

SCIENCE AT THE UPPER PRIMARY LEVEL

CHEMISTRY



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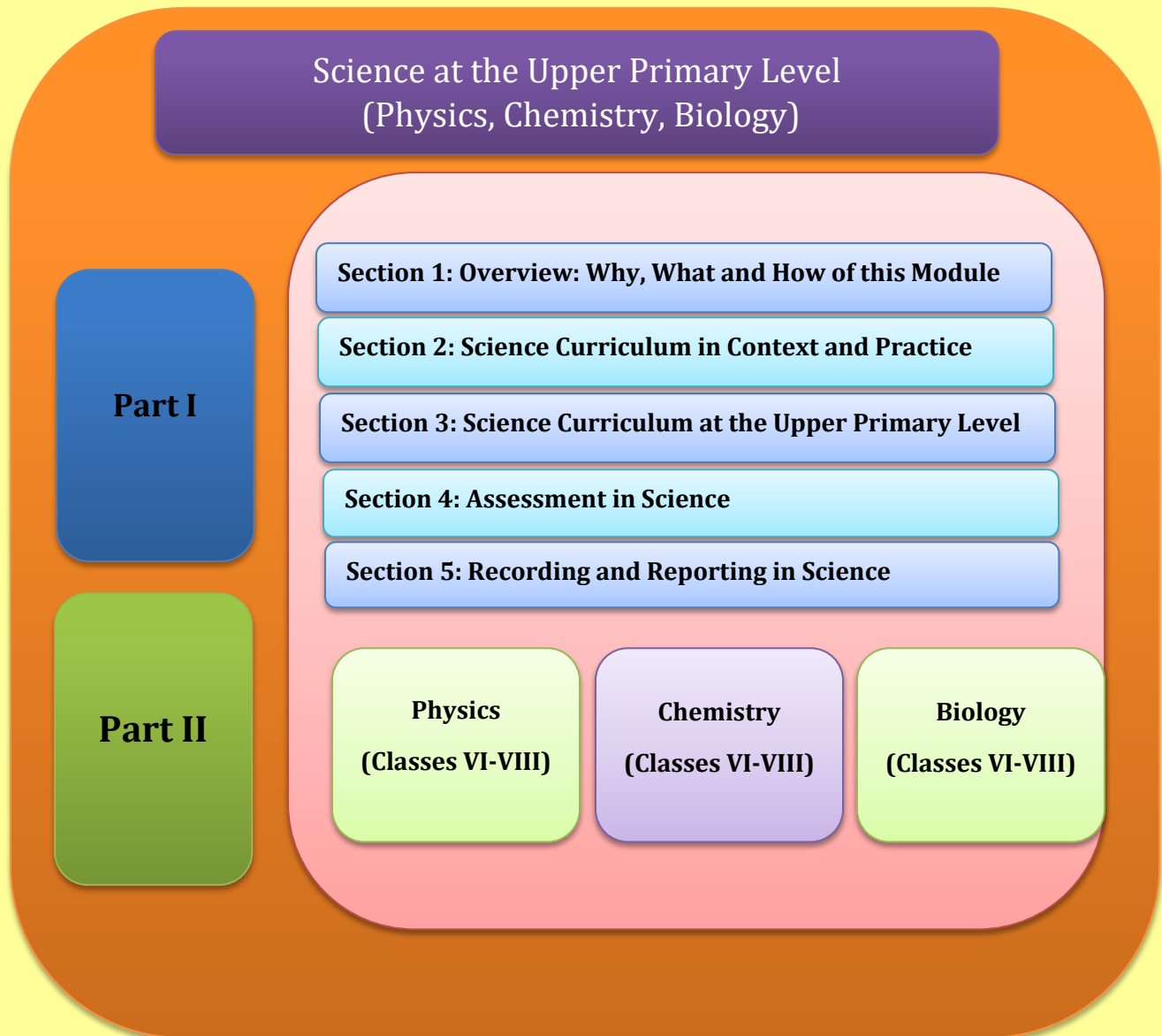
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Expectations of this Module

After reading/using this module the user/teacher will be able to:

- understand the need and significance of this module
- understand the nature and status of the SCIENCE curriculum and
- explain salient features of the SCIENCE curriculum and pedagogical principles in their own words
- discuss the need for exemplars in the curriculum and use them in practical situations by using activities (Hands- on and Minds- on activities)
- relate and frame learning based tasks for assessment
- understand some essential tips for using curriculum in the classroom situation.

Structure of this Module

Part I: Science at the Upper Primary Level: An introduction

- 1.0 Overview: Why, What and How of this module?
- 2.0 SCIENCE Curriculum in context and practice
 - 2.1 Introduction
 - 2.2 Science Process Skills
 - 2.3 Scientific Attitudes
- 3.0 SCIENCE Curriculum at the Upper Primary Level
 - 3.1 Objectives of teaching-learning Science
 - 3.2 Salient features of the curriculum
 - 3.3 Major components of the curriculum
 - 3.4 Suggested pedagogical principles
 - 3.5 Science teaching-learning strategies
 - 3.6 Dealing with errors and misconceptions
- 4.0 Assessment in SCIENCE
- 5.0 Recording and Reporting in SCIENCE
 - 5.1 Recording
 - 5.2 Reporting

Part II: Chemistry at the Upper Primary Level

Part I
Science at the Upper
Primary Level
An Introduction

1.0 Overview: Why, what and how of this module?

Why this module?

This module aims at providing an understanding on various aspects of the SCIENCE curriculum in Classes VI-VIII, along with the salient features of the curriculum. The pedagogical principles for SCIENCE learning and what makes SCIENCE classroom a happy classroom have also been discussed in this module. Users will also develop clarity on the various components of the SCIENCE curriculum such as learning outcomes, identified concepts in selected themes, transactional processes and learning resources. Apart from this, the module would attempt to empower users to contextualise in their particular situations. In order to understand all the components of the teaching learning process, some exemplars have been provided.

What does this module include?

This module has two parts.

Part I contains five sections which are as follows:

Section I provides an overview to explain why, what and how to use the module.

Section II discusses the Science Curriculum in context and practice and highlights the Science process skills and scientific attitudes.

Section III discusses the Science Curriculum at the Upper Primary level and includes the objectives of teaching learning of Science, salient features and major components of the curriculum, suggested pedagogical principles and teaching-learning strategies along with how to deal with errors and misconceptions.

Section IV deals with assessment in Science.

Section V focuses on recording and reporting processes in Science.

Part II is subject specific and discusses the objectives of teaching-learning of the subject. The subject specific exemplars, some common errors and misconceptions are given for teaching of Chemistry.

How should the module be used?

This module is meant for all stakeholders i.e. practicing teachers, master trainers and school administrators working at the Upper Primary Level. Exemplars have also been given which may be used in a real classroom situation or in simulation. Based on the exemplars given in this module, teachers may design their own teaching-learning plans.

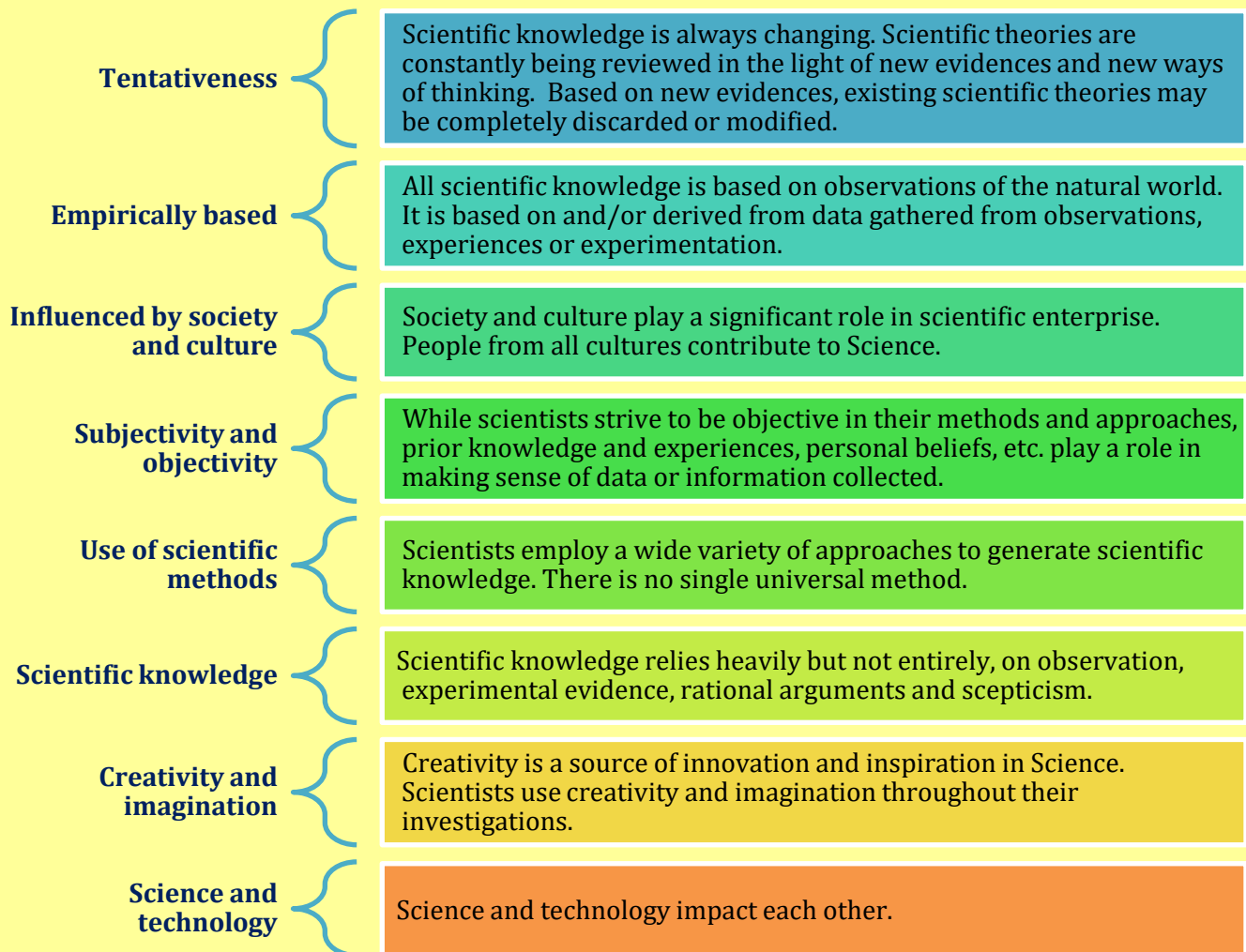
2.0 SCIENCE Curriculum in Context and Practice

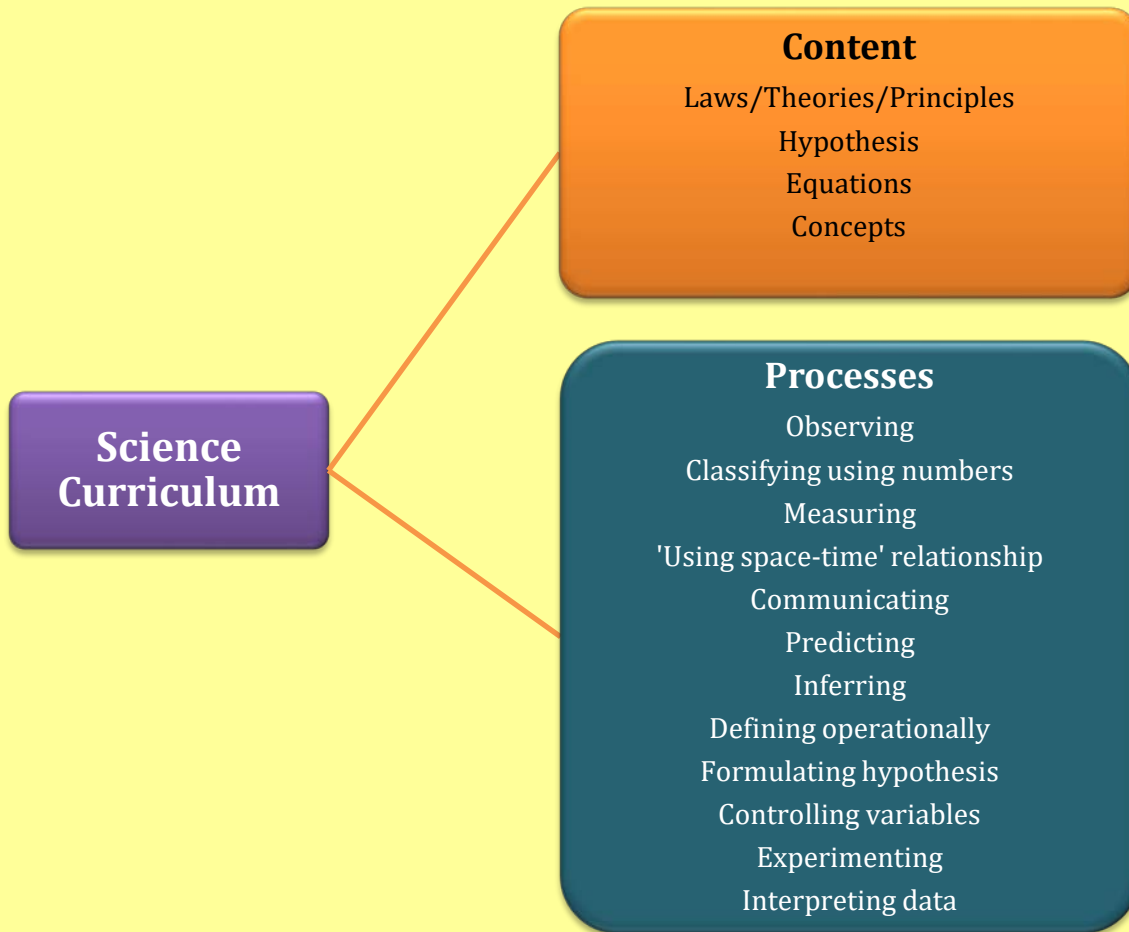
2.1 Introduction

Science begins for children when they realise that they can learn about the world and construct their own interpretations of events through their actions and experiences. “A child best learns to swim by getting into the water; likewise, a child best learns science by *doing* science” (Rillero, 1994). Doing science, as opposed to simply *hearing* or *reading* about it, engages children and allows them to test their own ideas and build their own understanding (Ewers, 2001). Therefore, it is difficult to imagine a science-teaching program without doing science experiences.

Human beings are curious by nature. Because of having a highly developed mind they can observe precisely, correlate observations and predict future happenings on the basis of their observations. They are able to explore, interpret and solve problems and change the physical world according to their own needs and requirements. This process of observing, describing, exploring, problem solving, understanding and describing phenomenon/ events in the physical world is nothing but Science.

Science has certain characteristics which distinguish it from other disciplines:





The teaching of Science involves more than just imparting scientific knowledge. In addition to teaching scientific concepts, the teaching of Science also involves development of Science process skills and Scientific attitudes in children.

2.2 SCIENCE Process Skills

Science process skills are useful not only in Science but also in any situation that requires critical thinking. While these are chiefly mental skills, they also involve some associated physical skills. They are concerned with processing evidence and ideas, and so are often called process skills.

When children interact with things in their environment in a scientific manner it is through using process skills such as handling, manipulating, observing, questioning, interpreting, etc. The more they develop these skills the more they can learn through their own activity and come to a real understanding of how the physical and biological parts of the world around them work. Process skills are thus the route by which children explore and gain evidence which they use in developing

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ideas (Reference: *UNESCO Source book for Science in the Primary School: Wynne Harlen, Jos Elsgaest*).

Basic Science Process Skills:

Observation

- This is the most fundamental of the science process skills. We observe objects and events and learn more about the world around us by using our five senses. The ability to make good observations is essential for development of other science process skills. The process of observing can be:
Qualitative – observation of the properties of an object such as its shape, colour, size, texture, smell, and sound or
Quantitative – involving measurement; Change – observation of result of mixing, crushing, burning, shifting, decaying, etc.

Classification

- We are surrounded by a number of things, living and non-living. We can bring order by grouping objects or events, based on similarities, differences and interrelationships and by grouping them accordingly to suit some purpose. e.g., a class of insects, flowers, acids, carnivores, etc.

Measurement

- This is used for recording precise and accurate observations. For example, rise in temperature, change in dimensions, change in duration, etc.

Communication

- This involves expressing or sharing of ideas with others orally, in writing through graphs, diagrams, tables of data, charts, maps, photographs, etc. Communication needs to be clear and precise so that the other person is able to understand and interpret the information.

Estimation

- Sometimes when accuracy is not required, estimation can be used e.g. half a glass of water or one fourth of a piece of bread, number of flowers in a bunch, height of a tree, etc.

Prediction

- Prediction helps us to know the behaviour of any object or phenomenon before it happens. It involves the process of using past observations or data along with other kinds of scientific knowledge to forecast an event or relationships. Our planning should depend on predictions based on scientific knowledge. For example, predictions about crops, weather, population, pollution, etc.

Inference

- An inference is an explanation based on an observation. It is a link between what is observed and what is already known. We use our past experience to help us interpret our observations.

Generalisation

- Generalisation is the ability to establish relationship between various phenomena/concepts or facts. It involves using one or many facts to make a broader statement. The more data/ information one has, the more accurate is the generalisation.

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Science Practical Process Skills:

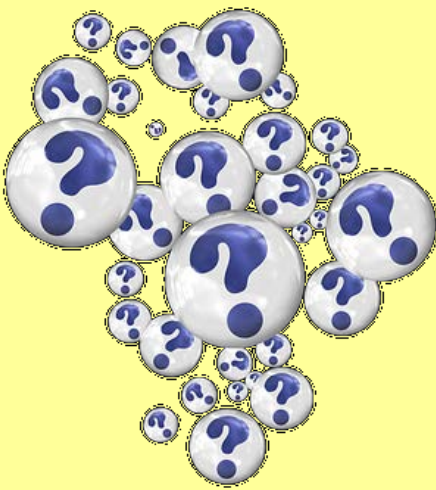
Forming Hypothesis	<ul style="list-style-type: none">•Forming a statement of the expected outcome of an experiment
Identifying and controlling variables	<ul style="list-style-type: none">•Involves identification of variable/s that may affect the outcome of an experiment, keeping some variables constant and manipulating the independent variable/s
Defining Operationally	<ul style="list-style-type: none">•Involves statement of how a variable will be measured in the experiment
Designing Investigations	<ul style="list-style-type: none">•Designing the experiment by identifying the materials and developing a suitable procedure to test the hypothesis
Experimenting	<ul style="list-style-type: none">•Carrying out of an experiment by following the instructions carefully, so that the result can be verified by repeating the procedure/ testing a hypothesis through manipulation of the independent variable and noting the effect on the dependent variable
Collection of data	<ul style="list-style-type: none">•Collection of data as observations/ measurements and its grouping, if required. Rejecting a particular observation based on the pattern of collected data
Tabulation or Graphing	<ul style="list-style-type: none">•Making tables and graphs of the data collected
Interpreting Data	<ul style="list-style-type: none">•Analysing data statistically, arriving at explanations, inferences, evaluating the hypotheses, formulating conclusions and recommendations
Understanding cause and effect relationships	<ul style="list-style-type: none">•Identifying what caused what to happen and reason for the same
Formulating models	<ul style="list-style-type: none">•Creating a mental or physical model of a process or event

Through the systematic and organised use of the above-mentioned process skills, people unfold the mysteries of nature which in turn help them to use nature according to their own needs and requirements.

The present Science curriculum follows a disciplinary approach. The curriculum for Physics, Chemistry and Biology for classes VI to VIII is designed to ensure that children build a proper foundation in Science by connecting with concepts learnt in primary classes and applying them in a variety of ways and situations. To support this process, wherever possible, teachers need to integrate concepts from various themes and apply them to real-life situations in children's daily lives.

2.3 Scientific Attitudes

Science fosters development of attitudes such as:



Inquiry based approach to Science

The aim of practical work in Science should be development of inquiry skills among children. Scientific inquiry refers to the scientific approaches used by scientists in an effort to answer their questions of interest. Following Herron (1971), different types of laboratory activities may be arranged by the degree of openness and the demand for inquiry skills in four levels as given in the table below:

- In *Level 0*, problem, procedures and conclusions are given and the only task remaining for the student is to collect data.
- In *Level 1*, problem and procedures are given and the student has to collect data and draw conclusions.
- In *Level 2*, only the problem is given and the student has to design the procedure, collect the data and finally draw the conclusions.
- Finally in *Level 3*, the highest level of inquiry, the students have to do everything by themselves, beginning with problem formulation and ending with drawing conclusions.

It is a common practice to lay more emphasis on the lower levels, namely 0 and 1. There is little emphasis on levels 2 and 3 which are considered essential for the development of problem solving skills. The result is that many children still perceive the laboratory as a place where they do things but fail to see the connection between what they do and the theory and the place of the laboratory in the larger context of the scientific enterprise.

Attempts should be made by teachers to include practical tasks in designing assessments *for*, *of* and *as* learning, for developing higher inquiry skills among children.

Table: Level of Inquiry in Science Laboratory

Level of Inquiry	Problems	Procedures	Conclusion
Level 0	Given	Given	Given
Level 1	Given	Given	Open
Level 2	Given	Open	Open
Level 3	Open	Open	Open

Reference: Herron, M.D. (1971). *The nature of scientific inquiry. The School Review, 79(2), 171-212*

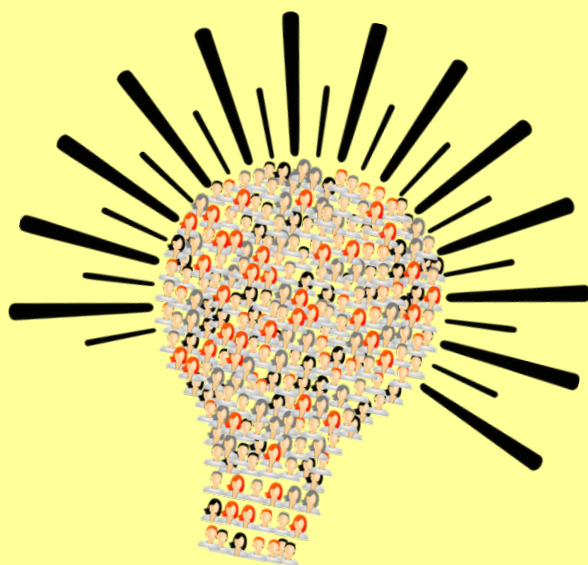
3.0 Science Curriculum at the Upper Primary Level (Classes VI-VIII)

The Science curriculum at the Upper Primary level aims to develop many processes and problem-solving skills in children such as observing and describing, classifying and organising, measuring and charting, communicating, predicting, inferring, hypothesising, hypothesis testing, identifying and controlling variables, interpreting data, constructing instruments, simple devices and physical models.

At the upper primary stage, children get the first taste of the power of Science through the application of powerful abstract concepts that reinforce previous learning and experience. This enables them to revisit and consolidate basic concepts and skills learnt at the primary stage, which is essential from the point of view of achieving universal science literacy.

To support this process, teachers need to find ways and means of integrating concepts from various themes and apply Science to real life situations in children's daily lives. While transacting this curriculum we need to remember that each child is unique in terms of her/ his likes, dislikes, interests, dispositions, skills and behaviour. Each child learns and responds to learning situations in her/his own special way. There are a variety of approaches and methods for teaching science e.g., Inquiry based Approach, Problem Solving Approach, Lecture cum Demonstration Method, Laboratory Method, Scientific Method and Project Method. The teaching strategies at this stage must address the needs of all children.

The present Science curriculum expands spirally from Classes VI to VIII. For example, let us take the concept of Physical Quantities and Measurement. The child picks up measurement skills gradually, with measurement of length, mass, time, temperature and area in class VI to measurement of density of irregular solids and fluids in class VIII. Similar approach percolates down to all other themes in the curriculum.



3.1 Objectives of teaching-learning SCIENCE at the Upper Primary Level

Major objectives of teaching-learning of Science at this stage is to enable children to:

recall, relate and interpret scientific explanations of the natural world;

develop an understanding of the world based on current scientific knowledge;

connect that Science involves processes and ways of developing and organising knowledge and that these continue to evolve;

generate and evaluate scientific evidence and explanations;

use various objects, places, plants, animals, in the immediate environment etc. as learning resources;

collect, represent (graphically and in tables) and interpret data/information from their life experiences;

handle abstraction in Science;

provide reasoning and convincing arguments to justify their own conclusions;

use her/his current scientific knowledge and skills for problem solving and for developing further knowledge;

inculcate values, attitudes and skills related to protection of the environment;

develop an awareness of the natural, social and cultural environment which help them to deal with issues/concepts in an integrated manner through various activities related to daily life experiences;

participate productively in scientific practices and discussions;

enhance/promote curiosity and creativity in relation to the surroundings;

The above curricular expectations envisage the goals the child should be able to achieve during the upper primary classes. These goals need to be appreciated by the teachers by first understanding them and then trying to achieve them through various teaching learning-strategies. This will lead to a holistic development of the child as well as develop the child's interest in Science. The curricular goals if implemented in the full spirit will lead to the child becoming a 21st century citizen who is capable of logical and analytical thinking, who can find creative solutions to problems.

Note: For learning outcomes of Science at the Upper Primary Level, refer to the Curriculum document.

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Areas of concern with respect to the teaching-learning of **SCIENCE**

Children's perception of Science

- Science is a set of rules, theories, laws, algorithms and procedures;
- Scientific knowledge is by its nature dull, abstract and theoretical, often contradicting 'common sense';
- Science is "difficult" and meant only for intelligent children;
- Science is boring - there is little room for enjoyment, curiosity, critical thinking and creativity ;
- Learning Science requires hard work and considerable intellectual effort besides memory;
- School science lacks relevance to real life.

Concerns regarding teaching-learning of Science

- In a world where multiple sources of information are available to children, Science subjects are readily perceived as unattractive;
- The cultural, social or historical dimension is often missing in the teaching of Science;
- Teaching strategies are teacher-centred with little scope for experiential learning;
- The learning requirements of the talented minority, average and below average children in the class are taken to be the same;
- Teaching strategies often emphasise on memorisation rather than construction of knowledge, based on experimentation.

What teachers need to do

- Elicit the existing ideas and beliefs of children, discuss them and link them to their classroom experiences;
- Teach Science in contexts in which children can make links between their existing knowledge, the classroom experiences, and the Science to be learnt;
- Ensure that the concept is clear to the children, especially in practical work situations;
- Design learning tasks to ensure that the children are involved in thinking about the Science they are learning;
- Develop knowledge of content, procedure and understanding of the nature and characteristics of Science simultaneously, not separately;
- Involve children in creativity, problem solving skills and critical thinking; encourage children to suggest plausible solutions to a given problem.
- Ensure every child is involved, with a sense of success, and there are also some conceptual challenges for the emerging scientists;
- Use a variety of resources to provide appropriate experiences to children according to their learning requirements;
- Ensure assessment focuses on examining children's abilities and understanding rather than just procedural knowledge.
- Help children to build up their vocabulary of scientific terms by appreciating specific meaning of each and every term as and when it is required.

'I never teach my pupils: I only attempt to provide the conditions in which they can learn.'

Albert Einstein US (German-born) physicist (1879 - 1955)

3.2 Salient features of the **SCIENCE** curriculum

Salient Features	What does it mean?	Examples
Theme-based and integrated approach to learning	<p>The present curriculum encourages a 'theme-based' rather than a 'topical' approach in this curricular area. Thus, it does not proceed with a list of topics where focus is on coverage of content.</p> <p>Instead of moving from one topic/ subject area to another, in a disconnected, compartmentalised manner, the present curriculum encourages an integrated and enquiry-based approach to teaching-learning, so as to enable children to comprehend learning experiences as a unified whole. The curriculum aims to help children make sense of life's experiences by helping them connect and correlate knowledge and experiences across various topics within as well as across subject areas.</p>	<p><i>In SCIENCE, the content has been presented through themes rather than topics e.g. In the theme Physical Quantities and Measurement, the content of the theme is related to the child's life experiences rather than facts connected with it.</i></p>
Child-centred approach	<p>The curriculum gives primacy and evolves through children's experiences and their active participation. The identified concepts, skills, issues/concerns included in the SCIENCE curriculum are developmentally age-appropriate with the understanding of the child progressing gradually from self to the immediate surrounding and further to the wider environment.</p>	<p><i>In order to follow a child centred approach in SCIENCE, the learning process followed under each theme needs to be from simple to complex, concrete to abstract, informal to formal in a logical and phased manner e.g., food in the family → sources of food → production and conservation of food OR measurement of length → area → volume.</i></p>

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Salient Features	What does it mean?	Examples
Range of learning experiences	Recognising different learning styles and individual differences among children, the SCIENCE curriculum suggests a wide range of learning experiences and transactional strategies. Thus, the curriculum aims at ensuring that learning is a joyful experience for all children and that they are able to understand not only what they learn, but also how this learning is relevant in their lives, both for the present and the future.	<i>Use a range of interesting and engaging activities/tasks that cater to different learning styles e.g. in SCIENCE various strategies ranging from discussions, experimentation, hands-on experiences, case studies, field visits, role play, project work, surveys, model making, poster making, slogan writing, etc. are to be followed.</i>
Spiral approach to learning	As children progress, they will revisit certain concepts/themes which are repeated consciously as an entry level behaviour to build new learning. However, the depth and complexity of the theme/concept will increase with each revisit. The new knowledge would be put in the context of the pre-existing knowledge which would serve as a base or the foundation for the next level of learning.	<i>Plan lessons taking into account prior knowledge and experiences of the children. Thus, the new learning should be built on the previous experiences of the child. e.g., Reflection → plane mirror → laws of reflection → spherical mirror.</i>
Holistic approach to learning	Different domains of learning, i.e. cognitive, affective and psychomotor (head, heart, hand) have been dealt with in an integrated manner rather than addressing them in isolation within/across the themes.	<i>In the exemplar on the theme Physical Quantities and Measurement you will find learning outcomes of all the three domains. i.e. cognitive, affective and psychomotor.</i>
Scope for Contextualisation	The curriculum provides flexibility to schools to adapt and contextualise as per their own requirements and the needs of the children. While the key concepts/areas have been spelt out for this subject in the curriculum, it is expected that the teachers would adapt and use appropriate transactional processes, based on the resources available, the interests and aptitude levels of children, as well as their	<ul style="list-style-type: none"> • <i>Design activities and cite examples that are relevant for children in terms of life experiences and their local contexts.</i> • <i>Help children in connecting and applying their learning to home and community e.g. reducing the flame once the</i>

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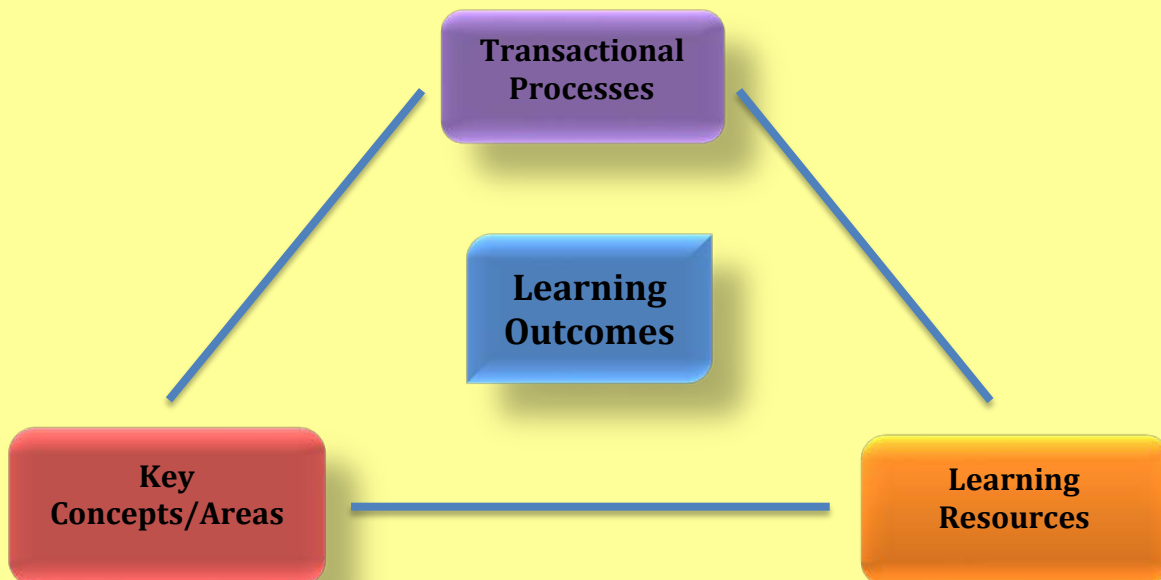
Salient Features	What does it mean?	Examples
	geographical locations and the socio-economic and cultural contexts.	<p><i>water/vegetable curry begins to boil saves energy as heat supplied no longer increases temperature once boiling begins.</i></p> <ul style="list-style-type: none"> • <i>Use learning resources that are locally available. Many physical phenomena like heating/boiling/freezing could be related with day to day activities at home.</i>
Social Constructivist approach	<p>This approach lays emphasis on learning by doing (I do, I understand much better). Also, children learn better while interacting/discussing with elders/peers. Thus, this approach provides opportunities for children to construct their knowledge rather than placing them as recipients of information in the transactional process. The knowledge gained by them is thus an outcome of the children's involvement in the learning process. Engaging/involving children in exploring, observing, discovering the world around them, helps in the process of construction of knowledge.</p>	<ul style="list-style-type: none"> • <i>Provide opportunities for collaborative and group learning through interaction with peers and elders (group learning).</i> • <i>Provide opportunities as well as the necessary resources to enable children to experiment, explore and discover for themselves (learning by doing).</i> • <i>Create an environment in the class where the children feel safe to ask questions - non-threatening environment.</i> • <i>Prompt enquiry by asking thought provoking, open-ended questions (opportunity for soft skills).</i>
Values and Life Skills	<p>The values and life skills are not to be developed in isolation and are not as 'add on' activities, rather, these are to be developed in an integrated and infused manner from this curriculum area. (Age appropriate skills and life skills have been</p>	<p><i>While dealing with all the themes in SCIENCE, one of the considerations is to inculcate values and develop life skills as per the nature of the theme e.g. in the theme Physical Quantities and</i></p>

Unfolding the Curriculum: SCIENCE Curriculum in Practice

Salient Features	What does it mean?	Examples
	mentioned in the curriculum as a reference point for teachers).	<p><i>Measurement correct method of measurement using a standard device and actual reporting of observation is to be stressed upon, as a value and life skill.</i></p> <p><i>Similarly, while dealing with lateral inversion of image formed by mirrors, one can cite the example of AMBULANCE written in laterally inverted form so that the rear-view mirror shows the correct image. It could be reemphasised that one should give way to an ambulance whenever one is on the road.</i></p>

3.3 Major components of the curriculum

- Each theme begins with a brief introduction, followed by learning outcomes. These learning outcomes cover different aspects of the child's behaviour, i.e. knowledge, comprehension, skills, values/ attitudes. These learning outcomes are age-appropriate in nature. However, other relevant learning outcomes may be added, keeping in view the need, context and understanding of the children.



Unfolding the Curriculum: SCIENCE Curriculum in Practice

The curricular components of SCIENCE have been dealt with in three columns.

Theme		
Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
>	>	>

- In column 1, Key Concepts have been mentioned.
For example, the Theme, '**Physical Quantities and Measurement**', covers key concepts related to the Measurement of Length - Concept of Length as distance between two points, Measurement of length using ruler and measuring tape; Measurement of mass - Concept of Mass as matter contained in an object, measurement of mass using beam balance, electronic balance; Measurement of time - Concept of Time and expression in terms of hours, minutes, seconds, days, weeks, months and years. Time measuring devices (clock, watch, stop watch); Measurement of temperature - Measurement of temperature using clinical thermometer, laboratory thermometer, normal temperature of a human body; Measurement of Area-Area of regular and irregular shapes using graph paper; units of length, mass, time, temperature and area, etc.
- In column 2, suggested transactional processes have been mentioned. These transactional processes have been identified keeping in view the following:
 - Age/ Class
 - Nature of the theme
 - Key Concepts
 - Learning Outcomes
 - Learning Resources
- In the third column, suggested learning resources have been mentioned. The learning resource(s) include any action or material which enhances the learning process. These also include audio-visual material, tables, charts, models, plant specimens, field trips, etc.
- In each theme, at the end of the Curriculum presentation, integration of the theme with other subjects has also been highlighted. The implication of this reference is that wherever there are linkages, they should be addressed simultaneously, rather than dealing with them in isolation.
- Life Skills/ Values have also been addressed in the curriculum in an infused manner. While transacting the curriculum, life skills and values should be dealt with in context and in an integrated manner.

3.4 Suggested pedagogical principles in teaching-learning of SCIENCE

- **Active involvement of ALL children:** Successful implementation of classroom transaction is that which involves all children in the classroom activities. Active participation of every child is important in constructing knowledge. It does not however mean that all children should be kept engaged in similar work.
- **Opportunity for participation:** Select strategies that provide ample opportunities for children's participation/active engagement in the learning process. Include more than one strategy in the transactional process depending on the nature of the concept/s.
- **Range of strategies:** Select strategies that involve all aspects of human behaviour, cognitive (head), affective (heart/emotions) and conative (hands/manipulative).
- **Emphasis on process of learning:** In addition to coverage of content/concepts, emphasis should be laid on the processes of learning. Give opportunities through a variety of ways to explore, observe, draw, categorise, discuss/ speak, ask questions and enlist, etc. to develop various process skills. These processes would make SCIENCE classrooms more child-centred and activity based.
- **Building on children's prior experiences:** Efforts should be made by teachers to relate the child's local knowledge to the school knowledge, this would discourage rote memorisation. Create an environment for brainstorming and discussion, building on children's experiences e.g. "Why do we bend forward while walking?"
- **Being realistic:** Transactional processes for selected key concepts need to be planned keeping practical aspects such as age-appropriateness and suitability, availability of time and resources, etc. in mind.
- **Being flexible:** One also needs to be flexible in approach. If any strategy does not work, switch to another one.
- **Variety of resources:** In addition to textbooks, use illustrations/pictures/tables/charts/graphs/audio-visual material. Also design activities that involve interaction with peers, family members, etc. This would help children in not only collecting the required information, but also develop their discussion and questioning skills. Simple survey on type of plants/wild animals in the neighborhood may be one example.



REMEMBER

Ask questions from children during interaction and provide opportunities for children to raise questions.

Try to encourage them to ask, explore, discuss in the class. Questioning not only develops confidence in children but also develops analytical and critical thinking.

All children are not in the habit of asking questions. Some children might not be good in framing questions or their questions may be irrelevant. Be attentive. Discourage other children from laughing or commenting in such situations. If a child raises an absurd question, do not snub him but try to convince him logically and give a valid argument/example. If you do not know the answer to a question, admit it and try to answer it at a later stage.

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- **Skill development:** Activities/questions should not be used only for assessing children but also to develop skills such as creative expression, observation, classification, explanation, etc. amongst children.
- **Assessment *for* and *of* learning:** Use assessment *for* learning (formative) for diagnostic purpose to improve children's learning and develop their best potential. Use assessment *of* learning (summative) not to compare the progress of children but to track the progress of each child regularly. This assessment should be done periodically by using a variety of modes (not restricted to only the written mode). Suitable tasks should be designed for assessment *for* and assessment *of* learning and the same should be integrated into the teaching learning process.
- **Recording children's work:** Maintain a portfolio of each child (the work done by the children in a variety of situations, covering various aspects of the child's behaviour) to know the progress made over a period of time. An e-portfolio can also be maintained by teachers to reduce the task of recording work.

3.5 SCIENCE Teaching-Learning Strategies

To develop any Science concept, teachers need to think about the strategies for classroom interaction. Given below are some suggested teaching-learning strategies with examples, that can be used in classrooms. These are suggestive and should be modified according to children's needs.

Experiential Learning

Children are born with a natural curiosity about the world around them. They learn by exploring, experiencing, creating, discovering and interacting with the world around them. These activities allow children to experience Science concepts as they experiment with spatial awareness, measurement and problem solving. Experience has an important place in the process of knowledge construction or understanding of a concept. It is an important step in the process of exploration through which individuals can be made to feel, reflect, and arrive at ideas.

"Experiential Learning takes place when a person involved in an activity looks back and evaluates it, determines what was useful or important to remember, and uses this information to perform another activity."

John Dewey

The process of experiential learning depends on creating experiences where learning can be facilitated. For example, in a Science park, children can play with various models and exhibit and learn the basic principles involved in them. In some cases, the children can be engaged in survey work, conducting interviews of the scientists, collecting different specimens and materials for activities, writing assignments, etc. For example, while dealing with the concept of density, children may be asked to investigate which items in the kitchen are denser than water.

Problem Based Learning (PBL)

Problem Based Learning uses real world problems to develop understanding of concepts. The emphasis is on children learning through hands-on activities rather than simply memorising facts. PBL fosters development of Lion skills of critical thinking, questioning, analysis, hypothesising, evaluating, etc. This method provides ample scope for integrating various curricular areas. The goal is to activate prior knowledge of children and to help them to start a learning process by reconstructing their knowledge and making new sense of it. In the process, the children need to define what information is relevant and what steps or procedures are required in order to solve a problem. It may also require children to search beyond the information that is readily available.



REMEMBER

- The problem should be based on real life situations, based on contexts the child is familiar with
- Children should be encouraged to connect previous knowledge to new concepts and connect the new knowledge to concepts of other courses
- All members of the group should be encouraged to participate
- The problem need not have a closed solution that is either correct or incorrect. It should allow for discussion so that knowledge and different possible solutions can be shared amongst children.
- The problem under discussion should encourage a process among the children of assessing and discussing the related issues.

In order to develop better thinking skills in children, we need to ask better questions. What sort of questions do you ask in your classroom?

Questions can be either closed or open. Example:

Closed questions

Closed questions are used to obtain knowledge or an understanding of facts and have only one correct answer.

Example of a closed question

- **What is the length of the Physics book that you are using?**
- **Who is the discoverer of *Theory of relativity*?**

Open-ended questions

Open-ended questions involve thoughtful and investigative responses. More than one correct answer is acceptable, and children are encouraged to be creative when responding to open-ended questions. Open-ended questions can have a variety of possible answers and these allow children to make explorations. It could be even fictitious, as long as it serves the purpose for which it is used.

An example of an open-ended question is:

- ***The night is going dark, the skies are going darker
I heard a roaring sound Look, it's the lightning above. (By Hunter Kejick)
Based on your learning of Physics, opine on the poet's understanding of
thunder and lightning.
OR***
- ***Suggest some ways of reducing usage of plastic at home.
OR***
- ***What would be the consequences if air had only oxygen, but no nitrogen?***

Allow the children to discuss their answers in groups and agree upon an answer for presentation and discussion.

Project Based Learning

The core idea of Project Based Learning is that children develop a deeper understanding of concepts through active exploration and investigation of real world problems over an extended period. Project Based Learning helps in development of children's problem solving and critical thinking skills, besides giving them an opportunity to study in-depth a topic/ area that interests them.

A project work is a planned and definitely formulated piece of study involving a task or problem to solve or a phenomenon to investigate. It may be taken up by the child either individually or in a group, to supplement and apply classroom and laboratory learning. For Project work to be effective, it must be meaningful to the child - it must matter to him/her and it must serve an educational purpose.

Make a list of different types of wastes in the school compound and find out:

- The source/s for each type of waste;
- The quantity of each type of waste;
- Ways in which each type of waste can be disposed off safely.
- Ways in which children/teachers can contribute in: (a) Reducing waste and (b) Safe disposal of waste.

Types of Projects:

Projects may be categorised based on the tasks involved:

- Practical oriented, involving actual construction of material such as a model – children build something, explain how it works, and what improvements they can make;
- Experiment/Research oriented where children perform experiments, conduct simple research and present their findings in the form of a report stating the problem studies, aims/objectives, methods, data, results and conclusion.

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- Search and find projects where children select an area of interest and collect information on it, prepare a presentation/make a report of their findings.

Projects allow children to use a wide range of concepts in practical/real contexts. Children can apply their understanding, in various activities in which they are participating. For example, children could collect and use traditional materials to make informal measurements, or draw to scale simple maps of the house, school or community.

Field Trips

A field trip is a visit to a place outside the regular classroom which is designed to achieve certain objectives, which cannot be achieved as well by using other means. Field trips provide opportunities for children to get out of the classroom and experience something new. They provide a break from the regular classroom teaching, while allowing them to appreciate the relevance and importance of what they learn in the classroom.

Field trips provide the opportunity for hands-on, real world experiences, improved quality of education, motivation and development of positive attitude towards the subject, improvement of the socialisation between children as well as development of rapport between teachers and children.

In addition to providing opportunities for experiential learning, field trips also help in development of concrete skills such as note-taking, report writing, and communication skills.

Games

Games are a natural way in which children learn. Children love to play games. It is the process through which children explore, investigate, recreate and come to understand their world. Game is an activity in which everything that a child knows and can do is practised or used to make sense of what is new. Games teach children to work together as a well-coordinated team. They help in development of coordination skills which are necessary to perform delicate jobs.

- Games complement traditional teaching
- Make learning more fun
- May be adapted to the needs of the children and the learning environment
- Allow a large amount of flexibility
- Enhance development of observation
- Help children in monitoring their own understanding of the subject area
- Provide instant feedback to the children and teachers

Teaching Science through games

- Basketball can be used to teach Motion in Physics.
- Billiards can be used to develop functional understanding about Momentum.
- Tug-of-war is a good analogy for developing concepts about balanced or unbalanced forces either in Physics or Chemistry.
- Carrom board can be used to reemphasise laws of reflection.

- Develop thinking and problem-solving skills,
- Foster spirit of collaboration, healthy competition

There are a lot of games children can play as part of their learning.

Group Work

The purpose of group work is to provide opportunities to children to share ideas and at the same time learn from other group members. Every group should have a leader to observe the group's activities. The leader should delegate tasks to group members and consult the teacher for assistance. Group activities can take place inside or outside the classroom. A good example of a group activity would be measuring length of different items in the surroundings. Groups of children could also use a cricket or hockey field on which to measure distance and perimeter using traditional methods of measuring such as with strings and sticks.

Collaborative Learning and Cooperative Learning

It is a known fact that learning is enhanced through peer interaction. This kind of interaction also provides children with an opportunity to speak and discuss more freely.

Collaborative learning is a kind of peer learning in which children work in pairs or in small groups to discuss concepts, or to solve problems. By sharing their knowledge, ideas and experiences, by clarifying doubts and misconceptions, children learn from each other. Cooperative learning is a specific kind of collaborative learning. In cooperative learning, children work together in small groups on a structured activity. They are individually accountable for their work, and the work of the group as a whole is also assessed.

3.6 Dealing with Errors and Misconceptions/ Alternative Conceptions

“To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advances in science.” –Albert Einstein

Children come to the class with certain existing ideas and experiences. When a new concept is introduced in class, they try to make sense of it by trying to connect it with their existing ideas and experiences. Sometimes the knowledge that children bring to a new situation impedes subsequent learning because it guides thinking in wrong directions. This may result in the formation of misconceptions/alternative conceptions or naive concepts.

For example, if the experience of a child is that whenever she wants to move an object, she has to apply force, it would not be surprising if she develops a concept that when an object is static, no force is acting on it. This concept may be called a misconception/alternative conception. The challenge for the teacher is to devise activities, thought experiments or arguments to confront the

shortcomings in her concept and lead her to understand that forces are acting on the static object, but they balance each other, and it is the net force acting on the object that is zero. In this way, a misconception can be reformed to a scientifically accepted concept.

It is important to know, how children process the information to explore their naive concepts/ misconceptions. If their misconceptions are not addressed and reconstructed, they continue to function as constraints in learning. The longer they remain unchallenged, the deeper they get embedded in their cognitive framework. Therefore, it is important to catch, challenge and change their naive concepts/ misconceptions for meaningful teaching-learning.

Some ways in which misconceptions may be addressed are:

- Encourage children to talk, enter into conversation, discussion, and argumentation. Encourage them to raise and ask questions.
- Listen to their conversation and questions.
- Demand explanation and give them opportunities to defend their ideas supported with data.
- Ask children to generate, collect and give evidences of their learning.
- Encourage them to perform experiments, activities and projects, make diagrams, concept maps and models to ponder over their existing ideas.
- Create situations where the child's existing ideas are in conflict with the new ideas that are consistent with scientific explanation.
- Relate the problem/concept to everyday life experiences of the children.
- Provide learning situations that support new ideas. Children should find the new ideas convincing to accommodate them with their existing ideas and bring about conceptual change.
- Help them to reflect on their new understandings.

A misconception is a mistaken idea or view resulting from a misunderstanding, which usually lead to errors. All errors are not the result of misconceptions.

Errors may occur for a variety of reasons, ranging from careless mistakes (less serious) to errors resulting from misconceptions (more serious).

It is a challenging task for the teacher to help children to revisit and reconstruct their existing concepts. Therefore, in the first-place, care should be taken to prevent formation of incorrect or partially correct concepts by designing suitable teaching-learning experiences involving children actively.

4.0 Assessment in Science

The process of assessment involves monitoring children's progress, which enables parents and teachers to modify instructions to meet children's needs and improve their performance.

During the teaching-learning process, the teacher assesses and monitors the child's progress while focussing on different levels of learning. It also enables teachers to assess appropriateness of the activity/activities for the class and/or individual child and finding out what the child has learnt and how. Continuous assessment during teaching-learning provides input/feedback to the teacher to improve her/his teaching strategies or to plan for remedial teaching of the individual and/or the class.

The assessment can be more objective and useful if it provides for:

- feedback to each child about her/his progress in Science.
- feedback to the teacher about the strength/weaknesses in her/his method(s)/strategies of Science teaching.
- information to individuals so as to prepare them for furtherance of their Science education and employment opportunities.
- children to develop interest in Science.
- feedback about accomplishment of stated objectives of the curriculum and specific objectives of the given unit/theme.

To address the demands of broader objectives of the Science curriculum, the teacher needs to employ a variety of tools, techniques and strategies. These tools include observations, analytical reviews of children's computational and problem-solving tasks, portfolios, anecdotal records, checklists, rating scales, children's self-assessment and traditional and non-traditional paper-pencil procedures.

The major focus of assessment lies on three essential parts; assessment **for** learning, assessment **as** learning and assessment **of** learning. Generally, the first two are termed as formative assessment and the last one as summative assessment. It is important to note that the formative assessment does not mean frequent testing. The above-mentioned tools help in assessing a child's strengths and weaknesses. The gaps in learning found by teachers through continuous assessment need to be addressed through enriching and interesting classroom strategies.

Assessment, Evaluation and Grading

- Assessment emphasises finding out what children know and can do and recording that in a useable form.
- Evaluation establishes criteria for judging different levels of proficiency or performance, whether the performance is excellent, acceptable, or needs improvement.
- Grading involves reporting the results of evaluation in some conventional manner, like A, B, C, ... or percentage.

The Assessment Process:

- Planning the assessment,
- Gathering data and information,
- Interpreting and understanding the data, and
- Making decisions based on the data.

After completion of each unit/theme, the teacher may assess the children, keeping in view the learning outcomes related to that unit/theme. In due course (quarter, month, etc.), such information can provide a comprehensive picture of the child's learning. The progress made by the children can be communicated to their parents along with the records. Based on this information, the teacher can draw inferences about performance of the individual child and the group as a whole and can modify her/ his teaching strategies accordingly.

5.0 Recording and Reporting in SCIENCE

Recording and Reporting are essential components of the assessment process. Generally, school-based formats are used to record and report the progress of a child. However, these may not reflect the actual teaching-learning process for providing inputs for improving child's learning.

5.1 Recording

Record keeping enables teachers to plan, organise and create the best learning environment for each child. Record keeping is also a useful tool for keeping a track of contributions made by different children in the classroom, for assessing children, for providing feedback to children and their parents about their progress over a period of time. It also helps teachers and children in setting future targets.

Recording should bring out a comprehensive picture of children's development. Thus, the record of a child's progress should be maintained in a qualitative manner and not in quantitative terms only (marks). Recording may be done through Anecdotal records (written descriptions of a child's progress that a teacher keeps on a day-to-day basis), which provide specific observations of the child's behaviour, skills, attitudes and provide information on the child's learning along with the direction for further improvement. A Portfolio (a collection of a child's work on various aspects and in a variety of formats over a period of time), may also be maintained by the teacher to track growth and progress of the child over the entire school year. This portfolio should be referred to while reporting the child's progress on a quarterly/ half yearly basis. Other ways of recording include Classroom Observations, Teacher's Diary, Checklists, Rating scales, etc.

Information from classroom record keeping may be shared with parents throughout the year so that they too can see specific examples of their child's progress. Teachers/schools may create their own systems for record keeping to suit the environment in which they teach.



Remember

- Recording should be simple and easy to understand by all users;
- It should relate to the Learning Outcomes;
- Language used should especially be sensitive to those whose attainment is currently below the age-related expectation.

5.2 Reporting

The progress made by the child over a period of time needs to be reported to the parents in a way that is easily understood by them. Providing information on the strengths and challenges faced by the children can help teachers and parents focus on ways to support learning at school and at home.

Very often, the child's progress is reported in the form of 'grades' such as 'A', 'B', 'C' without giving any remarks/descriptions/feedback which neither communicates to children about their strengths or areas of interest nor communicates to parents/elders about the progress of the child.

In order for it to be useful, reporting needs to:

- be clear, informative and easy to understand;
- describe what the child can do (strengths) and the areas that require further development or improvement;
- be constructive and positive in nature;
- help in setting realistic targets;
- explain clearly the relationship between the child's attainment and any comparative data provided;
- indicate ways the teacher is supporting the children's learning needs and, where appropriate, ways the child or the parents might support the learning;
- be sent to parents at times which allows for appropriate action or discussion to take place.

Report Cards are not the only ways to communicate a child's progress. Other means include:

- Informal reports are an important link between the school and home and can be in the form of weekly and monthly progress reports;
- Telephone calls, notes, parent-teacher conferences, etc.

Homework can also be used to communicate critical information to parents.



Part II
CHEMISTRY at the
Upper Primary Level

1.1 Objectives of teaching Chemistry at the Upper Primary Level

At the upper primary stage, children enter into the world of Chemistry, as one of the branches of Science, taught at the primary stage. Therefore, it is appropriate to specify the objectives of teaching Chemistry in consonance with different domains of Science as described on pages 169 and 170 of the Curriculum document for preschool to Class VIII. Within each domain, the objectives can be stated as follows:

(1) Concept Domain: Children will be introduced to the elementary ideas of matter, different forms of matter, elements - compounds and mixtures as detailed in Curriculum. At this stage, the emphasis will be more on development of qualitative understanding of concepts, qualitative reasoning and not on rigour of Chemistry. Attempt should be made to help children understand terms used in the context of mentioned topics in the curriculum.

(2) Process Domain: Children will develop different process skills like observation, description, classification, inference, reasoning and drawing conclusions. Children should be engaged in hands-on activities (in groups as well as individually) so that they develop these skills, at different levels of Enquiry as described in this module.

(3) Creativity Domain: One of the basic objectives of teaching Chemistry is to empower children to answer or attempt to answer, “What, how and why” about things and events around them. Children should be able to visualise - form mental images, combine ideas in new ways, produce alternatives and unusual uses of objects, and solve problems. The discipline provides situations to propagate new ideas and design experiments and equipment to test the validity of new ideas and theory.

(4) Attitude Domain: Children will develop a positive attitude towards Chemistry, in particular and Science, in general. This will also help them to develop positive attitude towards oneself, and sensitivity and respect for the feelings of other people. It will help them in decision-making, not only about personal issues but also about social and environmental issues.

(5) Application Domain: Children should be able to apply learning of Chemistry to new situations. They must be able to recognise instances of Chemistry concepts in everyday life experiences, application of Chemistry concepts and skills to everyday problems, understanding and evaluating of mass media reports of scientific developments. They should be able to apply their knowledge and skills of Chemistry in decision-making related to personal health and hygiene, nutrition and life style. Children should also be able to integrate Chemistry with other subjects of not only Science but Social Sciences and Humanities as well.

(6) Worldview Domain: Teaching-learning of Chemistry should help children develop understanding of ways in which scientific knowledge is created. It should enable them to see the place of Chemistry in the domain of other Science subjects (Biology and Chemistry) and domain of subjects like Economics, Politics, History, Sociology and Philosophy.

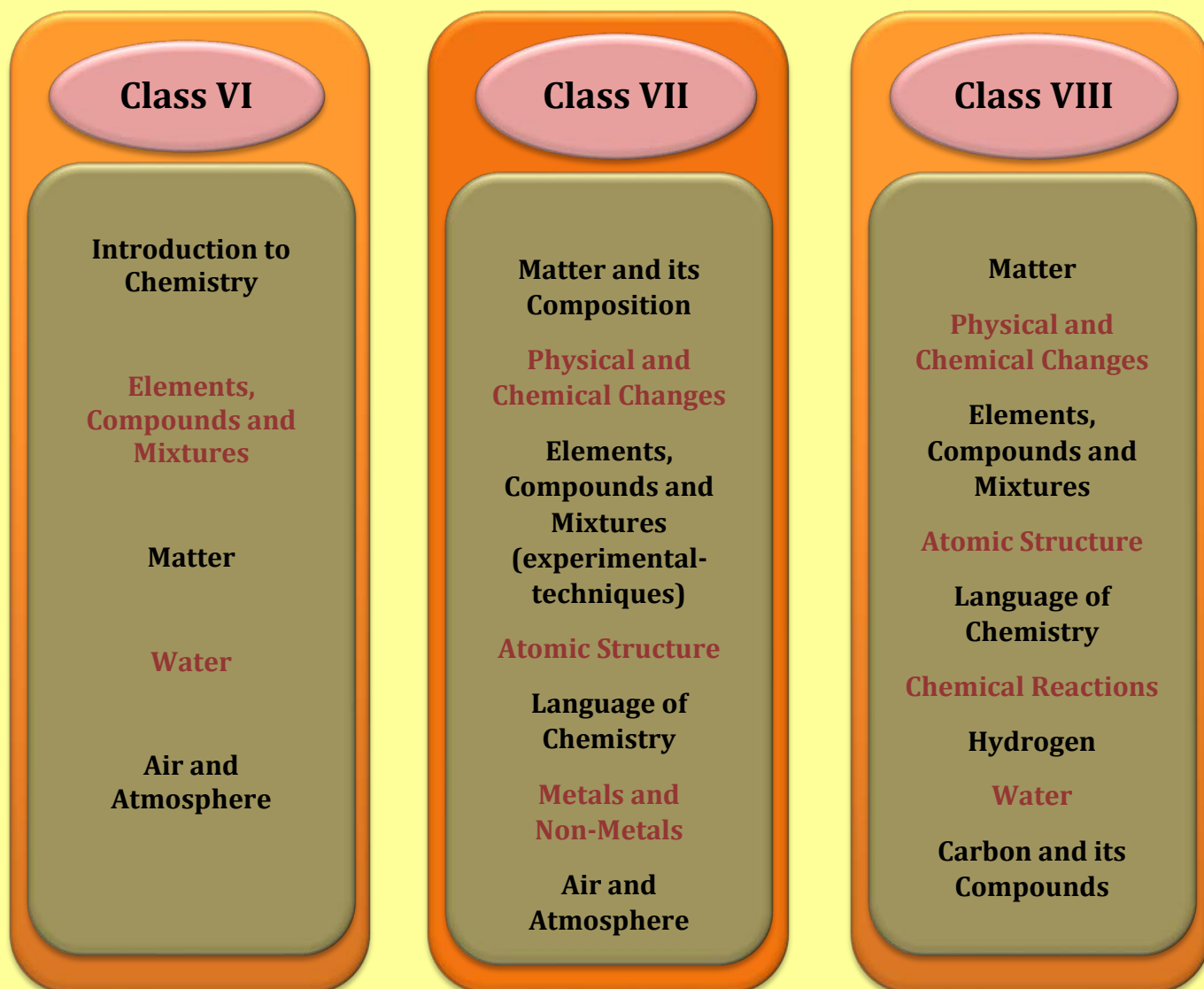
While teaching the subject at the upper primary level, the historical perspective of the development of Chemistry and the scope of career options should be highlighted to generate interest amongst children. Important applications of Chemistry in the area of health and hygiene, food, building materials and

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enhancing the production of different useful materials should be discussed to help children understand how Chemistry applies to various aspects of day to day life.

Some activities to show different chemical changes or phenomena could be performed by children so that they can develop scientific skills such as, observation, measurement, analysis, interpretation, drawing conclusions, etc. In the present scenario of the world, where technology has boosted our performance and our understanding of the world affairs, many are focusing their thoughts to the environmental issues. Chemists all around the world are looking into solutions for proper waste disposal, biodegradable products, fuel efficiency. Children too must be sensitised towards environmental concerns. Use of chemicals in the form of pesticides, insecticides, fertilisers and their effect on the environment must be highlighted in class.

The major themes to be covered in CHEMISTRY, from Classes VI to VIII, are briefly outlined below:



1.2 Exemplars in CHEMISTRY

Why do we need exemplars?

- To enable practitioners to translate the curriculum into practice in the classroom.
- To develop an understanding of the different components of the teaching-learning processes in a sequential manner.
- To understand how to translate learning outcomes of the selected concepts in the classroom context.

How do we plan the Teaching – Learning Process in SCIENCE

- Select a theme
- Brainstorm for ideas to develop a concept map
- Identify learning outcomes from the curriculum to write sub-competencies/specific learning outcomes of selected concepts
- Select appropriate content, activities and pedagogical process to develop concepts/skills
- Select learning resource material for the selected concepts
- Identify assessment activities
- Identify follow up activities

1.3 Common Errors and Misconceptions/ alternative conceptions in CHEMISTRY

Misconceptions/alternative conceptions arise mainly due to the child's previous knowledge and experiences and her/his understanding of the subject. Some common misconceptions found in research studies related to the themes of Chemistry at the upper primary stage are given below:

- **In expressing the results of measurements, often units and/or their standard symbols are not used**, for example, unit for mass is written as 'gm' whereas standard symbol is 'g'. Thus, a mass expressed as 1.20 gm must be expressed as 1.20 g. Similarly, the symbol for second, the unit of time is written as 'sec' and not as 's'. It should be '40 s' not as '40 sec'. The unit of quantity of substance is expressed in terms of 'mole'. It should be mentioned as '0.5 mol' and not as '0.5 mole'.
- **Very often the symbols of elements and formulae of compounds are incorrectly represented**. For example, chlorine is represented as cl_2 in place of Cl_2 ; similarly, formulae of compounds are incorrectly given, for example calcium hydrogen carbonate is commonly written as CaHCO_3 which is incorrect. It should be given as $\text{Ca}(\text{HCO}_3)_2$. It is necessary to consider the valencies of cations and anions while writing the formula of ionic compounds.
- In case of States of Matter, there is a wrong notion that **Particles of solid have no motion**. The fact is that the particles of solids vibrate about their mean position.
- **The hardness of matter depends on the state in which it exists. The hardness decreases from solid to gaseous state**. For example, hardness of particles of water decreases from ice to steam. The fact is that the hardness is a bulk property and arises due to arrangement of particles in a matter.
- **Atoms are hard like a cricket ball**. The fact is as stated above. Hardness is a bulk property. It is a matter which is hard or soft. Hardness does not depend on the atoms constituting matter.
- **Atoms have properties same as those of bulk matter which they constitute**. For example, copper metal appears brown so atoms of copper are also brown, which is incorrect. The colour of any matter is a bulk property.
- **Mercury atoms are liquid**. The state of a matter is again a bulk property.
- **Elements and atoms are synonyms. Elements are atoms with the same number of protons in the nucleus**. The common misconception is, for example, that oxygen is an element whereas O_2 is a molecule and not an element.
- **Molecules are basic, simple and indivisible entities**. The fact is that the molecules are formed by bonding together of certain atoms. They are not indivisible as a molecule can always be divided into simple entities constituting it.
- **A common misconception is that substances can be pure or impure**. The fact is that the term substance is used only for pure material i.e. which contains only a single substance.

Steel which consists of iron and carbon is a material whereas iron is a substance. Children feel that air is a substance whereas it is a mixture of many substances.

- **Particles of matter expand on heating.** The correct explanation is that expansion of any matter is a bulk property and depends upon interparticle distances at a given temperature.
- **The wrong notion is that all physical changes are reversible and all chemical changes are irreversible.** There are many physical changes which are irreversible and chemical changes which are reversible changes. For example, tearing of paper, breaking of glass bottle etc. are irreversible physical changes. The formation of ammonia from nitrogen and hydrogen is a reversible chemical change.

Some other common misconceptions are as follows:

- Any gas or a mixture of gases can be compressed to nothing.
- When two or more substances are mixed, a chemical reaction takes place.
- During a chemical reaction mass is either gained or lost.

1.4 Types of Questions

Teachers use questions all the time for assessment. Questions need to be framed keeping in mind the key concepts and the learning outcomes. A variety of questions must be included in assessment.

Generally, various types of questions may be classified as *very short answer* type, *short answer* type, *long answer* type (also called essay type), etc.

Questions can also be categorised based on the nature of expected answers. For example, objective type and subjective type; fixed response type and open response type. In objective type questions, children are required to select the correct alternative from the given choices or to provide a word or short phrase to complete a statement. Objective type questions may include Multiple Choice Questions, True and False type, Match the Following type and Completion type. In subjective type questions, children are expected to provide an answer in their own language and format. Subjective type questions may be of short answer type or long answer type (essay type).

True-False Type: There are many situations which call for either-or decisions, such as, deciding whether a specific solution is right or wrong, to continue or to stop proceeding further in a structured format (e.g.... if yes, answer the following; if no, give reasons), whether to use a singular or plural construction, and so on. For such situations, true-false items are more suitable for assessment.

Matching-Type: These types of questions provide a suitable way to test knowledge in learning situations in which events, dates, names, and places are important. Matching questions are also appropriate for the sciences in which numerous experiments, experimental results, and special terms and definitions have to be remembered.

Objective type items can further be classified on the basis of responses required as:

(a) Supply/Recall Type

(b) Selection/ Recognition Type

Supply type items are those in which answers are not given in the question. The children supply their answer in the form of a word, phrase, number or symbol. These items are also called as 'free response' type items.

Constructing a good quality objective type question (supply type or selection type) requires skill and practice. Following points are worth consideration in framing these types of questions:

(a) Supply type objective questions

- In short answer or completion items of supply type, be sure that one and only one word (or group of words) can fill the blank correctly. The stem of the question should be framed in such a manner that it does not provide any clue to the answer. The blank space should be towards the end of a statement, as far as possible. In no case, a statement should begin with a blank.
- Ensure that the scoring is objective.

For example, consider the following structure of the questions for testing the same concept.

- (i) What kind of change is shown by tearing of paper? (short answer)
- (ii) The gases are higher..... due to large vacant spaces between the molecules of a gas.
- (iii) The number ofin an atom is called atomic number.

The answer of question (i) could be *physical* as well as *irreversible*. Both are correct.

The answer of question (iii) is *protons* but students may write *electrons*. Numerically both numbers are same for electricity neutral atom but as per instructive conversation, it is the number of protons which is equal to atomic number for any atom.

(b) Selection type objective questions:

- Clear instructions must be given to the children, to indicate their preference for each of true/false, multiple choice and matching type questions.
- Space must be provided for putting a tick (✓) mark/Yes (Y) or a cross (✗)/No (N) to mark the answers. For example:

In the following statements, mark a tick (✓) /Yes (Y) for correct and a cross (✗)/No (N) for incorrect.

- (i) The symbol for SI unit of time is s. ()
- (ii) Force is a scalar quantity. ()

Always write clear instructions for getting a correct and precise answer from the children.

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While constructing a true/false type item keep in mind the following points:

(i) Avoid broad general statements.

Broad general statements generally do not hold true unless qualified. However, use of qualifiers may provide clue to the answer. Consider the following examples:

- (a) All substances expand on heating.
- (b) All solids usually change into liquids on heating to a certain temperature.

The first one is false, because water is an exception and second is although true, but the word 'usually' provides a clue.

Words like generally, usually, commonly, often, etc. are likely to appear in true statements.

(ii) Avoid long complex sentences and use of words which are not likely to be a part of child's vocabulary.

(iii) Avoid including two ideas in one statement as one may be true and the other may be false.

For example: Consider the statement for a true/false item.

"Clouds contain very small particles of water or ice that are held up in the air by the lifting action of air currents, wind and convection".

This is a poor example because it includes more than one ideas. It is a complex sentence too. Moreover, air current, wind and convection mean the same to the children at this stage.

(iv) The number of true statements and false statements should be approximately equal.

Some children tend to guess the answer if they are in doubt. Neither response set should be favoured by overloading the test with items of one type.

(v) The true/false statements should be arranged randomly rather than in some discernible pattern so as to minimise chances of guessing.

Multiple Choice Questions (MCQS)

A set of MCQs should include instructions like:

For each of the questions given below, four possible answers 1, 2, 3, 4 are given. Only one of them is correct. Put the number of the answer you consider correct in the box given at the end.

Example: The solution of which of the following oxides will change colour of blue litmus to red?

- 1. Sulphur dioxide
- 2. Magnesium oxide
- 3. Iron oxide
- 4. Copper oxide

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So, you see that a multiple-choice item has a stem, and a few (2-5) distractors, i.e. probable answers and one key (can be more than 1 to increase the difficulty level). The key provides the correct answer.

All selection type items are basically multiple-choice items. In case of T/F, multiplicity is just 2 whereas the multiplicity increases in a multiple-choice item. In the above example, as there are four choices, multiplicity is 4 and becomes maximum in matching the column type questions. For example, if column A has 5 entries and column B has 7 entries, then for each entry in column A, there are seven choices with which it can be matched. Here the multiplicity is 7. Therefore, the form in which the question is constructed also has an impact on its difficulty level.

A question when asked in a T/F form is the simplest and a matching type format is the most difficult form for the same question. Thus, by changing its form we can make a question more or less difficult.

For construction of a good multiple-choice question (MCQ):

• The most crucial element in framing such questions are distractors. These are included to distract the child who is not sure of the correct response (key) and is trying to guess the correct response. Some points that a constructor of MCQ has to keep in mind are:

- (i) How many distractors should be used?
- (ii) How should they be placed in a multiple-choice item i.e. 1, 2, 3 should be distractors and 4 the key or any other permutation?
- (iii) How permutation should be used for deciding percentage of the key in a particular order, i.e. how many questions will have 1, 2, 3 or 4 as the key and in what sequence?
- (iv) Same number of distractors should be used in all the items in a given test paper.
- (v) The distractors like **all of the above** or **none of the above** should be avoided.

• The stem of the item should be meaningful by itself and should present a definite problem.

Consider the following example:

Example: Making ice from water is an example of

- | | |
|---------------------|------------------------|
| (a) Man-made change | (b) Chemical change |
| (c) Sublimation | (d) Undesirable change |

It is an example of a poorly framed MCQ for the following reasons:

- It is a physical change, may or may not be man-made. Naturally ice may change to water.
- It may be desirable, or undesirable depends on the situation.

A better way of framing the above MCQ could be:

Example: Conversion of ice to water is an example of:

- | | |
|-----------------------|-------------------------|
| (a) Physical change | (b) Chemical change |
| (c) Exothermic change | (d) Irreversible change |

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In constructing matching type items

- For each entry in column A, all entries in column B should have plausible alternatives.
- There should be an unequal number of entries in column A and B.
- There should not be a clue in the alternatives for entry in column A.

Poor example:

Column A	Column B
1. Isotopes	(a) Number of protons
2. Isobars	(b) Number of protons + neutrons + electrons
3. Atomic number	(c) ${}^{16}_8\text{O}$ ${}^{18}_8\text{O}$
4. Mass number	(d) Number of protons + neutrons
5. Atoms of different elements having same number of neutrons	(e) ${}^{40}_{20}\text{Ca}$ ${}^{40}_{18}\text{Ar}$
	(f) Number of electrons
	(g) Number of neutrons

A better way of framing the same question could be:

Column A	Column B
1. Isotopes	(a) Number of protons
2. Isobars	(b) Number of protons + neutrons + electrons
3. Atomic number	(c) ${}^{16}_8\text{O}$ ${}^{18}_8\text{O}$
4. Mass number	(d) Number of protons + neutrons
5. Isotones	(e) ${}^{40}_{20}\text{Ca}$ ${}^{40}_{18}\text{Ar}$
	(f) ${}^{13}_6\text{C}$ and ${}^{14}_7\text{N}$
	(g) Number of neutrons

Column A should contain items belonging to the same category.

Short answer type questions

Well-designed short answer questions, can test with reasonable accuracy many aspects of learning in terms of the subject matter, abilities and skills. Answers to these questions are rather specific. They help in providing the feedback to the teacher regarding a child's misconceptions and naïve concepts, for effective teaching-learning.

Common features of these questions are:

- Usually take a short time (1-3 minutes) to read and answer.
- Include some guidance on the extent of the answer required, e.g. specific instruction such as 'answer in not more than 10 words' regarding length of the answer sentences or required space in the answer sheet is provided.

Long answer type questions

These questions measure certain outcomes of learning (e.g. organising, summarising, integrating ideas and expressing in one's own words). Long answer type questions are deceptively easy to construct but are difficult to assess objectively.

Long answer type questions could be divided into following categories:

Restricted response type:

In this form of long answer questions, limit is imposed by restricting the coverage of content and length of the expected answer in the statement of the question. These types of questions are useful for testing learning outcomes which require interpretation and application that are specific and clearly defined in nature.

Extended response type:

In this form of long answer questions, no limit is imposed, and the child is given full freedom to write any number of pages and organise the material according to her/his choice. Enough freedom is provided to select, integrate, evaluate and express in any way one likes. These types of questions are useful for measuring broad abilities of children.

Open-ended type:

Open-ended questions can be very useful in evaluating the creativity and innovativeness amongst children. These are used to help children to be imaginative and to think divergently. They provide scope to individuals to apply their knowledge and are used to provide space to generate and express individual thoughts and ideas in a variety of ways.

Example: Describe how four metals (Al, Na, Mg, Fe) could be placed in order of reactivity.

Open-ended type questions could even be fictitious, as long as they serve the purpose for which they are designed. Open-ended questions often bring out surprising answers from children. We can also ask the way an experiment could be designed, an apparatus to be fabricated, etc.

Drawing of diagrams/figures

Drawing of any topic related diagram may be part of any type of written questions for assessment or it may be assessed as a separate question. Children may be asked to:

- draw the diagram
- correct the diagram
- complete the diagram
- label the diagram

Diagram based questions are used to assess knowledge of children (even if the children are poor in language or communication). They help to effectively test their skills in drawing, labelling along with practical knowledge. Drawing clear and labelled diagrams facilitates understanding of many concepts.

While framing long answer type questions that expect drawing of a diagram, the stem of the question should clearly specify the required information in a diagram. Consider the following examples:

1. With the help of a labelled diagram, explain the process of sublimation.
2. Draw the structures from the following information:
 - (a) An atom has mass number 16 and number of protons equal to 8.
 - (b) An atom has 10 protons, 10 electrons and 10 neutrons.

Note that in each of the above questions, the intended information to be provided in a diagram varies. The marking scheme should be designed accordingly.

1.5.1 Exemplar 1

Class VIII

Theme: Chemical Reactions

Key Concept: Types of chemical reactions, nature of oxides and effect of heat on some metal oxides

Life Skills: Observation, critical thinking, analysis, synthesis, interpretation

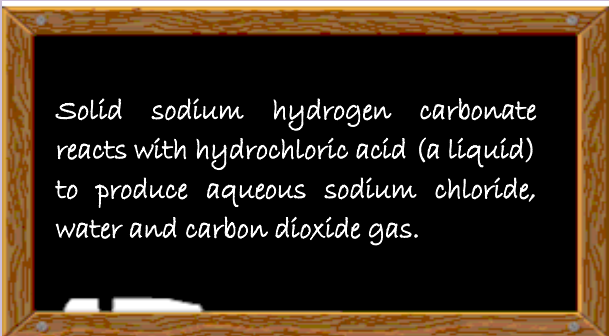
Learning Outcomes:

Children will be able to:

- ✓ share personal experiences related to chemical reactions;
- ✓ explain the law of conservation of mass and its importance in balancing a chemical equation;
- ✓ describe different types of chemical reactions with examples;
- ✓ identify different types of chemical reactions;
- ✓ know the reactivity series, understand its significance,
- ✓ and make predictions using it.

Classroom Transaction:

Pedagogical Processes	
Learning Points:	Classroom Interaction
<p>➤ Types of chemical reactions:</p> <ul style="list-style-type: none"> • Combination • Decomposition • Displacement • Double displacement 	<p style="text-align: center;">Strategies</p> <p>Brainstorming and discussion</p> <p>While introducing the concept, use children's prior learning about the chemical changes and ask them to recall some chemical reactions that they observe in everyday life.</p> <p>Note down their answers on the blackboard. Then give the following activity to children:</p> <div style="background-color: #002060; color: white; text-align: center; padding: 5px; font-weight: bold;">GROUP WORK</div> <p>Discuss the given statements (processes/items) and decide whether these can be brought under the category of chemical reactions:</p> <ul style="list-style-type: none"> ➤ Digestion of carbohydrates ➤ Photosynthesis ➤ Melting of wax ➤ Respiration ➤ Burning of paper ➤ Burning of LPG/PNG ➤ Boiling of water ➤ Rusting of exposed surfaces ➤ Spoilage of food

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction
		<ul style="list-style-type: none">• If YES, express the above in the form of word equation i.e., reactants \Rightarrow products.• If NO, give reason. <p>Ask children to identify the reactants and products in the word equations written by them.</p> <p>Explain to them that the word equations show change of reactants to products through an arrow placed between them. The reactants are written on the left-hand side with a + sign between them. The products are written on the right side. The arrow points towards the products and shows the direction of the reaction. (Recapitulation).</p> <p>Explain to children that a chemical reaction is represented in the form of a chemical equation.</p> <p>Also tell children that certain abbreviations such as <i>l</i>, <i>g</i>, <i>s</i>, <i>aq</i>, <i>dil</i>, <i>conc.</i>, etc. in parenthesis, may be used in chemical equations to represent the state/concentration etc.</p> <p>Then write the following equation on the black board:</p> <div data-bbox="812 1130 1417 1463"><p>Solid sodium hydrogen carbonate reacts with hydrochloric acid (a liquid) to produce aqueous sodium chloride, water and carbon dioxide gas.</p></div> <ul style="list-style-type: none">• Ask children to write a skeleton equation for the above, including the appropriate symbols• Ask them to balance the equation. <p>From the above, help children arrive at the understanding of the term chemical reaction and that it <i>involves breaking of existing bonds in reactants and formation of new bonds in products with absorption or release of energy normally in the form of heat or light.</i></p>

Learning Points:	Pedagogical Processes	
	Strategies	Classroom Interaction
	<p>Demonstration</p>	<div style="border: 1px solid orange; border-radius: 15px; padding: 10px; margin-bottom: 10px;"> <p style="text-align: center;">DEMONSTRATION: BURNING OF A MAGNESIUM RIBBON</p> <ul style="list-style-type: none"> Take a small piece (about 3-4 cm) of magnesium ribbon. Clean the surface of the ribbon by rubbing it with sand paper? Hold the ribbon with a pair of tongs and put it into a flame of spirit lamp/ bunsen burner. </div> <ul style="list-style-type: none"> Ask children to note what they observed. Ask them to write the chemical reaction. Are the properties of reactants and products the same? <p>Discuss the observations, inference drawn and help them to identify the type of chemical reaction. Here, magnesium ribbon burns with dazzling light in the air and forms a white substance (magnesium oxide). It is a combination reaction: $\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$</p> <div style="background-color: #1a3d4d; color: white; padding: 5px; text-align: center; font-weight: bold;"> Combination Reaction </div> <p>Now write the following chemical equations on the blackboard: $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ $2 \text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2$</p> <p>Ask children:</p> <ul style="list-style-type: none"> What is the common pattern you are observing in these equations? Can you write general representation for these equations? <p>Note their responses and help children in identifying the reaction as Combination reaction in which two or more substances form a new compound and their general representation is: $\text{A} + \text{B} \rightarrow \text{AB}$</p>

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction
		<p>where A and B are two elements/ one is an element and the other is a compound or both are compounds.</p> <div style="border: 1px solid orange; border-radius: 15px; padding: 10px; margin: 10px 0;"> <p style="text-align: center;">DEMONSTRATION: DECOMPOSITION OF RED LEAD(SINDUR)</p> $\begin{array}{ccc} 2\text{Pb}_3\text{O}_4 \text{ (s)} & \xrightarrow{\text{heat}} & 6\text{PbO} + \text{O}_2 \\ \textit{orange} & & \textit{yellow} \end{array}$ <ul style="list-style-type: none"> Take a little amount of red lead in a china dish. Place it over a wire gauge on the tripod stand. Strongly heat the dish with the help of a spirit lamp/bunsen burner. </div> <p>Questions for children:</p> <ul style="list-style-type: none"> What did you observe during the reaction? (Change of colour) Why is it happening? What can you say about the chemical equation given? <p>Discuss the observations, inference and help them to identify the type of chemical reaction. Write the following chemical equations on the black board and ask children to observe these chemical equations also:</p> $ \begin{array}{c} \text{Heat} \\ \text{PbO}_2\text{(s)} \rightarrow \text{Pb (s)} + \text{O}_2\text{(g)} \\ \\ \text{Heat} \\ 2 \text{HgO(s)} \rightarrow 2 \text{Hg (l)} + \text{O}_2 \text{(g)} \\ \\ \text{Light} \\ 2 \text{AgNO}_3\text{(s)} \rightarrow 2 \text{Ag (s)} + \text{O}_2 \text{(g)} + 2\text{NO}_2\text{(g)} \\ \\ \text{Electric current} \\ 2\text{H}_2\text{O} \rightarrow 2 \text{H}_2\text{(g)} + \text{O}_2\text{(g)} \\ \text{Heat} \\ \text{CaCO}_3\text{(s)} \rightarrow \text{CaO(s)} + \text{CO}_2\text{(g)} \end{array} $ <p>Questions for children:</p> <ul style="list-style-type: none"> What is the common pattern you are observing in these equations?

Unfolding the Curriculum: **SCIENCE** Curriculum in Practice

Learning Points:	Pedagogical Processes	
	Strategies	Classroom Interaction
		<ul style="list-style-type: none"> What is happening in the above written balanced chemical equations? <p>Note down their responses on the blackboard and help children in identifying the reactions as decomposition reactions in which a single compound is broken down into two or more products. The products can be two elements or compounds. Extremely rapid decomposition can often be accompanied by gases and heat – commonly known as an explosion. These decompositions usually require energy either as heat, light or electricity.</p>
<p>► Classification /types of reactions</p> <p>A. Based on matter (material interaction)</p> <ul style="list-style-type: none"> Combination Decomposition Displacement Double displacement <p>B. Based on energy exchange endothermic / exothermic chemical reactions</p>	<p>Experimentation (Group Activity)</p>	<div style="border: 1px solid orange; border-radius: 15px; padding: 10px; background-color: #fff9c4;"> <p>DEMONSTRATION: DISPLACEMENT REACTION</p> $\text{Fe(s)} + \text{CuSO}_4 \text{ (aq)} \rightarrow \text{FeSO}_4 \text{ (aq)} + \text{Cu(s)}$ <ul style="list-style-type: none"> Take a small amount of copper sulphate in a beaker/ glass tumbler. Add distilled water to it and dissolve copper sulphate in it. Now place an iron nail (after rubbing on the sand paper) in the copper sulphate solution. </div> <p>Questions for children:</p> <ul style="list-style-type: none"> What did you observe? (children will say that after some time, the brown coating on the nail and fading of blue colour of copper sulphate solution is noticed.) Why is it happening? What can you say about the chemical equation given in this activity? <p>Discuss the observations, inference and help them to identify the type of chemical reaction.</p> <p>Write the following chemical equations on the black board and ask children to observe these chemical equations also:</p> $\text{Zn(s)} + \text{CuSO}_4 \text{ (aq)} \rightarrow \text{ZnSO}_4 \text{ (aq)} + \text{Cu(s)}$ $\text{Cl}_2 \text{ (g)} + 2\text{KI (s)} \rightarrow 2\text{KCl (aq)} + \text{I}_2 \text{ (g)}$ <p>Questions:</p> <ul style="list-style-type: none"> What is the common pattern you are observing in these equations? Can you write the general representation for these equations?

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction
		<p>Note their responses on the blackboard and help children in identifying the reaction as displacement chemical reaction (or single displacement or single replacement reaction) in which the element displaces an element in the compound, leaving you with that element and a new compound. Its general representation is</p> $A + BC \rightarrow AC + B$ $A + BC \rightarrow BA + C$ <div style="border: 1px solid orange; border-radius: 15px; padding: 10px; margin: 10px 0;"> <p style="text-align: center;">DEMONSTRATION: DISPLACEMENT REACTION</p> $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$ <ul style="list-style-type: none"> Take two beakers or tumblers. Add a small amount of BaCl_2 in one and Na_2SO_4 in another tumbler. Dissolve these salts completely by adding distilled water to them. </div> <p>Questions for children:</p> <ul style="list-style-type: none"> What did you observe? (appearance of white precipitate of barium sulphate) Why is it happening? What can you say about the chemical equation given in this activity? <p>Discuss the observations, inference and help them to identify the type of chemical reaction.</p> <p>Write the following chemical equation on the black board and ask children to observe this chemical equation also:</p> $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$ <p>Questions for children:</p> <ul style="list-style-type: none"> What is the common pattern you are observing in these equations? What is happening in the above written balanced chemical equations? Can you write the general representation for these equations? <p>Note down their responses and help children in identifying the reaction as double displacement</p>

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction												
		<p>chemical reaction (or double replacement reaction) which involves the exchange of positive ions between two reacting compounds. Typically, the compounds are in aqueous solution and the reaction is often characterised by the precipitate produced. Such type of reaction in which precipitates are formed is also known as precipitation reaction. One product is only slightly soluble and precipitates from solution.</p> <p>Its general representation is: $AB + CD \rightarrow AD + CB$ $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 (\downarrow) + 2NaCl$ $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$</p> <p style="text-align: center;">ASSESSMENT AS LEARNING Give the following checklist to children to assess themselves:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr style="background-color: #c0392b; color: white;"> <th style="width: 80%;"></th> <th style="width: 10%;">YES</th> <th style="width: 10%;">NO</th> </tr> </thead> <tbody> <tr> <td>1. I can identify the different types of chemical reactions.</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>2. I can give the general representation of different types of chemical reactions and form their chemical equations.</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td>3. I can give equation of each type of chemical reaction.</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </tbody> </table> <p style="text-align: center; background-color: #2c3e50; color: white; padding: 5px;">ENDOTHERMIC REACTIONS</p> <p>Activity</p> <ul style="list-style-type: none"> Take about 5 mL vinegar / lime juice in a test tube. Add small amount of baking soda powder to it. What do you observe? What do you feel on touching the test tube? <p>Note down the children's responses on the blackboard and discuss the observations and inference i.e., evolution of CO₂ with hissing sound (effervescence) and on touching the test tube, the temperature of the test tube feels to be less due to absorption of heat during reaction.</p> <p>Write the reaction between vinegar / lime juice and baking soda: $CH_3COOH + NaHCO_3(aq) \rightarrow CH_3COONa(aq) + CO_2 + H_2O$</p>		YES	NO	1. I can identify the different types of chemical reactions.	<input type="checkbox"/>	<input type="checkbox"/>	2. I can give the general representation of different types of chemical reactions and form their chemical equations.	<input type="checkbox"/>	<input type="checkbox"/>	3. I can give equation of each type of chemical reaction.	<input type="checkbox"/>	<input type="checkbox"/>
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Learning Points:	Strategies	Pedagogical Processes Classroom Interaction
		<div style="background-color: #1a3d4d; color: white; text-align: center; padding: 2px 5px; font-weight: bold;">EXOTHERMIC REACTION</div> <p>Activity:</p> <ul style="list-style-type: none"> Take a small amount of quick lime powder (calcium oxide) in a test tube. Add a little water to it. What do you feel on touching the test tube? <p>Explain that the test tube gets heated up because here calcium oxide on reaction with water changes to slaked lime (calcium hydroxide) with evolution of heat:</p> $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{Heat}$ <p style="text-align: center;">Quicklime slaked lime</p> <p>Thus, help children arrive at the understanding that many reactions often absorb/give energy in the form of heat or light. Chemical reactions that absorb energy are called endothermic whereas those that give off energy are called exothermic reactions.</p> <p>All combustion reactions are examples of exothermic chemical reactions:</p> $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO} + \text{heat}$ <p>Example of endothermic chemical reaction:</p> $2 \text{NaHCO}_3 + \text{Heat} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$ <p>Note: Dissolution of ammonium chloride in water is an endothermic physical change.</p> <div style="border: 1px solid black; border-radius: 20px; padding: 10px; margin-top: 10px;"> <p style="text-align: center; font-weight: bold;">ASSESSMENT FOR LEARNING*</p> <p>Classify the following chemical reactions:</p> <ol style="list-style-type: none"> 1. $\text{K}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{KOH} (\text{aq}) + \text{Heat}$ 2. $\text{Cl}_2 + 2\text{NaBr} \rightarrow 2\text{NaCl} + \text{Br}_2$ 3. $\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3$ 4. $2\text{NaCl} + \text{Pb} (\text{NO}_3)_2 \rightarrow \text{PbCl}_2 + 2\text{NaNO}_3$ 5. $\text{NH}_4\text{NO}_2 + \text{Heat} \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$ 6. $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$ 7. $2\text{HClO} + \text{Sunlight} \rightarrow 2\text{HCl} + \text{O}_2$ 8. $2\text{FeSO}_4 + \text{Heat} \rightarrow \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$ <p><small>*The basic aim is to let the children classify reactions in four different classes leaving aside endothermic and exothermic which have been covered earlier also.</small></p> </div>

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction																																																																								
	Experimenting observation and finding inferences (Group Activity)	<div style="border: 1px solid #ccc; border-radius: 15px; padding: 10px; background-color: #ffe0b2; margin-bottom: 10px;"> <p style="text-align: center; margin: 0;">ACTIVITY</p> <ul style="list-style-type: none"> Take approximately 2 mL of NaOH and dilute HCl separately in two test tubes. Touch each of the test tubes to feel the temperature. Mix the contents of the test tubes in any one of the test tubes. Now again touch the test tube and feel the temperature. <p style="text-align: center; margin: 0;">$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$</p> </div> <p>Discuss children's observations and inference i.e., in this reaction an acid is being neutralized by a base, therefore, it is also called neutralisation reaction.</p> <p>The fact that the test tube feels comparatively hot after the chemical reaction (due to heat evolved during the reaction), also gives an idea that it is an exothermic reaction.</p> <p style="text-align: center;">ASSESSMENT AS LEARNING</p> <p style="text-align: center;">Ask children to assess each other using the given checklist:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-bottom: 10px;"> <thead> <tr style="background-color: #c0392b; color: white;"> <th></th> <th style="text-align: center;">YES</th> <th style="text-align: center;">NO</th> </tr> </thead> <tbody> <tr> <td>1. Able to interact with peers about chemical reactions based on exchange in energy.</td> <td style="width: 40px;"></td> <td style="width: 40px;"></td> </tr> <tr> <td>2. Able to differentiate clearly between exothermic and endothermic reactions.</td> <td></td> <td></td> </tr> <tr> <td>3. Able to classify the type of reaction based on various criteria.</td> <td></td> <td></td> </tr> </tbody> </table> <p>Classify the following reactions by ticking in the appropriate box. Use the key given below the table.</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-bottom: 10px;"> <thead> <tr style="background-color: #c0392b; color: white;"> <th></th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> <th>7</th> <th>8</th> <th>9</th> </tr> </thead> <tbody> <tr> <td>$2\text{C} + \text{O}_2 \rightarrow \text{CO}_2$</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>$\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>$2\text{Na} + 2\text{H}_2\text{O} \rightarrow$ $2\text{NaOH} + \text{H}_2$</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} +$ H_2O</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>$\text{BaCl}_2 + \text{Na}_2\text{SO}_4$ $\text{BaSO}_4 + 2\text{NaCl}$</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </tbody> </table> <p style="text-align: center;">1-Combination, 2-Decomposition, 3-Displacement, 4-Double displacement, 5-Exothermic, 6-Endothermic, 7-Neutralisation, 8-Precipitation</p>		YES	NO	1. Able to interact with peers about chemical reactions based on exchange in energy.			2. Able to differentiate clearly between exothermic and endothermic reactions.			3. Able to classify the type of reaction based on various criteria.				1	2	3	4	5	6	7	8	9	$2\text{C} + \text{O}_2 \rightarrow \text{CO}_2$										$\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$										$2\text{Na} + 2\text{H}_2\text{O} \rightarrow$ $2\text{NaOH} + \text{H}_2$										$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} +$ H_2O										$\text{BaCl}_2 + \text{Na}_2\text{SO}_4$ $\text{BaSO}_4 + 2\text{NaCl}$									
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Unfolding the Curriculum: **SCIENCE** Curriculum in Practice

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction																										
<p>➤ Reactivity series of metals</p>		<div style="border: 1px solid #4b4b9b; border-radius: 15px; background-color: #ffcc99; padding: 10px; margin-bottom: 10px;"> <p style="text-align: center; margin: 0;">ACTIVITY</p> <p style="margin: 5px 0;">$\text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)}$</p> <p style="margin: 5px 0;">$\text{Cl}_2(\text{g}) + 2\text{KI}(\text{s}) \rightarrow 2\text{KCl}(\text{aq}) + \text{I}_2(\text{g})$</p> <p style="margin: 5px 0;">Calcium + copper(II) oxide \rightarrow calcium oxide + copper</p> </div> <p>Questions for children:</p> <ul style="list-style-type: none"> Identify the type of above reactions. What is happening in these reactions? Why is it happening? <p>Note their responses.</p> <p>Hence, help children to arrive at an understanding of the reactivity series in which the metals are arranged in order of their decreasing chemical reactivity, the series formed is called reactivity series. More Reactive metals react with oxygen of air and water more vigorously; less reactive metals react with heating in air and with boiling water and least reactive metals with steam. The more reactive metal displaces the less reactive metal from its salt solution. With the help of displacement reaction and literature following is the reactivity series:</p> <div style="margin-top: 20px;"> <p>K Most Reactive</p> <table style="border-collapse: collapse; margin-left: 20px;"> <tr><td style="padding: 2px 10px;">Na</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Ca</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Mg</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Al</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Zn</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Fe</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Sn</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Pb</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">H</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Cu</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Hg</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Ag</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> <tr><td style="padding: 2px 10px;">Au</td><td style="border-left: 1px solid black; padding-left: 5px;"></td></tr> </table> <p style="text-align: center; margin-top: 5px;">↓</p> <p style="text-align: center;">Least Reactive</p> </div>	Na		Ca		Mg		Al		Zn		Fe		Sn		Pb		H		Cu		Hg		Ag		Au	
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		<div style="border: 1px solid #ccc; border-radius: 15px; background-color: #e0ffe0; padding: 10px; margin-bottom: 10px;"> <p>Do you know!</p> <p>A mnemonic to memorise the reactivity series is:</p> <p><i>"Please Send Charles, Monkeys And Zebras In Tin Lead Hard Cage with Maximum Security Guards."</i></p> </div> <div style="border: 1px solid #ccc; border-radius: 25px; background-color: #e0e0e0; padding: 10px; margin-bottom: 10px;"> <p style="text-align: center;">ASSESSMENT FOR LEARNING (Group Activity)</p> <ol style="list-style-type: none"> 1. What conclusion is drawn from the experiment of displacement reaction of zinc with copper sulphate? 2. Take salt solutions of various metals (CuSO₄, FeSO₄, MgSO₄, AgNO₃, etc.) in a glass beaker/tumbler. Add samples of various metals into it and record your observations in the following table: <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr style="background-color: #800000; color: white;"> <th style="padding: 5px;">Metal</th> <th style="padding: 5px;">Salt Solution</th> <th style="padding: 5px;">Changes in colour of solution</th> <th style="padding: 5px;">Deposit formed surface</th> <th style="padding: 5px;">Displacement of metal occurs/ does not occur</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">Fe</td> <td style="padding: 5px;">CuSO₄</td> <td style="padding: 5px;">Blue to green</td> <td style="padding: 5px;">Brown</td> <td style="padding: 5px;">Yes</td> </tr> <tr> <td style="padding: 5px;">Cu</td> <td style="padding: 5px;">FeSO₄</td> <td style="padding: 5px;">No change</td> <td style="padding: 5px;">nil</td> <td style="padding: 5px;">No</td> </tr> </tbody> </table> </div> <div style="border: 1px solid #ccc; border-radius: 25px; background-color: #e0e0e0; padding: 10px;"> <p style="text-align: center;">ASSESSMENT FOR LEARNING</p> <p>Predict if the following reactions will take place:</p> <ul style="list-style-type: none"> Iron and Lead Oxide Calcium and Sodium Oxide Zinc and Aluminium nitrate Magnesium and lead chloride </div>	Metal	Salt Solution	Changes in colour of solution	Deposit formed surface	Displacement of metal occurs/ does not occur	Fe	CuSO ₄	Blue to green	Brown	Yes	Cu	FeSO ₄	No change	nil	No
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	<p>Application of Activity Series:</p> <p>Galvanising is a method of rust prevention. The iron or steel object is coated in a thin layer of zinc. This stops oxygen and water from reaching the metal underneath - but the zinc also acts as a sacrificial metal. Zinc being more reactive than iron, oxidises in preference to the iron object.</p>	<p>ASSESSMENT AS LEARNING</p> <ul style="list-style-type: none">• Give the children some opportunities to share their understanding on reactivity series and ask them to reflect on each other's work.• Ask the children to frame questions/puzzles and conduct a quiz on reactivity series in the class (group activity). <p>ASSIGNMENT</p> <p>Archaeologists frequently dig up gold, silver, iron and copper objects in their excavations. Why do you think these metals were used in ancient times? Can you relate this to the activity series of metals?</p>

Exemplar 2

CLASS VII

Theme: Physical and Chemical Changes

Key Concept: Physical and Chemical Changes

Life Skills: Communication skills, critical thinking, drawing inferences, cooperation and working together, environmental sensitivity

Learning Outcomes:

Children will be able to:

- differentiate between physical and chemical changes;
- perform activities related to physical and chemical changes;
- classify changes such as respiration, preparation of solution of sugar, burning of paper, ripening of fruits, spoiling of food materials as physical and chemical changes;
- discuss that in a chemical change, a new substance with different properties is formed;
- differentiate between exothermic and endothermic changes.

Classroom Transaction:

Pedagogical Processes		
Learning Points:	Strategies	Classroom Interaction
<ul style="list-style-type: none"> ➤ Classification of changes: <ul style="list-style-type: none"> (i) Desirable and undesirable (ii) Physical and Chemical changes - Difference - Formation of new substances. ➤ Types of change/s involved in <ul style="list-style-type: none"> - Change of state of matter - Change of energy 	Brainstorming and discussion	<p>In the previous class, children have learnt classification of matter- solid, liquid and gases based on their properties and factors responsible for the existence of matter in different states.</p> <p>You may begin the class by asking children to list down a few changes occurring in their surroundings. The children's responses may include:</p> <div style="border: 2px solid #8e7cc3; padding: 10px; margin: 10px 0;"> <p style="text-align: center; font-style: italic;">evaporation of water, melting of ice, drying of clothes, rusting of iron, burning of fuels, paper and fireworks, lighting of an electric bulb, curd from milk, ripening of fruits, flowering of plants, folding and tearing of paper, spoilage of food if kept for long, dissolution of salt or sugar in water, changing of seasons, growing of a baby to an adult, breaking of a glass, falling of leaves, etc.</p> </div> <p>Note down their responses on the blackboard.</p>

Learning Points:	Pedagogical Processes	
	Strategies	Classroom Interaction
		<p>Then ask children the following questions:</p> <ul style="list-style-type: none"> • How are these changes taking place i.e., is someone bringing about the change or is it happening naturally? • Which of these changes are required in our daily lives?
	Tabulation	<p style="text-align: center;">GROUP WORK</p> <p>Ask children to classify the above changes as natural change and man-made change, desirable change and undesirable change.</p>
	Differentiation	
	Connecting daily life experiences	<p>Also ask children to make a table of the above changes based on whether a new substance is formed during the change or not.</p> <p>From the above, help children to understand and classify the changes scientifically as physical or chemical change.</p>
	Narration	<p>Explain to the children that a change in which no new substance/material forms is called a physical change. A physical change involves a change in physical properties i.e. the shape, size, colour, texture, or state of a substance may change. For example, evaporation of water, making paper boat, glowing bulb, inflation of a balloon. It is generally reversible.</p> <p>A chemical change is a change in which new substance(s) is/are formed. Cooking of food, curdling of milk, ripening of fruit, rusting of iron are examples of chemical change.</p>
	Experimentation	<div style="border: 1px solid #f4a460; border-radius: 15px; padding: 10px; background-color: #fff9e6;"> <p style="text-align: center;">ACTIVITY</p> <p>Divide children into groups. Give one chalk to every group and ask them to do the following: Crush the chalk into a fine powder. Add a little water to the powder to make a paste. Roll it into the shape of a chalk. Allow it to dry.</p> <p>Questions: Are you able to get the chalk back from the chalk powder? What kind of change is this?</p> </div>

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		<p>ASSESSMENT FOR LEARNING</p> <p>Classify the following changes into Physical and Chemical changes. Tick the appropriate box:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr style="background-color: #c00000; color: white;"> <th style="width: 5%;">S.No</th> <th style="width: 65%;">Changes</th> <th style="width: 15%;">Physical</th> <th style="width: 15%;">Chemical</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">1.</td><td>Curdling of milk</td><td></td><td></td></tr> <tr><td style="text-align: center;">2.</td><td>Melting of ice</td><td></td><td></td></tr> <tr><td style="text-align: center;">3.</td><td>Ripening of fruits</td><td></td><td></td></tr> <tr><td style="text-align: center;">4.</td><td>Burning of wax</td><td></td><td></td></tr> <tr><td style="text-align: center;">5.</td><td>Condensation of water</td><td></td><td></td></tr> <tr><td style="text-align: center;">6.</td><td>Making a paper boat</td><td></td><td></td></tr> <tr><td style="text-align: center;">7.</td><td>Burning of paper</td><td></td><td></td></tr> </tbody> </table>		S.No	Changes	Physical	Chemical	1.	Curdling of milk			2.	Melting of ice			3.	Ripening of fruits			4.	Burning of wax			5.	Condensation of water			6.	Making a paper boat			7.	Burning of paper		
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		<p>Name of the Experiment:</p> <p>Hypothesis (What do you think will happen and Why?)</p> <hr/> <hr/> <p>What did you observe during the experiment? Draw a labelled diagram.</p> <hr/> <hr/> <p>What is your conclusion from the experiment? Was your hypothesis correct? Explain.</p> <hr/> <hr/> <p>What kind of a change did you observe?</p> <hr/> <hr/>																																	
	Experimentation	EXPERIMENTS																																	
		<p>1. Common salt in water</p> <ul style="list-style-type: none"> - Take a tea spoon of common salt in a glass tumbler and dissolve it in minimum amount of water. - Transfer content of glass tumbler into a china 																																	

Learning Points:	Pedagogical Processes	
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	Demonstration	<p>dish and heat it till water evaporates completely.</p> <p>2. Reaction between vinegar/lime juice and baking soda</p> <ul style="list-style-type: none"> - Take a small amount of baking soda (sodium hydrogen carbonate) in a glass tumbler. - Add a small amount of vinegar (dilute solution of acetic acid) or lime juice (citric acid). <p>Change of State of Matter Most substances exist in three states: solid, liquid or gas. Children already know about melting of ice, freezing of water, evaporation of water etc.</p> <div style="background-color: #002060; color: white; text-align: center; padding: 2px;">DEMONSTRATION</div> <p>Demonstrate the following experiments to children. Melting of wax: Heat a small amount of candle wax in a china dish for some time. Allow the china dish to cool down to room temperature. Ask children to note down their observations.</p> <p>Sublimation of naphthalene balls/camphor</p> <ul style="list-style-type: none"> - Take a small quantity of crushed naphthalene balls or camphor in a china dish. - Place the china dish on a wire gauze that is placed over a tripod stand. - Cover the china dish with an inverted glass funnel. - Plug a little cotton in the opening of the stem of the glass funnel. - Heat the china dish with the help of the burner/spirit lamp. - Ask children to note their observations (they may observe that on heating, white fumes evolve and rise inside the funnel; when heating is stopped, white fumes stop rising). - Allow the funnel to cool. - After cooling, ask children to observe the inner surface of the glass funnel and note their observations. - Transfer the solid substance sticking on the

Note:

Please do not give example of sublimation of ammonium chloride at this stage because it involves physical and chemical changes.

$$\text{NH}_4\text{Cl} \rightarrow \text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}$$

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction																				
	Narration	<p>walls of the funnel into a watch glass with the help of a spatula.</p> <p>Explain to the children that the process they observed, in which a substance changes its state from solid to gas directly without changing to the liquid state on heating and the gas (vapour) of the substance on cooling, converts into solid again, is called sublimation.</p> <p style="text-align: center;">ASSESSMENT AS LEARNING</p> <p style="text-align: center;">Design questions to assess your friend's understanding of the concepts of Physical change and Chemical change.</p> <p style="text-align: center;">Based on the above task, fill in the following table:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr style="background-color: #c0392b; color: white;"> <th style="width: 70%;"></th> <th style="width: 10%;">To a great extent</th> <th style="width: 10%;">To some extent</th> <th style="width: 10%;">Very less</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">Knows the meaning of Physical change and chemical change</td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> </tr> <tr> <td style="padding: 5px;">Applies her/his knowledge to differentiate between the given changes</td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> </tr> <tr> <td style="padding: 5px;">Is able to explain the concepts giving appropriate examples</td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> </tr> <tr> <td style="padding: 5px;">Is able to explain sublimation with example</td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> <td style="text-align: center;"><input type="text"/></td> </tr> </tbody> </table> <p>Change of Energy</p> <p>Ask children to respond to the following questions:</p> <ul style="list-style-type: none"> How do you feel when the doctor, before giving an injection, cleans your skin with spirit? Why does an ice cube melt at room temperature? Why does water evaporate from a wet cloth? What happens when a fuel is burnt? Why is the food taken out of the refrigerator cold? 		To a great extent	To some extent	Very less	Knows the meaning of Physical change and chemical change	<input type="text"/>	<input type="text"/>	<input type="text"/>	Applies her/his knowledge to differentiate between the given changes	<input type="text"/>	<input type="text"/>	<input type="text"/>	Is able to explain the concepts giving appropriate examples	<input type="text"/>	<input type="text"/>	<input type="text"/>	Is able to explain sublimation with example	<input type="text"/>	<input type="text"/>	<input type="text"/>
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Learning Points:	Pedagogical Processes	
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	Discussion	<ul style="list-style-type: none"> • Why is freshly cooked food hot and why does it cool down when you place it in an open environment? <p>Note their responses on the blackboard and discuss the exact cause of the changes that involve exchange of energy, that is, either absorption of energy or evolution of energy. Thus, help children arrive at the understanding of the terms endothermic and exothermic change i.e., If energy is absorbed, the change is called endothermic and if energy is evolved, it is called exothermic.</p> <p>Endothermic and Exothermic changes Following activities /experiments may be performed to explore about the energy change in everyday life.</p> <p style="text-align: center;">PAIR WORK (of endothermic change)</p> <ul style="list-style-type: none"> • Take some lemon juice in a glass tumbler/test tube. • Add a pinch of baking soda into it. Observe what is happening in the tumbler. • Touch the test tube and describe what you feel. <p>Explain to the children that when they touch the test tube, it feels cold as the reaction mixture has taken heat from the surroundings. It is therefore, an endothermic reaction.</p> <p style="text-align: center;">PAIR WORK (of exothermic change)</p> <ul style="list-style-type: none"> • Take a small amount of quick lime powder (calcium oxide) in a test tube. • Add little water to it. • Touch the test-tube and feel the temperature. <p>Explain to the children that the test tube gets heated up because here calcium oxide on reaction with water changes to slaked lime (calcium hydroxide) with evolution of heat.</p>

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	<p style="text-align: center;">ASSESSMENT FOR LEARNING</p> <p>Classify the following as endothermic and exothermic changes:</p> <ul style="list-style-type: none"> • Combustion of fuel • Respiration • Evaporation • Melting of ice • Sweating • Transpiration in plants • Photosynthesis 	<p style="text-align: center;">ASSESSMENT AS LEARNING</p> <p style="text-align: center;">Give the following checklist to children to assess themselves:</p> <p style="text-align: center;">Self-Assessment checklist:</p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr style="background-color: #800000; color: white;"> <th style="width: 80%;"></th> <th style="width: 10%;">YES</th> <th style="width: 10%;">NO</th> </tr> </thead> <tbody> <tr> <td style="text-align: left;">1. Able to define the two types of energy changes</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td style="text-align: left;">2. Able to classify the given examples of energy changes</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td style="text-align: left;">3. Able to explain the cause of energy changes in most of the cases</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table>		YES	NO	1. Able to define the two types of energy changes	<input type="checkbox"/>	<input type="checkbox"/>	2. Able to classify the given examples of energy changes	<input type="checkbox"/>	<input type="checkbox"/>	3. Able to explain the cause of energy changes in most of the cases	<input type="checkbox"/>	<input type="checkbox"/>
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	<p style="text-align: center;">SUGGESTED ASSIGNMENTS</p> <ol style="list-style-type: none"> 1. Prepare a project on chemical changes occurring in our daily life. 2. Show children one example of a physical change and one example of a chemical change through a drawing. <ul style="list-style-type: none"> - Ask children to complete the Chemical versus Physical Properties worksheet. - Ask children to pick an object. Have them think of a physical change or chemical change that the object could go through. - Instruct children to write two properties that would change because of the change. - Ask children to share what they wrote, with the class. 													

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<p><u>ASSESSMENT OF LEARNING</u></p> <ol style="list-style-type: none">1. Make a list of eight changes you have noticed around you.2. Give five examples of man-made changes.3. Classify the following as physical change or chemical change:<ul style="list-style-type: none">- Metabolism of food in the body- Crumpling a paper bag- Chopping an apple- Mixing salt and sand- Filling a candy bowl with different candies- Cooking an egg- Digesting sugar with the amylase in saliva- Mixing baking soda and vinegar to produce carbon dioxide gas- Baking a cake- Explosion of fireworks- Rotting of a banana- Souring of milk- Melting of an ice cube- Mixing water and oil- Boiling of water- Breaking of glass- Dissolving sugar and water- Shredding of paper- Chopping wood- Mixing red and green marbles- Sublimation of dry ice- Moth balls gradually vaporising in a closet- Fogging of a mirror with your breath- Mixing flour, salt, and sugar- Breaking a bone- Mending a broken bone- Mixing sugar with coffee- Rusting of an iron nail- Burning of wood- Mixing water and food colouring- Rotting of food- Writing on paper- Dyeing a fabric- Perfume evaporating on your skin- Melting of butter- Autumn leaves changing colour- A hot glass cracking when placed in cold water- Melting of a copper metal- Burning of sugar			

Learning Points:	Strategies	Pedagogical Processes Classroom Interaction
<p style="text-align: center;"><u>ASSESSMENT OF LEARNING</u></p> <p>4. Which of the following would NOT be a physical change?</p> <ul style="list-style-type: none">- freezing water to make ice cubes- melting gold to make jewellery- burning gas for cooking- boiling water for soup- tearing a piece of aluminium foil <p>5. Which of the following is NOT a physical change?</p> <ul style="list-style-type: none">- grating cheese- melting cheese- fermenting of cheese- mixing two cheeses in a bowl <p>6. Earlier, you read that a chemical change is indicated if a new material is formed. Yet dissolving salt in water makes salty water, but it is a physical change. Explain.</p>		

Suggested activities for participants:



Let us do

Activities

1. Discuss in groups what are the three benefits of this module for teachers and master trainers. Make a list.
2. Give a specific example from everyday life and describe the process skills involved in making the decision.

References:

- Ewers, T. G. (2001). Teacher-directed versus learning cycles methods: effects on science process skills mastery and teacher efficacy among elementary education students. *Dissertation Abstracts International*, 62(07), 2387A (UMI No. AAT3022333).
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- Rillero, P. (1994). Doing Science with Your Children. *ERIC Clearinghouse for Science Mathematics and Environmental Education Columbus OH*.