subject matter:** The method of presenting the subject is very important and hence it should be presented in an interesting way. For this the teacher has

a) To study the subject matter on broad basis taking into consideration the interest and experiences of the students. The lesson should be correlated vertically as well as horizontally. The lesson can be made interesting and lively by quoting the interesting facts from the life-history of great-scientists and by quoting the personal experiences of the teacher and the students etc. The teacher should also try to illustrate the facts and principles.

b) To pose questions to the students. This will help them to understand the underlying principles. Questions not only bring for the required answers, but also create a desire in the student to know what he does not know.

c) To deliver the lesson slowly, deliberately and with correct pronunciation. Language should be clear and simple. The tone of

the voice should be modulated according to the nature of the statement. Lesson should be narrated in an interesting way. Try to avoid ambiguous terms.

4. **Performance of Experiment:** The work on the demonstration table should be a model for the students. Some of the important points to be kept in mind while demonstrating an experiment are:

a) Experiments should be simple and speedy

b) Experiment should be well spaced throughout the lesson.

c) Keep reserve apparatus near the demonstration table so that much time is not wasted in collecting the apparatus in case of breakages.

d) Arrange the apparatus in an order in which the experiments are to be shown.

e) Store the demonstration apparatus intact until it is to be used again. It results in much economy of time.

f) The experiments must work and their results should be clear and striking.

g) Involve the students while performing the experiments.

5. **Chalk-board Work:** It is an important aid in a demonstration lesson. It is mainly used for two purposes.

a) For writing important results and principles in a summarized form.

b) For drawing necessary sketches and diagrams.

Writing on the black-board should be neat, clean and legible. The diagrams should be labelled properly. The teacher may involve the students in making black-board summary.

4.2.3 HISTORICAL METHOD

In this method, the topic is developed from its very beginning and carried through various stages of evolution.

Science has its own history and every invention or discovery has its historical background. The children feel very much interested and fascinated in listening to the stories and the teacher can introduce his talk with an interesting story.

For example, the teacher is to teach Principle of Archimedes. He can narrate the whole story of how a king announced to his subjects that whosoever will find out whether the crown is made of pure gold or not without breaking it, will be given a big prize. The teacher should then tell that one day Archimedes was taking bath in a bathing tub and felt that his body was being lifted up by water. He thought of the reason of this loss of

weight in water. He conceived that like his body everything loses its weight in water and in this way he can find out the purity of gold in the crown. He was so much overjoyed with his finding that he ran naked to the king crying 'Eureka, Eureka! Which means I have found out?

Similarly, while teaching Newton's laws, Petrol Engine, Steam Engine, Telescope, Radio, Television and hundreds of modern inventions and discoveries, the teacher can give a historical sketch of each. This will arouse interest in the students for learning scientists.

This method is particularly suited for teaching to primary classes where the students are much interested in listening to the stories. It cannot be adopted as a method of teaching but it is suggested that historical approach should be made wherever it is possible.

Scientist	Period	Theorem
1. Dobereiner	1817	In Doberenier triad, the atomic weight of middle element is nearly the arithmetic mean of first and third elements or the atomic weights of all the three elements are approximately the same.
2. Pettenlcofer	1850	-
3. Dechacourtois	1862	-
4. JohnA.R. Newlands	1862	Newlands noted that the eighth element is a kind of repetition of the first, like eighth note of an octave in music.
5. Mendaleef Russia), Juthes Mayer Germany)	1869	The properties of elements are the periodic functions of their atomic weights.
6. Moslay	19th century	1. The Properties of the elements are periodic functions of their atomic members 2. This table is divided into 7 horizontal 18 vertical columns called Groups.

4.3 STUDENT-CENTERED METHODS

4.3.1 HEURISTIC METHOD

The term 'Heuristic' has its origin from the Greek word "Heurisco" which means to find out.

In this method the students learn by exploring. The teachers role is that of the path setter who rectifies the faults at the proper time.

Definitions:

1. "Children should be told as little as possible and induced to discovered as much as possible" - *Herbert Spencer*
2. "Heuristic method is a method of teaching which involves placing the students as far as possible in the attitude of a discover". - *Prof.Armstrong.*

Procedure:

i) A problem is assigned to the class and each student is made to feel responsible for finding out something for himself.

ii) Each student tries to acquire information about the problem for different sources. He is free to move about and discuss the problem with the class-mates. Each student is given a sheet of instructions regarding the problem in hand. The student gets a bit of guidance from the teacher. But some people are of the view that nothing should be told by the teacher and the student should follow instructions and work everything himself. But this will be too ambitious to expect so much from the students. The teacher should stand for help wherever the student feels its need. However the teacher should try to get everything out of the students by inductive method.

As many questions as possible should be allowed to arise from child's (students) own observation and at times the teacher should also put questions which well stimulate the pupils to know more about a particular problem. In this way, they are let to know the reason from observation.

iii) To devise the experiment.

iv) To interpret the data obtained.

v) To infer laws and generalizations.

Regarding the selection of the problem there is a view that the problems must be suggested by the pupils themselves as far as possible. The students cannot take a lively interest if the problems are imposed from above. For it is a demand for activity rather than receptivity.

Examples:

1. Finding the purification of water.
2. Finding the atomic structure of Crystals.

Role of the Teacher:

1. The teacher should be well prepared well equipped.
2. The teacher should act as Guide and a Friend.
3. The teacher should encourage students.
4. Detailed instruction sheet should be given to the students.
5. The teacher should help to develop values.
6. The teacher should keep psychological principles in mind.
7. The teacher should arouse, maintain curiosity of the students.
8. The teacher should provide freedom of thought.

Advantages:

1) It imparts knowledge in scientific method of thinking and inculcates scientific attitude among students which can prove to be useful for future life of students.
2) It develops in students self confidence.
3) It is based upon very important principle of learning that is "learning by doing".
4) The problem of home work is solved.
5) The teacher is not a dictator. He is just a friend and guide of students.

Disadvantages:

1) It seems rather difficult to put the small students in the position of original discoverers.
2) Our lengthy syllabus prescribed by universities does not allow except Lecture method.
3) Text books written on this method are not available.
4) This method demands a class of 10-15 students and in poor countries like India we cannot afford it.
5) It is very costly method because it requires furnished laboratories, libraries and well qualified teachers.
6) The child possesses a social heritage and has every right to make use of it. It is more foolishness to make him repeat mistakes and then reach right facts.
7) This method cannot be used in primary classes.

B) Analysis of Relationship

C) Analysis of Organizational Principals

5. **Synthesis:** The putting together of elements and parts so as to form a whole. This includes the production of a unique communication, of a plan or proposed set of operations and derivation of a set of abstract relations.

6. **Evaluation:** Judgments about the value of material and methods for given purposes. This includes judgments in terms of internal evidence or external evidence.

i) Internal Evidence:

Judgments in terms of internal evidence is qualitative in nature such as logical accuracy, consistency and other internal criteria.

In internal evidence judgments is made on the basis of a) Accuracy b) consistencies c) reliability d) precision e) exactness

ii) External Evidence:

In external evidence the judgments are made on the basics of a. Results, b. Efficiency, c. Economy, d. Utility, e. Standard, f. Generalization

Evaluation thus represents use of a standard of appraisal in a complex process which involve some combinations of all other behaviours of knowledge, comprehension, application, analysis and synthesis.

II. AFFECTIVE DOMAIN:

This domain is concerned with feelings and includes attitudes, interests, values and appreciation. These characteristics are hard to define and evaluate.

The different categories of the affective domain are described as follows:

1. **Receiving:** Receiving means to orient the learner to learn which is the first step. "Sensitivity to the existence of certain phenomena and stimuli, that is, the willingness to receive or attend to them." Receiving consists of three sub-categories that represent a continum.

It includes:

a) **Awareness:** Awareness is almost a cognitive behavior without specific discrimination or recognition of the objective characteristics of the objects.

b) **Willingness to receive:** Willingness to receive is to tolerate a given stimulus not to avoid it. It involves a neutrality or suspended – judgment toward the stimulus.

c) **Controlled or selected attention:** At a somewhat higher level we are concerned with a new phenomenon, the differentialities of a given stimulus into figure and ground at a conscious level.

2. **Responding:** This class comes after the learner has given his attention. "Behaviour which goes beyond merely attending to the phenomena, it implies active attending, doing something with or about the phenomena, and not merely perceiving them" sub categories of responding are:

a) **Acquiescence in responding:** It is the first level of active responding after the learner has given his attention (we might use the word compliance to describe the behaviour).

b) **Willingness to Respond:** It is voluntarily response to outside prompting, the response get social approval.

c) **Satisfaction in response on subjects:** In addition to the willingness to respond, the consent, the assent responding, the behaviours is accomplished by a feeling of satisfaction an emotional response generally of pleasure or zeal.

d) Appreciation on subjects and teachers.

3. **Valuing:** It includes acceptance of a value, preference for a value and commitment to or a conviction with regard to a certain point of view.

It includes:

i) **Acceptance of a value:** At this level we are concerned with the describing of worth to a phenomenon, behavior objects etc. At this level, there is more of a readiness to re-evaluate one's position than at the higher levels.

ii) **Preference for a value:** Behaviour at this level implies not just the acceptance of a value to the point of willing to be identified with it but the individual is to be sufficiently committed to the value, to pursue it, to seek it out, to want it.

iii) **Commitment:** Belief it this level involves a high degree of certainty. The ideas of conviction, certainity beyound a Shadow of doubt" help to convey further the level of behaviour intended.

4. **Organization:** When the learner develops certain values, he encounters situations for which more than one value is relevant. In such a case values are organized into systems.

It includes:

i) **Conceptualization of a value:** After developing values the quality of abstraction or conceptualization is added. This permits the

Activity : (3)

Pedagogy of Physical Sciences.

2) To subscribe good books, magazines, bulletins and newspapers for the library and study them.

3) To listen to and watch various programmers based on physics & chemistry on the radio and T.V.

4) To participate in the activities of occupational organizations of Physical Science.

5) To see the forms of other school, colleges, universities, research institutes and regional laboratories and acquire knowledge.

6) To take part in the local, regional and national meetings of Physical Science.

7) To acquire knowledge of good teaching methods of Physical science at national level.

8) To participate in meetings of committee preparing Instructional material.

The multifarious value of teaching science to the individual as well as society can be summed up by quoting Jawaharlal Nehru and Kothari Education Commission 1964-1966:

"My preferences are all for science. The world is narrower place now and there is little to discover in it. So it seems. But that is not so, for science has opened up tremendous new vistas which wait to be explored, and of adventure there is no lack, especially in India today".

– **Jawaharlal Nehru**

In the words of **Kothari 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 and also the instrument for the nation's progress, security and welfare".

Conclusion: In the end it can be concluded by saying that while Science acquaints the students with knowledge of facts, it also trains them as well balanced, useful citizens by preparing them vocationally, morally, intellectually and aesthetically. It develops in them a sort of scientific attitude which is transferable to other situations of life. It is said to be the art of precise thinking and working.

So the subject of science has every right to be included into the school curriculum.

1.4 CORRELATION BETWEEN PHYSICAL SCIENCE WITH OTHER SUBJECTS

No subject can be taught in isolation. Correlation signifies the 'close relationship between various subjects of the curriculum.' Different subjects have correlation with life and so they have correlation with each other. To explain any subject in meaningful way correlation is needed. To bring about the awareness of the unity of knowledge, features of the various subjects should work in harmony.

Correlation of different subjects is important for checking artificiality of treatment and for achieving the unity of knowledge. So the principle of correlation demands that various subjects should contribute to the child's development and education and help him to understand his environment in a better way. The various facts, concepts, principles and laws have a relationship with one another. These also have an application in the real life of the child. So all these should be integrated while teaching the different subjects. The effectiveness of the teacher lies in integrating the various concepts of science not only with real life situations but also with other subjects. This makes the study easier, more interesting more meaningful and natural.

Views of different Educationist about Correlation:

Correlation, as the word signifies, is the reciprocal relationship between various subjects of the curriculum.

1. **Carter V. Good:** "Correlation is bringing together the elements of two or more different subject matter fields that bear on the same large problem or area of human experience, in such a way that element is reinforced and strengthened".
2. **Froebel:** Play should be the centre of education while teaching the elementary classes. He suggested that all subjects should be correlated with play.
3. **Ziller:** He propounded that all teaching should centre around one core subject.

Correlation of science with various subjects is as follows :

1. **Physical Science with Mathematics:**

All branches of Mathematics have direct applications of Science. Scientific inventions cannot be achieved without the help of mathematics. Various theories of Science are tested on the touchstone of Mathematics. Science without Mathematics is incomplete. The mathematical

calculations determine the correctness of different scientific facts. In order to measure Mathematical help is needed. The tables and Graphs made available only with the help of Mathematics. Science and Mathematics very intimately related. All scientific Law's and interpretations are governed by Mathematics. Numerical calculations occupy an important place in science.

Science cannot be taught without the fundamental knowledge of mathematics. Some of the examples of correlation between the two subjects are mentioned here.

1. Physical science and mathematics are very closely related. Almost every topic in physics demands the knowledge of mathematics. For example the derivation in physics, problems in velocity speed etc. cannot be taught without the knowledge of mathematics. Thus physics and mathematics are inseparable.
2. Teaching of chemistry will be incomplete without mathematics. Topics like Atomic weight, equations, formulation, derivation of laws etc. requires the knowledge of mathematics.
3. In biological sciences the teacher has to mention, calculate, the size of the different cell organelles, which requires the knowledge of units and conversion.
4. The explanation of Mendel's Laws of segregation demands the knowledge of ratios.

Thus there is a close and intimate relationship between Science and Mathematics. It is because of this close correlation that new subjects have evolved like Biostatistics, Genetic Engineering etc.

All these things help not only the teaching of science but also the development of science.

A) **Physics and Mathematics:** There is a close relation between Physics and Mathematics. We can say that there is no difference in between Physics and Mathematics.

a) Measurements, Statistics, Kipematics, Collisions are based on Mathematics.

Eg : $V=U+at$

$V^2-U^2=2as$

b) The relation between Wave motion, Velocity and Wave length

Eg: $v = n\lambda$, $n = 1/T$

c) To explain Light Phenomenas like Refractive index.

Eg: $\mu = \frac{Sin\ i}{Sin\ r}$

d) So many calculations, derivations depends on Mathematics.

B) **Chemistry and Mathematics :** We can say that every branch of Chemistry to some extent depends on Mathematics.

a) **Balancing in equations :**

Eg : $2Na + Cl_2 \longrightarrow 2NaCl$

b) **Explaining Gas Laws:**

Eg: $P\alpha\frac{1}{v}$

$P\alpha T$

$PV = n.RT$

c) **Determining the values p^H of Acid, Base.**

Eg: $p^H = -\log[H^+]$

d) Explaining the structures of Atoms, Orbits, Electrons and Molecular structures and structures of the Crystals.

e) Calculating the morality, normality etc.

2. **Science and Literature:** Science and Literature had a deep relation. Language is the property of the Literature. No material and substance of Science can find expression unless it takes help of language. Through language only the knowledge of science is spread throughout the world.

Teacher of science should try to use correct language and encourage their students to write correct language. They should also be encouraged to read scientific material and books dealing with the knowledge of science.

3. **Science with Social Studies:**

Science and social studies are interdependent and interrelated. There are a number of topics that are common in both science and Social Studies like rainfall, climate, planets, rotation of crops, agriculture, earth etc. The science has tremendous impact on the social structure and social organization. Industrialization has brought about a complete revolution in social organization. Outlook of the people is completely changed due to this. Infact the scientific development is the development of the society

itself. A society that neglects science will always remain backward. Thus it can be said that it is science only that brings improvement in the way of living and thinking of man. Hence the science teacher has to correlate the science with social studies while teaching. Various projects can be given to the students under the guidance of science and social studies teachers together by which the students can understands the relationship and correlation between the two subjects. In this way students can learn both the subjects together in an interesting way.

i) **Science and Geography:** Some times geography is considered as science subject instead of an art. Geography cannot be understood properly unless certain principles of Science are employed. For example we can not have proper knowledge about weather, unless we use barometer. All the principles of Science employed in Geography like a student of Geography cannot have proper knowledge about the soil. The formation of rocks and other things unless he takes help from chemistry.

Geography is so much related to science, that now it has been regarded as one of the biggest branch of science. The two subjects are inseparable and very closely related. The topics like formation of soil, weathering of rocks, Universe, Climate, Seasons, distribution of plants and animals on the land, temperature etc. are common in both the subjects. Hence the science teacher can very easily correlate the scientific principles with the geography. The scientific principles are also the principles of geography. The science teacher can give various projects along with the geography teacher to teach the common principles of both the subjects to the students. In this way the teaching of both the subjects can become interesting and valuable to the students.

(ii) **Science and History:** No subject can be properly studied unless a scientific outlook and attitude adopted. In this respect also, it is the history that gains from science and art. The story of the scientific invention can be read only in history.

History is the study of the growth of the nation. The growth and development of any nation depends on Scientific advancement. Hence both science and history are very closely correlated.

The scientific discoveries and inventions are good sources of correlation of science with history. For example while teaching about the discovery of **Penicillin by Alexander Fleming, the discovery of planets** etc, the science teacher is actually teaching the history of science. Because history is nothing but continuous methodical record of events. To correlate

the science topic with history the teacher can rename the topic or lesson as the history of the discovery of penicillin, the history of the discovery of the different planets etc.

In this way the science teacher can correlated the science subject with history.

4. **Science and Art :** Art has two forms: 1) Fine Arts

2) Useful Arts.

In useful arts we find the application of the principles and facts of Science. Through fine arts we find that things of Nature are made more good looking and beautiful. To study these fine arts, useful arts we need science, because science involved scales and diagrams, pictures and other things.

Art requires creativity, deep imagination and thoughts. Science too requires creativity, deep imagination and thoughts. Hence the ingredients of both Science and Art is the same. An artist derives pleasure from his work. So also a scientist. In this way both the subjects are interrelated and interdependent. The science requires skills in drawing, in making models, in giving exact shade and colour to different parts in the model and in the charts, painting the model, making instruments etc. Art also requires skill in using exact shade of colour, drawing, depicting the features of living creatures properly etc. In this way the two subjects are correlated. Besides this the subject matter of both science and Art is the same. It is the Nature. Mostly Artists expresses the beauty of nature in their drawing, and a scientist studies about the nature, they try to unfold the mystery the nature by studying its intricate functioning. Hence the science teacher can very easily correlate the science with Arts, while teaching the subject in the classroom. For example the teacher can ask the students – to draw and paint different types of trees. While drawing the students have to give exact colour and shade to different parts of the tree as they see in nature. In this way the students learn both science as well as Art.

At higher levels, arts and science are no different. There can be no good piece of art without the application of scientific principles and on the other hand there is artistic or aesthetic element in all scientific activities. Thus act and science originate from the same root.

Thus the science subject as seen above is very closely correlated to almost all the subjects that are taught in the schools. So the science teacher has to take all the possible measures and use all the possible techniques to teach the subject in an integrated and correlated manner. In

this way she can achieve the aims of teaching science as well as aims of education.

5. **Science and Crafts:** Different crafts are based upon the principles of Science. The help of necessary in finding out the ingredients of wood, clay, metal etc., thus science and crafts is reciprocal and both are closely related with each other.
6. **Science and Music:** All the musical instruments are built on the principle of Science. They are gift of the Science. Now a day the modern inventions in the field of music such as sound films, Tape recorders and digital sound, stereophonic sounds are the product of science.

   In music the strings and sound waves are arranged on the basis of certain principles based on science.
7. **Science & Hygiene:** Science can be needed to understand the importance of Hygiene.
8. **Science & Language:** It is not possible to learn science without adequate knowledge of knowledge. On the other hand science has its own vocabulary and way of expression. The knowledge of terminology, symbol, formulae etc widens the circle of a language. While teaching science a teacher must try to improve the expression power of the students.

Language is a means of communication. So learning and teaching of any subject demands fluency in language. The students of science should express their scientific ideas in a lucid, systematic and organized way. Then only they can excel in science. So science and languages are closely related and inseparable. Hence the science and language teacher together can work to correlate their subjects in a wonderful way. The language teacher can ask the students to write essays on scientific topics and poems on nature etc. The students can write fictions, short stories on inventions, discoveries etc. The science and language teachers together can conduct debates, elocution on scientific topics. The students can contribute essays in science magazine and so on and so forth. The linking of these two subjects not only creates interest for learning science but also a taste for language in which they can express their ideas very well. Besides this the two subjects together can develop various skills like writing, expressing, arguing etc. The only thing require is the co-operation of the science and language teachers.

Conclusion: In the end we can conclude by saying that while Science acquaints the students with knowledge of facts, it also trains them as well balanced, useful citizens by preparing them vocationally, morally, intellectual and aesthetically. It develops in them a sort of scientific attitude which is transferable to other situations of life It is said to be the art of precise thinking and working.

Review Questions

1. Write the meaning, and nature of science?
2. Write the characteristics of science?
3. Write the scope of science?
4. Write the importance of science?
5. Describe the Structure of Science?
6. Write the values of teaching physical science?
7. Write the correlation between physical science with other subjects?

Activity-(4)

Every one must write only one Scientist

The NCERT was established as an autonomous organisation on Sept. 1st 1960. It is located at Sri Aurobindo Marg, New Delhi, N.I.E., it is concerned with research instruction and evaluation. It functions through its various units like Library, National Science Talent Search, Examination reform etc.,

The State Institute of Science Education have been set in all the States and they aimed at

(i) providing inservice training to science teachers.

(ii) preparing instructional material in science.

(iii) conducting research in science education.

2.2 CONTRIBUTIONS OF WESTERN SCIENTISTS

1. NICOLAS COPERNICUS

Name : Nicolas Copernicus
Occupation: Mathematician, Astronomer
Birth Date : February 19, 1473
Death Date: May 24, 1543

Nicolas Copernicus was a Renaissance Mathematician & astronomer who formulated a heliocentric model of the universe which placed the sun, rather than Earth, at the center.

The publication of Copernicus book **"On the Revolutions of the Celestial spheres"** just before his death in 1543 is considered as a major event in the history of Science. It began the Copernican Revolution and contributed importantly to the scientific revolutions.

The Copernican theory demanded two important changes.

The first change had to do with the apparent size of the universe. The stars appear to be in the same fixed positions but if the earth is the orbit around the sun, they should display a small periodic change. Copernicus explained that the starry sphere was too far distant for the change to be detected.

The Second change concerned the reason why bodies fall to the ground.

According to heliocentric theory, the earth no longer coincided with the centre of the Universe.

Copernicus was born & dead in Royal Russia, a region of the kingdom of Poland since 1466. Copernicus has a doctorate in Canon law and though without degrees was a physician, polyglot, classics scholar, translator, governor diplomat and economist who in 1517 set down a quantity theory of money, a principal concept in economics to the present day and formulated the version of Gresham's law in 1519, before Gresham.

His father was a merchant and his mother was the daughter of a wealthy merchant. Nicolas was the youngest of four children. His brother Andreas became an Augustinian canon. His sister Barbara became a nun. His another sister Katharina married a businessman and city councilor Barthel Getner and left five children whom Cōpernicus looked after to the end of his life. Copernicus never married or had children.

Languages:

Copernicus is postulated to have spoken Latin & German with equal fluency. He also spoke Polish, Greek & Italian.

Heliocentrism:

He discusses about the heliocentric hypothesis. It contained seven basic assumptions. He still gathered data for a more detailed work.

Death:

Towards the close of 1542, Copernicus was seized in the apoplexy and paralysis and died at age of 70 on 24 May 1543. Legend has it that he was presented with the final printed pages of his books on the very day he died.

2. ISAAC NEWTON (1642-1727)

Newton was born on 25th December 1642 at Lincolnshire. He became a world famous scientist. As a child he was good at drawing and mechanical inventions. He was not much attentive at school. Newton was brought up by his grandmother. His father was dead His mother married again Newton did not receive any love from his parents.

Newton was an extraordinary scientist. Throughout his schools and college days, he lived like a hippie, rejecting the world and its ways. He never married and lived a bachelor's life in a cottage in the countryside

where he was always busy conducting scientific experiments or writing about them in the form of books. He laid the foundations of physics by propounding the three laws of motion and the theory about gravitation in his famous book **'Principia'**.

Newton also conducted several experiments on light in the later years of his life, he became obsessed with the idea of creating gold out of base metals which cost him his life. Those all chemical experiments released metallic vapours which he inhaled over the years and eventually died.

Newton did his graduation from Trinity College, Cambridge in 1665. His professor was Isaac Barrow, a giant in mathematics. He recognized the talent in Newton. Newton occupied his chair at the age of 27. In 1672 he was elected as a fellow of the Royal Society. Newton published his epic work **"Principia Mathematica"** in 1687

Newton showed that the Sunlight is composed of seven colours VIBGYOR or Violet, Indigo, Blue, Green, Yellow, Orange and Red. These colours can be separated with the help of a prism and the mixture of these colours produces white light for which Newton made a disc.

Newton became famous by his three laws of motion.

They are :

1) Everybody continues in a state of rest or uniform motion unless acted upon by an external force.
2) The rate of change of momentum is proportional to the impressed force and takes place in the direction of force
3) Action and reaction are equal and opposite. These laws were first stated by Newton in his principia (1687). Newton also invented calculus, a mathematical method. He wrote a book 'optics' describing his studies of light.

It was in the year 1655, Newton was in his native woods Thorpe for holidays. One day he was lying on the ground under an apple tree. Suddenly an apple fell to the ground. He wondered at this scene. On the basis of the falling apple he gave his famous law of Universal gravitation which states, that every-body in this universe attracts every other body with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

In 1689 Newton was the Member of Parliament. He had represented the university. He was the President of the Royal Society in 1703 and continued till his death. He was knighted by Queen Anne in 1705. Even

at his ripe age of 85 presided over a meeting of the Royal Society. Newton was a simple man. His scientific achievements are unique. He died on 20 March 1727 at London.

3. ALBERT EINSTEIN (1879-1955)

Once he climbed a ladder to change the picture on the wall. His foot slipped and he fell to the floor. Quickly recovering from the fall, he took out a paper and pen and began working to the causes of the fall. Like the fall of the apple in Newtons Garden, this incident led him to restructure the theory of gravitation; he was **Albert Einstein.**

Einstein was born at Wlm in Germany. He learnt piano from his mother. Right from his childhood he was interested in science. He was sharp in mathematics but a medicore in other subjects. He completed his education in 1900 and became a citizen of Switzerland where he had tried for admission in the Zurich University. He joined the Swiss Patent office as a clerk. He married science student Mileva Marec. In 1905 he got his doctorate degree from Zurich University. By than he had published five research papers which made him a famous scientist as he showed that when light falls on metals like tungsten etc. they emit electrons. These electrons he called photo electrons and the effect is 'Photo-electric effect'. He was awarded the Nobel Prize in 1921 for his discovery of the law of Photo electric effect.

His major contribution was the special theory of relativity. He showed that the physical quantities like mass, length and time are not constant, but vary with the velocity of the body. He established the equivalence of matter and energy. The interconnection of mass and energy was embedded in the formula $E=mc^2$ Where E is energy, m is the mass and c is a constant equal to the velocity of light. The atomic bomb was the result of this equation. He also explained in one of his papers the way the force of gravity works.

In 1993, in Germany the dictatorship of Hitler was found intolerable. Einstein opposed it. The conditions of Jews were miserable. Einstein went to America on an invitation to deliver a lecture. He didn't come back to Germany as he was likely to be punished. He held a high post in Princeton University till 1945. There he worked on the development of Atom Bomb. When he found the harmful and disastrous effect of the

bomb on the two cities of Japan, he became very sad and decided to advocate only the Peaceful use of atomic energy.

Activity - (5)

Pedagogy of Physical Science

instructional objectives may be defined as "A group of statements formulated by the teacher for describing what the pupils are expected to do or will be able to do after the completion of a specific classroom instruction" Therefore instructional objectives could be considered as the products or results of teaching-learning.

Instructional objectives are more specific, definite, tangible, precie and functional. They are the statements of what the pupils could exactly do after the teaching-learning task. That is why they are also defined as the "End views of the possible achievement". Instructional objectives are always stated in terms of expected behavioural changes in pupils and hence they may also be termed as behavioural objectives.

Bloom has defined the instructional objectives as

"By educational objectives, we mean the explicit formulations of the ways in which students are expected to be changed by the educative process i.e. the ways in which they will change in their thinking, feelings and actions".

In the above definition Bloom has stated that there will be three changes in the behavior of pupils as a result of learning i.e. the changes in their thinking, feelings and actions. Hence, Dr. Benjami.S.Bloom has classified these changes into three domains as follows and named this classification as Bloom's Taxonomy.

3.2 BLOOMS CLASSIFICATION OF EDUCATIONAL OBJECTIVES

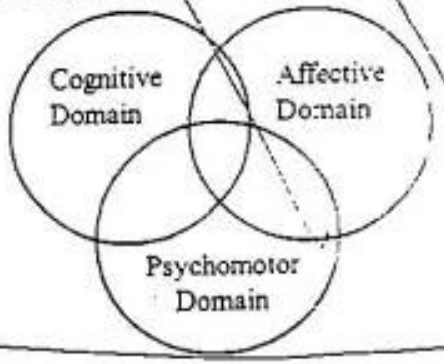
The word Taxonomy is originally associated with the sciences. It refers to the system of classification of plants and animals into different categories.

The word Taxonomy is derived from the Greek word "Taxa" – meaning arrangement. So as it is referred arrangement, it can very well be applied to the other sciences also for the arrangement of anything in hierarchy. In the field of education Prof. **B.S.Bloom** have attempted to classify the educational objectives into an hierarchy. He is considered as a pioneer in this field and was the editor of the first volume of **"Taxonomy of educational objectives"** (1956) produced by an American committee of college and university examiners. He has classified the Taxonomy in to 3 domains as follows:

The classification of Blooms Taxonomy

COGNITIVE DOMAIN	AFFECTIVE DOMAIN	PSYCHOMOTOR DOMAIN
1.knowledge	1.Receiving	1.Perception
2.Comprehension	2.Responding	2. Imitation
3.Application	3.Valuing	3.Manipulation
4.Analysis	4.Organisation	4. Precision
5.Synthesis	5.Characterization	5. Articulation
6. Evaluation		5. Naturalisation

All these three domains are interrelated as shown in figure below-



(5)

I. COGNITIVE DOMAIN:

This domain containing six major classes or categories as proposed by Bloom.

1. **Knowledge:** It involves the recall of specific and universals, methods and processes, or of a pattern, structure or setting.
   a) Knowledge of terminology and facts.
   b) Knowledge of conventions, trends and sequences, classification and categories, criteria, methodology.
   c) Knowledge of principles and generalizations of theories and structure.
2. **Comprehension:** It represents the lowest level of understanding and includes translation, interpretation and extrapolation.
   i) **Translation:** Translation means that an individual can put a communication into other languages, into other terms, or into another form of communication i.e.

Translation form one level of abstraction to another: It means the ability to translate a problem given in abstract terms into concrete or less abstract.

Ex: State the problem in your own words.

The ability to translate a lengthy part of a communication into briefer or more abstract terms.

Ex: To explain the whole experiment in two or three sentences.

The ability to translate an abstraction, such as some general principle, by giving an illustration or samples.

Ex: Give example for Newton's third law of motion i.e. for every action there is equal and opposite reaction.

To answer the questions given above the students writes the problem in simple language in order to make it concrete.

b) **Translation from symbolic form to another form, or vice-versa.** It means the ability to translate relationships expressed in symbolic form, including illustrations, maps, tables, diagrams, graphs, mathematical and other formulas, to verbal form and vice versa.

Ex: 1. Ability to translate geometrical concepts into verbal terms and into visual terms.

2. The pupil translates a given problem into an equation.

c) **Translation from one verbal form to another:** It means the ability to translate non-literal statements (Metaphor, Symbolism, Irony, Exaggeration) to ordinary language.

Ex: 1. The building is touching the sky.

2. The student re-states it as "The building is very high".

It is also the ability to translate from (with or without a dictionary) one language into another language.

ii) **Interpretation:** In order to interpret a communication, one must be able to translate each of the major parts of it. It includes competence in recognizing the essentials and differentiating them from the less essentials or from the relatively irrelevant aspects of the communication. It requires the ability in abstracting generalization from a set of particulars.

The essentials behaviour in interpretation is that when given a communication the student can identify and comprehend the major ideas which are included in it as well as understand their inter- relationships.

iii) **Extrapolation:** To extrapolate one must be able to translate as well as interpret and in addition one must be able to extend the trends or

tendencies beyond the given data and findings in order to determine implication, consequences, corollaries, effects etc. Extrapolation can only be an inference which has some degree of probability. Extrapolation includes.

a) Drawing conlusions and

b) Making predictions.

Ex:

- Strike a matchstick against the rough surface, what happens? (The Pupil Predicts)
- The pupil concludes that all living beings require, oxygen to live.

3. **Application:** Application occupies the third position in the hierarchy of the objective under cognitive domain. It requires something more than knowledge and comprehension. It implies the ability to apply an abstraction, method, theory, principle, formula etc. to an unfamiliar or noval situation.

The effectiveness of the teaching program lies in how far students are able to carry over the effects of their learning into situations that they may face in future.

Under the objective application we try to inculcate the following abilities among the students.

i) Searching familiar element in an unfamiliar situation.

ii) Using familiar elements to re-structure problem in familiar context.

iii) Classifying the problem as familiar in type.

iv) Selecting abstractions (theory, principles, idea, method) suitable to problem type.

v) Use of abstraction to solve problem.

vi) Finding solution to a problem.

4. **Analysis:** The breakdown of a communication into its constituent elements or parts so that the relative hierarchy of ideas is made clear and / or the relations between the ideas expressed are made explicit.

Analysis refers to the ability to breakdown material into component parts so that its organizational structure may be understood. Learning outcomes here represent a higher intellectual ability than comprehension and application because they require an understanding of both the content and the structural form of the material.

Analysis is attempted at three levels.

A) Analysis of Elements