PHYSICAL SCIENCE

SYLLABUS

(FROM CLASS 8 TO CLASS 10)

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ముందుమాట

ఉపాధ్యాయ మిత్రులారా!

మానవ జీవితం సుఖవంతంగా సాగడానికి విజ్ఞానశాస్త్రం ఆవిష్కరణ చేయాలని మనకందరికీ తెలుసు. పాఠశాల స్థాయిలో విజ్ఞానశాస్త్రం అంటే ప్రకృతిలోని సూత్ర సిద్ధాంతాలను, నియమాలను అర్థం చేసుకోవడం ద్వారా ప్రకృతిని పరిరక్షించడానికి విద్యార్థులను సంసిద్ధులను చేయడమే. కాబట్టి పాఠ్యప్రణాళిక దీనికి అత్యధిక ప్రాధాన్యతనిస్తుంది. జాతీయ విద్యా ప్రణాళికా చట్రం – 2005 విజ్ఞానశాస్త్రం తరగతి గది నాలుగు గోడలకు పరిమితమైనది కాదనీ చుట్టూ ఉన్న పరిసరాలతో సజీవ, నిర్జీవ అంశాలతో సన్నిహిత సబంధం కలిగివీటిని అర్థం చేసుకునేదిగా ఉండాలనీ చేసిన సూచనల మేరకు పాఠ్యప్రణాళిక రూపకల్పన జరిగింది. విద్యాహక్కుచట్టం 2009 సూచించినట్లు పాఠశాల విద్య పూర్తయ్యే సరికి ప్రతి విద్యార్థి తప్పనిసరిగా నిర్ధారిత విద్యా ప్రమాణాలను సాధించాలి. లేకపోతే ఇన్ని సంవత్సరాల విద్యార్థి పాఠశాల జీవితం నిరుపయోగమవుతుందని పేర్కొన్నది. కాబట్టి పాఠశాలలో కల్పించే అభ్యసన అనుభవాలు పిల్లల్లో నిర్ధారిత విద్యా ప్రమాణాలు సాధించేందుకు వీలు కలిగించేవిగా ఉండాలి. ఆంధ్రప్రదేశ్ రాష్ట్ర విద్యా ప్రణాళికా పరిధి పత్రం – 2010 కూడా విజ్ఞానశాస్త్ర అధ్యయనంపట్ల స్పష్టమైన వైఖరిని వ్యక్తంచేసింది. అదేమిటంటే నేర్చుకున్న జ్ఞానం పిల్లల భావిజీవితానికి సహకరించేదిగా ఉండాలి. శాస్త్రీయ వైఖరులు కలిగిన వ్యక్తులుగా రూపుదిద్దేందుకు బోధనాభ్యసన ప్రక్రియలు దోహదపడాలని నిర్దేశించింది. వీటన్నింటిని దృష్టిలో ఉంచుకున్నప్పుడు పాఠశాలలో పిల్లలకు అందించే ప్రతి కార్యక్రమం ప్రకృతిని అర్థంచేసుకోవడం, వినియోగించుకోవడంతోపాటు దానిని సంరక్షించుకోవడం కూడా అవసరమనే భావనను అందించేదిగా ఉండాలని మనకు అర్థమవుతుంది.

తరగతి గదిలో ఉపాధ్యాయుని పాత్ర అత్యంత కీలకమైనది. ఉపాధ్యాయుడు తాను బోధించే అంశాల వెనుక ఉన్న తాత్వికతను, వాటివల్ల సాధించవలసిన లక్ష్యాలను, పిల్లల శక్తి సామర్థ్యాలను గురించి స్పష్టమైన ఎరుకతో ఉండడం అత్యవసరం. అలా అయినప్పుడు మాత్రమే పాఠ్యపుస్తకంలోని పాఠాన్ని కేవలం సమాచారం రూపంలో కాకుండా పిల్లలో జ్ఞాన నిర్మాణం కలిగే రీతిలో బోధనాభ్యసన అనుభవాలను కల్పించగలుగుతారు. విజ్ఞానశాస్త్రమంటే కేవలం ఏవో కొన్ని ప్రయోగాలుగా, ప్రదర్శనలకు పరిమితమైనది కాదని, విభిన్న భావనలను నిశితంగా పరిశీలించి అధ్యయనం చేయడం ద్వారా నూతన ఆవిష్కరణలకు దారి తీసేదిగా ప్రకృతిని, పర్యావరణాన్ని పరిరక్షించుకునే బాధ్యతకలిగిన వ్యక్తులుగా పిల్లలను తీర్చిదిద్దడమని అర్థంచేసుకోవాలి.

ఉపాధ్యాయునికి పాఠ్యాంశాల అమరిక ఆరోతరగతి నుండి పదో తరగతి వరకు ఏ విధంగా ఉంది? ఏయే లక్ష్యాలను సాధించాలని నిర్దేశించబడింది అనే అంశాలపై స్పష్టమైన అవగాహన కలిగి ఉన్నప్పుడు అతడి బోధనా విధానంలో స్పష్టమైన మార్పు చోటుచేసుకుంటుంది. అందుచేత ఉపాధ్యాయుడు పాఠ్యప్రణాళిక, బోధనాభ్యసన ప్రక్రియలు, బోధనా వ్యూహాలు, విజ్ఞానశాస్త్రం–విద్యాప్రమాణాలు, బోధనాభ్యసన సామగ్రి, ఉపాధ్యాయుని సంసిద్ధత, మదింపు, నమోదు విశ్లేషణ మొదలైన అంశాలన్నింటిపట్ల సంపూర్ణ అవగాహన కలిగి ఉండాలంటే ఉపాధ్యాయుడు తప్పనిసరిగా విజ్ఞానశాస్త్ర తాత్విక నేపథ్యాన్ని తప్పనిసరిగా అర్థంచేసుకోవలసిన అవసరం ఉంది.

విజ్ఞానశాస్త్రం విద్యాప్రమాణాలు, బోధనా వ్యూహాలు, పాఠ్యప్రణాళిక పేరిట రూపొందిన ఈ పుస్తకం ఎంతో ఉపయోగకరమైనది. విద్యార్థులు, తల్లిదండ్రులు, ఉపాధ్యాయులు, పాఠశాల యాజమాన్యం, మానిటరింగ్ అధికారులు, మండల, జిల్లా విద్యాధికారులు, ఉపాధ్యాయ విద్యాబోధకులు, విద్యావేత్తలు మొదలైన వారందరూ తప్పనిసరిగా పరిశీలించవలసిన పుస్తకం ఇది. పిల్లలు నిర్ధారిత సామర్థాలు సాధించాలంటే ఉపాధ్యాయులు, విద్యాధికారులు, తల్లిదండ్రుల సమిష్టి కృషి అవసరం. ఈ సందర్భంలో విద్యారంగంతో సంబంధం కలిగిన వారందరికీ ఈ పుస్తకం ఒక కరదీపికలా ఉపయోగపడుతుంది. విజ్ఞానవంతమైన రేపటి సమాజాన్ని నిర్మించడానికి శాస్త్రీయ ఆలోచనలు కలిగిన విద్యార్థులు అవసరం. దేశాభివృద్ధికి విద్యార్థులకు అత్యంత ప్రధానమైన ఉత్పాదక వనరు. సమర్థవంతమైన పాఠశాలల నుండే సమర్థవంతమైన విద్యార్థులు రూపు దిద్దుకుంటారు కాబట్టే ఉపాధ్యాయులు సంపూర్ణ అవగాహనతో కృషిచేయవలసిన అవసరం ఉంది.

తేది :
స్థలం : హైదరాబాదు

రాష్ట్రవిద్య, పరిశోధన, శిక్షణ సంస్థ,
తెలంగాణ.

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Need of change - New Text Books

In the classroom, the textbook is as important as the teacher and the student. At present, all the teaching learning activities in the school are conducted based on the textbook only. In other words, activities like explaining the contents of the textbook, answering the questions are all done based on the textbook. We all know this. Now, let us see how the new textbook is useful; what its limits are; and the need for a new textbook.

How are we using the present textbooks?

- The present textbooks give preference to a lot of information.
- They are all filled with mountains of information in the name of syllabus.
- Since the syllabus and the school working days do not commensurate with each other, they cannot be finished within the time available.
- They encourage rote-memory.
- They are not favourable to adapt according to the latest changes and the new findings of research in different fields.
- Though they appear to have the nature of science, they do not give preference to awoke inquisitive thoughts and ideas in children. They do not give scope for questioning, and learning through experimentation.
- They are the root cause for the miserable state of teaching learning activities which are distanced themselves from the laboratory and the science classroom.
- The large amount of information makes it very difficult, even for the teachers, to understand the concepts and explain them.
- Since there is no time to explain and make children understand all the concepts in the textbook, teaching lesson has been reduced to a process of giving answers to the questions in the textbook.

- Since getting children ready for examinations has become the main objective of teaching, trying to secure good marks and good ranks have taken precedence over conceptual understanding (which is considered an unnecessary thing).
- The objective of teaching of science has been reduced to mere memorization of a few important questions instead of making children learn the whole lesson and understand it well.
- Question-banks and guides have become the most sought-after books making the textbook insignificant and unnecessary.

Why do we need new textbooks?

The textbooks needed to be changed in accordance with the directions and recommendations of the National Curriculum Framework 2005, The Right to Education Act 2009, and the State Curriculum Framework 2011. Since the so called science textbooks in use do not facilitate learning by doing; learning through observation, investigation, problem-solving, inductive and deductive reasoning; and since they go on increasing the number of lessons in the name of syllabus, there has been an urgent need to revise the textbooks.

New Textbooks - Desirable Characteristics:

The new textbooks are designed keeping the following components in view:

- The position paper on science, State Curriculum Framework 2011 has proposed a curriculum which is mutually interdependent, thoughtful and value-based. Therefore, the syllabus, the lessons, the teaching-learning processes and the evaluation should reflect all the above components.
- The textbooks should enable the children to learn through interaction with their teachers, other learners, and the teaching-learning material.
- The components of lessons should be in the experiential orbit of the children and they should enable the children to construct new knowledge. Children in 8th and 9th classes can understand even abstract concepts, so concepts like motion, heat, reproduction, cells, etc., should be made clear by starting with what they knew and then moving on to their critical analysis.
- The activities should be so planned that they facilitate learning the science concepts through observation, deductive and inductive reasoning, and experimentation. (Unfortunately, working in the laboratory, field visits and project reports are looked down as trivial things.)
- Science melas, exhibitions and fairs are conducted only as rituals but not with the true spirit of encouraging scientific outlook among children. The present textbooks are not doing anything in this direction.
- It seems studying textbook in the classroom has been banned with the onslaught of question banks and guides.

- Though there are a few activities and experiments in the textbook that facilitate learning by doing, since the teachers do not take initiative to conduct them, the difference between a science class and other classes has become negligible.
- Most of the teachers read the lesson and explain or write important points / draw pictures on the blackboard and explain, so the main objective of the textbook is defeated.
- Instead of encouraging the children to write answers to the questions in the textbook on their own, the teachers give answers or mark the answers in the textbook or ask the children to copy them down from question banks or guides.
- The textbook has become a thing to memorize instead of an essential tool that helps children think analytically and learn important concepts.
- The children should be able to construct new knowledge by participating in activities / tasks, by experimenting and by testing the suitability of various alternatives to a problem.
- In the classroom, the teachers should not be the ones that thunder instruction reducing the children to mere passive listeners. They should ask a multiplicity of questions on the concepts that facilitate / call for deep thinking. To achieve this, the lessons in the new textbooks, instead of giving mountains of information, are so designed that they give a lot of scope for discussion, questioning and analytical thinking.
- Demystifying the false belief that ¡¥children should not study or look into textbooks while the teacher teaches¡¦, these textbooks are so designed that they help children understand various concepts through in-depth reading of the textbook, detailed study and discussion.
- Though complex concepts are to be explained in higher classes, the new textbooks move forward with great ease as they are linked with real-life situations and the flora and fauna in which children live. This helps children understand that science helps society in many ways.
- Instead of questions/activities that have fixed responses, the topics for discussion, the questions, and various other activities in the textbook should be open-ended that will give scope for the children to think and write individually. Hence, the new textbooks have some activities under the heading "Think & Discuss".
- Good understanding of a concept in a subject (like science) demands some information and knowledge in other subjects like mathematics, social studies, and even languages, so lessons like Prevention of Disasters, The Space, The Stars, Agriculture - Crops are taught mixed with social studies.
- Questions are given in the middle and at the end of the lesson to facilitate selfassessment by the student
- Questioning help children a lot to analyze the content of a lesson, so lessons are prepared in such a way that they give a lot of scope for questioning and thinking.
- The activities are developed giving a lot of scope (on many occasions) for children to search for answers themselves.
- The activities in the new textbooks help children to check their assumptions and come to a conclusion.

- The activities are developed in such a way that the children can make observations as well as experiments either on their own or with the help of the teacher.
- To assess the progress of the children continuously, a multiplicity of questions are given in the middle and at the end of each lesson.
- Sections like "DO you Know", "Read and Learn", and "Annexure" are planned and put in appropriate places so as to enable the children to observe and learn more in addition to the content of the lesson.

The new textbooks are developed in such a way that they help children learn even abstract concepts through observation and research. Therefore, as they learn through activities, they not only form clear concepts without any ambiguity, but also get required skills to apply them to solve problems they face in day to day life. The new textbooks help children grow with scientific and positive attitude towards nature and environment.

Key Elements in the New Textbooks:

- The new physical sciences textbook and the biology textbook for classes 8th and 9th classes are prepared in accordance with the suggestions and directives of the National Curriculum Framework - 2005, The Right to Education Act - 2009, and the Position Paper on Science, State Curriculum Framework - 2011.
- In the new textbooks, Physics and Chemistry sections are integrated into one without any bifurcation.
- Construction of knowledge through mutual interaction between teachers and children.
- Preparation of lessons from the experiential orbit of the children and their surroundings.
- Construction of knowledge by children through their analysis of the concepts of the lesson.
- Scope for clarification of doubts and construction of new knowledge through free talk and questioning.
- Gaining a good understanding of the concepts through reading the textbooks and related / supplementary books.
- Useful and helpful for children to relate and apply what they have learnt to their day to day life and nature or what they see around them.
- Learning by doing individually and in groups while during field visits and experiments.
- Activities and exercises are open-ended giving scope for the children to learn individually and to think creatively.
- Getting opportunities to participate and to find solutions to various problems in science.
- Exercises/activities have a lot of scope for the children to express themselves and to write their answers individually.
- Facilitate continuous comprehensive evaluation.

2 State Curriculam Framework - 2011

(Executive Summary)

In our state, there has not been any change in the form or content of the textbooks. They are prepared following the conventional fossilized methods. And it does not seem to take into consideration the new pedagogic principles that have evolved consequent to the changing needs of the society. Against this backdrop, the National Curriculum Framework-2005 and the Right to Education Act-2009 suggested that the education imparted should develop able and competent citizens that can face the challenges of the contemporary world. Taking the suggestions/directives into consideration, the State Curriculum Framework – 2011 was prepared. Based on this framework, the Position Paper on Science was prepared. The Position Paper on Science has proposed certain basic theoretical principles and has directed that the new textbooks should be prepared closely following them. Let us see what they are.

Propositions of SCF – 2011:

1. India should come up as a society that creates new knowledge but should not remain as the one that only uses knowledge.
2. The textbooks should help children think and learn using their innate abilities.
3. The textbooks should not be filled with mountains of information. Instead, they should give room for children to analyze information.
4. The textbooks should facilitate knowledge construction among children. Also, there should be scope for children to use that knowledge in real life situations.
5. The textbooks should not limit the children to just textbooks but take them beyond to enable them to learn more through the use of reference books, magazines, newspapers, etc. and through interaction with teaching learning material as well as the members of the society.
6. The language used in the textbooks should be simple. It should not hamper comprehension and thus learning. Multilingualism should be taken into consideration while preparing the textbooks.

7. The textbooks should not give room for gender bias. They should develop in the children self-confidence, thinking skills like reflection, critical thinking, dialectical thinking, creative thinking, communication skills, and sensitivity to human rights.
8. Culture, productive activities, local arts and crafts, local issues should go into science lessons.
9. The activities and exercises should help children achieve the expected learning outcomes and the academic standards specified for the level.
10. The exercises should essentially consist of activities, tasks, projects, explorations, experiments, open-ended questions, games and puzzles which make children think.
11. The tasks/exercises should have room for children to work individually and in groups and help the entire class to learn.
12. Some lessons /tasks/exercises should be from subjects that come under cocurricular areas like art, health, work, human values, ethical values, etc.(SCF-2011 listed them under curricular areas) so that children get the essence of them.
13. The textbooks should have scope for children to revise what was learnt in the previous class; to achieve academic standards specified for the class s/he is in; and link these to what s/he is going to learn in the next class.
14. The textbooks should be attractive with beautiful pictures and good printing on quality paper.

APSCF - 2011 Key Principles

- To concentrate essentially on making children learn according to their innate talents and capabilities
- To respect the language of the child, the knowledge systems in society and to use them in learning
- To link knowledge with life outside the school
- To say not to rote methods and to substitute them with interactions, projects, explorations, experiments, analyses which facilitate meaningful learning
- To see that the syllabus has room for the comprehensive development of children and to make changes in textbooks so that learning is limited to textbooks.
- To simplify and make examinations a part and parcel of teaching learning activities by implementing continuous comprehensive evaluation and to reform the assessment in a way that it helps children learn but not assess them to know what they have learnt ¡V assessment for learning instead of assessment of learning.
- To conduct teaching learning activities based on the principles of social constructivism and critical pedagogy by relating various components of the syllabus with one another so as to facilitate meaningful learning.

- To give priority to the culture and experience of children and their local issues/topics

The State Curriculum Framework - 2011 was developed taking the vision of the state and its guiding principles. SCF - 2011 proposed the following changes:

The Textbooks:

So far the textbooks were changed once in ten years. But it can be said that the fundamental changes were insignificant and negligible. Moreover, neither the curriculum framework, nor the positions paper (which are essential to develop new textbooks) were prepared. Consequently there were changes only in the lessons but not in the tasks, exercises, and the structure which were routine and devoid of any variety. Also, the nature of the subject, the nature of the child, the expected outcomes of teaching various subjects in school were not given due importance and consideration in the development of textbooks. Added to this, the textbooks became more bulky and heavy with more information dumped in, in the name of ¡¥standards¡¦. In the case of science and mathematics, some topics from higher classes found their way into lower classes putting additional cognitive burden on the young minds. However, there had been some changes in the textbooks because of the state initiatives and interventions through APPEP and DPEP. But still there is a need for comprehensive changes in textbooks to have concurrence with NCF-2005, RTE-2009 and APSCF-2011.

The State Curriculum Framework - 2011 made the following propositions to overcome the shortcomings mentioned earlier.

- There should be separate position papers for each subject to develop textbooks for subjects like language, mathematics, science and social studies.
- The textbooks should help children think and use their natural talents and capabilities
- The textbooks should not be made heavy with a lot of information. Instead they should give scope for the children to collect information and analyze it to make conclusions.
- The textbooks should help children construct knowledge and use it in their daily life.
- The textbooks should not limit children to just textbooks but take them beyond to enable them to learn more through the use of reference books, magazines, newspapers, etc. and through interaction with teaching learning material as well as the members of the society.
- The language used in the textbooks should be simple. It should not hamper comprehension and thus learning. Multilingualism should be taken into consideration while preparing the textbooks.
- The textbooks should not give room for gender bias. They should develop in children self-confidence, thinking skills like reflection, critical thinking, dialectical thinking, creative thinking, communication skills, and sensitivity to human rights.

- Culture, productive activities, local arts and crafts, local issues should go into science lessons.
- The activities and exercises should help children achieve the expected learning outcomes and the academic standards specified for the level.
- The exercises should essentially consist of activities, tasks, projects, explorations, experiments, open-ended questions, games and puzzles which make children think.
- The tasks/exercises should have room for children to work individually and in groups and help the entire class to learn.
- Some lessons /tasks/exercises should be from subjects that come under cocurricular areas like art, health, work, human values, ethical values, etc., so that children get the essence of them.
- The textbooks should have scope for children to revise what was learnt in the previous class; to achieve academic standards specified for the class s/he is in; and link these to what s/he is going to learn in the next class.
- The textbooks should be attractive with beautiful pictures and good printing on quality paper.

Teaching learning activities:

Instead of stereotypes like rote memorization, repetition, copying answers from guides and question banks, reading mechanically, etc., good teaching learning activities should ensure meaningful learning. To achieve this APSCF 2011 made the following propositions:

- Interactions, self-expression and questioning should essentially be a part of teaching learning activities
- Experiments, explorations, activities, projects, games, etc., should form the core of the teaching learning activities.
- Teaching learning activities do not mean explanation of the lesson or reading it aloud by the teacher. Teachers should motivate children to learn and participate in the teaching learning process. They should use necessary teaching learning material and make it available to the children thus creating a good learning atmosphere.
- The teaching learning activities should be conducted in a way that help children learn individually, through other children, through teachers and through teaching learning material. The time available for learning should be utilized optimally.
- The teacher should use the language of the child and should create conducive atmosphere for the child to learn using his/her language.
- The teaching learning activities should be conducted based on the previous knowledge and experiences of the children.
- Local arts and crafts, productive components, experiences of manual laborers should be used as resources in the teaching learning activities.

Evaluation - Examinations:

So far we have been depending on only examinations to evaluate children. They, in turn, instead of evaluating children, subjecting them to great pressure and anxiety by showing them as wrongdoers. One way, it can be said that examinations are ruling and dictating the education system. With this backdrop, the State Curriculum Framework - 2011 put forward the following propositions:

- Evaluation and examinations should not be limited to assessing the child. They should go beyond and help the child learn too ¡V not only assessment of learning but also assessment for learning
- To implement continuous comprehensive evaluation as suggested by the Right to Education Act - 2009
- To use projects, assignments, portfolios, seminars, exhibitions, anecdotes, observations, etc., to assess children instead of restricting to examinations alone to do it.
- To make evaluation a part and parcel of teaching learning activities to achieve what was said above.
- To change the nature of questions in use: substituting questions that encourage rote memorization and questions that are restricted to the information in the textbooks with questions that have scope for children to think on their own and write, open ended questions, application oriented questions and questions that have room for children to express their own experiences.
- To make evaluation help teachers to assess how far children have been successful in using the knowledge they have gained.
- To have open and transparent evaluation system that enables children to do selfassessment, and the parents to know the progress of their children themselves.
- To give weightage in the board examinations for the continuous comprehensive evaluation conducted in school.
- To put the answer scripts at parents¡¦ disposal when asked and revalue them if needed/demanded
- To evaluate subjects in co-curricular areas like attitudes, values, work, health, games, etc. too in addition to the subjects in curricular areas.

Nature of Science

Science as a Process of Constructing Knowledge and Nature of Scientific Knowledge

Over the course of human history, people have developed many interconnected and validated ideas about the physical, biological, psychological, and social worlds. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable understanding of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, discovering meaningful patterns and relationships, building conceptual models, theorizing, experimenting, and validating. These ways represent a fundamental aspect of the nature of science and reflect how science tends to differ from other modes of knowing. Understanding nature of science itself has been a challenging task as it emerges from a complex interjection of philosophy, history, sociology and psychology of science and its practice.

Some important aspects of nature of science are:

- Science presumes that the things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study. However, nature is not simply revealed to us as we see it. There is much more to it to be discovered in fine structures or simplifying complexities of phenomenon through constructing concepts which are totally abstract in nature expressed as mathematical entities. More often, our intuitive concepts based on direct experience get overthrown giving rise to very counter-intuitive concepts that defy simplistic metaphorical understanding. Learning science calls upon teachers and students to come to grips with and understand such concepts very early. Concepts like force, inertia, cells, atoms and molecules, mass, energy, electric current, etc. all fall in this category.
- Science also assumes that the universe is, a vast single system in which the basic rules are everywhere the same. Knowledge gained from studying one part of the universe is applicable to other parts. For instance, the same principles of motion and gravitation that explain the motion of falling objects on the surface of the earth also explain the motion of the moon and the planets.

- Science is a process of constructing knowledge. The process depends both on making careful observations of phenomena and on inventing theories for making sense out of those observations. Consequences of theories are deduced through devising qualitative or mathematical models based on rational arguments leading to their verification or falsification through observations and controlled experiments giving rise to principles, theories and laws governing the physical world. Interestingly enough, what we choose to observe is in turn dictated by the tentative conceptualization or theorization prevailing at that time. Philosophers of science describe this as 'observations are theory-laden.
- Speculation and conjecture also have a place in science, subject to subsequent verification by relevant observations and/or experiments**.** There is an important creative element in practice of science.
- Scientific ideas are subject to change making science a dynamic, expanding body of knowledge. Change in knowledge is inevitable because new observations may challenge prevailing theories, as the domain of human experience expands. The laws of science are never viewed as fixed eternal truths. Even the most established and universal laws of science are always regarded as provisional, subject to modification in the light of new observations, experiments and analysis.
- Feynman, a famous scientist said "Scientific knowledge is a body of statements of varying degrees of certainty — some most unsure, some nearly sure, none *absolutely* certain." He further goes on to say, "Of all its (science) many values, the greatest must be the freedom to doubt." Indeed scepticism has been an important characteristic of scientific thinking and has played an historic role in progress of science.
- Most scientific knowledge is durable. For example, in formulating the theory of relativity, Albert Einstein did not discard the Newtonian laws of motion but rather showed them to be only an approximation of limited application within a more general concept. Continuity and stability are as characteristic of science as change is, and certainty as prevalent as tentativeness.
- Science cannot provide complete answers to all questions. There are many matters that cannot be usefully examined in a scientific way. There are, for instance, beliefs that, by their very nature, cannot be proved or disproved (such as the existence of supernatural powers and beings, or the true purposes of life). For scientific investigation to be possible it must be possible to ascribe to the phenomenon a consistent conceptual framework that lends itself to logical analysis leading to systematic observation and/or experimentation.
- Systematic inquiry is fundamental to the process of generating scientific knowledge. Science asks three basic questions-

  What is there?

  How does it work?

  How did it come to be this way?

- Scientific inquiry is not easily described apart from the context of particular investigations. There simply is no fixed set of steps that scientists always follow, no one path that leads them unerringly to scientific knowledge. There are, however, certain features of science that give it a distinctive character as a mode of inquiry. Although those features are especially characteristic of the work of professional scientists, everyone can exercise them in thinking scientifically about many matters of interest in everyday life.
- Science demands evidence. Fundamentally, the various scientific disciplines are alike in their reliance on evidence, the use of hypothesis and theories, the kinds of logic used, and much more. The validity of scientific claims is settled by referring to observations of phenomena. Hence, science concentrates on getting accurate data.
- Science is a blend of logic and imagination. Scientific concepts do not emerge automatically from data or from any amount of analysis alone. The assumption has to be connected with conclusions through scientific arguments that conform to the principles of logical reasoning. Sometimes discoveries in science are made unexpectedly even by accident and often by leaps of imagination.
- Science explains and predicts. The predictions may be about evidence from the past that has not yet been found or studied. A theory about the origins of human beings, for example, can be tested by new discoveries of human-like fossil remains. This approach is clearly necessary for reconstructing the events in the history of the earth or of the life forms on it. It is also necessary for the study of processes that usually occur very slowly, such as the building of mountains or the aging of stars.
- Science requires accurate record keeping, peer review and replicability. New knowledge must be reported clearly and openly.
- Science is not authoritarian. Theories are judged by their results: When someone comes up with a new or improved version that explains more phenomena or answers more important questions than the previous version, the new one eventually takes its place. The history of science reveals both an evolutionary and revolutionary character.
- Science is a complex social activity. Scientific work involves many individuals doing many different kinds of work and goes on to some degree in all nations of the world. Men and women of all ethnic and national backgrounds participate in science and its applications. These people—scientists and engineers, mathematicians, physicians, technicians, computer programmers, librarians, and others—may focus on scientific knowledge either for its own sake or for a particular practical purpose, and they may be concerned with data gathering, theory building, instrument building, or communicating.
- While not everything from different cultures would qualify as scientific knowledge, people from all cultures have contributed to science in some way or the other. This can be attributed to human endeavor to arrive at reliable validated knowledge in different cultures.

- Science has been part of social and cultural traditions and in turn scientific ideas have been rooted in the social and cultural milieu. An important contribution of science has been the way it has been reshaping our worldview. For example, till hardly four hundred years ago everybody believed the earth to be the centre of the universe with the sun and the moon going round it. Today, even if it might apparently not seem so, every child grows up with the knowledge that the earth is orbiting round the sun and is definitely not the centre of the universe.
- While technology definitely predates science, there has been a close relationship between technology and science, particularly over last four centuries. In fact, it would not be wrong to describe modern technology as applied science as much of technology around us is based on basic principles of science. Technological solutions are guided by design, aesthetics, economics and other practical considerations as also by scientific principles.
- The very definition of progress has come to be linked with advances in science and technology. New fields of work and production have emerged while traditional fields have been transformed beyond recognition like agriculture, manufacturing, construction, transport, communication and entertainment. People are faced with a fast-changing world demanding flexibility to adapt to new demands and creativity to take advantage of new opportunities. Science education has to rise to meet these expectations.

4 Objectives of Teaching Science

As per the general aims objectives content pedagogy and assessment would differ across different stages. While deciding gradation of science curriculum it must be borne in mind that a majority of the students study science as a compulsory subject up to class – X in Andhra Pradesh. Although most of these children are not going to train as professional scientists or technologists in their latter career, they need to become scientifically literate. The science curriculum up to class – X should be oriented more towards developing awareness among the learners about interface of science, technology and society besides being able to look at the world in a rational manner and apply principles of science to daily life. It should stress not only the content of the science but also the process skills and their linkage with the experiences and daily life.

Primary Stage

The main objectives of science teaching at this stage are to maintain the curiosity about the world and have the child engage in exploratory and hands on activities that would lead to the development of basic cognitive and psychomotor skills. All this would be through language, observations, recording, differentiation, classification, inference drawing, reading and making illustrations, design and fabrication of simple things, estimation and measurement. The curriculum should also help the child internalize values of cleanliness, honesty, co-operation, concern for life and environment at the primary stage.

During this stage,

1) Children should be encouraged to explore their immediate environment without too much focus. For example, in the first two years this exploration can be without the aid of a specific science textbook. The book on language can contain topics that induce the child to look around and develop a familiarity with their surroundings.

2) Science education can be a part of environmental studies from class III to V so that children can examine and relate to their world holistically.

The assessment of Science at this stage should aim at checking the knowledge acquired as well as the skills developed. Some not obvious skills only language comprehension and reading ability, ability to work in groups, etc.

The criteria for identifying the content at the primary stage are relevance, meaningfulness and interest to the child. The content should provide opportunities to deal with the real and concrete world of the children, rather than a formal abstract world. The present practice of introducing ideas and concepts pertaining to science and social science as environment studies should be continued and further strengthened, with opportunities for children to observe, explore and relate to environment closely. It is, therefore, essential for the curriculum, syllabus and textbook developers of both the 'sciences' and 'social studies' groups to work together.

Scientific concepts to be taught at this stage should be chosen so as to make sense of everyday experiences. Apart from simple experiments and hands on experiences, an important pedagogical practice at this stage is to engage the students (in groups) in meaningful investigations – including particularly the problems they perceive to be significant and important. This may be done through discussions in the class with the teacher, peer interactions, gathering information from newspapers, talking to knowledgeable persons in the neighbourhood, collecting data from easily available sources, doing simple experiments and carrying out simple investigations in the design of which the students have a major role to play.

Upper Primary Stage

Science education at this stage should provide a gradual transition from an exposé to ideas of science through environmental studies of the primary stage to elements of science including its concepts, processes and methods.

Scientific concepts to be taught at this stage should be chosen so as to be related to the child's life and to help the child acquire a better sense of her everyday experiences.

The emphasis on the process skills of science should continue through the upper primary stage to enable children learn how to learn for themselves so that they could carry on learning to even beyond school.

The examination should assess the child's practice and problem solving skills, ability to analyze data, application of learnt knowledge, development of concepts, understanding, reading and making graphical representations and solving simple numerical exercises.

The Technology component of Science Curriculum could include design and fabrication as well as practical knowledge about common mechanical and electrical devices and about local specific technologies.

1. Science education should remain as general science for class VI to VII.
2. At this stage group activity, peer group interaction allowing the child to articulate her formulations, questions, etc.
3. Children should be engaged in learning the principles of science through familiar experiences and to start recognizing the relationship of science and technology with society.
4. For example, students should be encouraged to make very simple working models using locally available materials.

Secondary Primary Stage

At the Secondary Stage concepts principles and skills of science would now appear appropriately but stress should be on use of concepts, on the ability to investigate and on comprehension and not on mere formal definitions. The organization of science content must be around what is close to children and the curricular load needs to be substantially reduced from the present to make room for aiding concept development and for the elements of design.

Relation with Other Subjects

When we want to relate learning of concepts to the experiences it becomes difficult to separate them into small pieces. Analysis of even experiments would cut across many concepts and thoughts sometimes across topics and even disciplines. Therefore, it is important to keep this in mind. The linkage of different aspects of the idea located in different disciplines makes it richer and nuanced. So in the sense of choosing themes and in the sense of deepening the relationship with the concept it is essential that the disciplines within science be visualised as linked and science be looked in terms of its relationships with other disciplines as well.

Application of Science in Daily Life

While organizing curriculum for teaching of science we should include all the essential aspects of the science subject needed by a child in meeting the general requirements of his day-to-day life. For this purpose attempts are to be made to take all essential and useful topics related with the day-to-day life activities and needs from all the different branches and areas of science. And then integrate them in a cohesive way for being used in a generalized way in ones day-to-day life. From early morning when we wake up, there are so many phenomena that excite our curiosity initiating us to think about how those things occur. We also see that science is with us every day. Children in washing face, brushing our teeth, noting time, reading in light and countless other things recognize the use of technology. Modern science and technology have changed our lives in many dramatic ways. Airplanes, automobiles, communication satellites, computer, plastics and T.V. are only a few of the scientific and technological inventions that have transformed human life.

Development of nuclear energy as source of power, development of better varieties of plants and highly effective fertilizer, development of antibiotics and new drugs which help to control may infections, diseases and also studies on anatomy and physiology have led to emerging new surgical operations and to invention of life caring machines that can do the work of organs as lungs, kidneys etc. Their impact on our life is a double edged sword and students must recognize the need to balance the use of technology in their lives.

We must point out science education today does not have enough examples from practical life. As a result, we are not able to use concepts in our daily life. The practical implications for life are totally distinct from the textbooks. It is not surprising that the students who are good at using ideas with the help of the textbook get puzzled by similar issues in daily life.

Science education does not develop the ability to analyze or discuss the possibilities to solve the problems that the individual and the society faces, and fails in creating an attitude that is required for solving a problem. There is also no scope for developing scientific awareness. Nothing is learnt of science if the child does not pass through stages of observation, data collection, data analysis, arriving at a conclusion, calculation and inference. Study of science should further pass through phases like locating an issue, its analysis, experimentation and observation. By taking up projects that are research-oriented, and undergoing the process of arriving at an inference, identifying mistakes and gaps child learns science and about life. The learner should pass through all the stages that the scientists pass through including temporary hypothesis formulation. Science education at present does not create such a favourable circumstance for any of this.

5 Academic Standards

"Learning is to go on extending the experiential orbit" (James Carlyle). Teaching learning activities should be such that they help us either to form new concepts replacing the old ones or strengthen them. The study of science should develop in children the competence to understand the laws and principles of nature and surroundings and to use them when needed. This is the purpose of academic standards.

We all know that science is organized knowledge. By studying science, children should develop in them qualities like rational thinking, making hypotheses, guessing results, estimating, giving proof by experimentation, searching for points in common results that can be generalized, love nature and environment, showing sympathy and be empathetic with flora and fauna.

Why Academic Standards?

We can see our children using many applications in mobile phones just like that effortlessly. How is it that they are able to do this? – No one teaches them. No tests. Then how are they able to acquire that competence? We all know the answer. It is nothing but 'learning by doing'. This is learning science.

Sagar studied up to degree. When his fan is revolving slowly, his friend suggested changing the condenser. But he does not know where he can get it and how to fix it. Not willing to bother about that, he started to search for an electrician. There are many such Sagars among us. Restricting teaching of science to textbooks is the root cause for this state of affairs.

Robin Frasther laments, that we learn from newspapers that repeated boiling makes edible oil poisonous. But we eat things made from such oil. We hear that our environment gets worse if there are not enough trees. But to improve the elevation of our house, we cut trees in the street. Someone says that polythene covers are life-threatening, but we never stop using them. Instead, we heap them and set them on fire. We leave rain water just like that and crave for potable water. We have innumerable experiences of this sort. Learning science means getting a good understanding of such things, but it never happens. Otherwise, we do not see doctors and teachers who suffer from sugar (except hereditary onset). This is true. There is no coordination between science and

our behavior in day to day life. They do not synchronize.

We appear to be humans who lost sensitivity either to a plant full of flowers or to a plant withered due to lack of water. The prime goal of teaching science is to develop a society that is kind to animals and sensitive to nature treating every living being as equals. To get what we have lost in the name of culture and modernization, and to correct the mistakes thus made, humanitarian dimension should be attributed to science. Academic standards are developed only to accomplish this. Since these should not be viewed as something to learn as content and since there is a need to look at it with new perspectives, let us try to understand them through the philosophy underlying them.

Academic Standards:

According to NCF-2005, RTE-2009 and APSCF-2011children are expected to achieve the academic standards specified for the class. The following academic standards should be accomplished as learning outcomes in science education.

1. Conceptual Understanding:

This indicates how best the student has understood the concept. Conceptual understanding includes explaining, classifying, analyzing, giving examples, giving reasons and forming mental images.

Explaining:

- Explaining the concepts observed or studied by him/her, or explaining an incident / an activity happened using appropriate scientific terms.
- Understand information collected by him/her or received from others through rational thinking and explaining them adding his/her own conceptual understanding

Classifying:

- Ability to distinguish differences among things in a group
- Ability to identify similarities in things
- Classifying things based on a special property
- Explaining the basis and procedure followed to classify things

Analyzing:

- Elaborating an incident or a situation in one's own words

- Ability to give logical reasons behind concepts in an orderly way
- Analyzing principles, equations, experimental results, etc., and identifying underlying principles and relations and forming new relations

Giving Examples:

- When a child can not only repeat what the teacher says but also talk about similar things which are exemplary, then it can be said as ¡¥giving examples.
- Giving examples based on common or distinctive features

Giving Reasons:

- Explaining experimental results, various concepts, phenomena, etc., with reasons
- Identifying relations based on causes for action and reaction
- Explaining observations based on reasons/causes

Forming Mental Images:

- To understand abstract concepts, which cannot be comprehended through direct experiences, through mathematical forms, logical reasoning and by forming mental images
- Using mental images thus formed in new situations when needed

2. Asking Questions and Making Hypothesis:

- To have the ability to observe things with curiosity and enthusiasm (as children have the nature of questioning.) Asking critical questions on various concepts
- The ability to ask critical questions to do in-depth analysis of the selected topic
- The ability to design questions to collect information, to observe and to interview
- Since questioning is natural for children and since it is the key to exploration and research, this should be developed in them so as to enable them to make hypotheses
- To predict results by thinking in advance critically about solutions to problems
- Forming hypotheses and predicting results while doing experiments and observations

3. Experimentation and Field Investigation:

Choosing required apparatus, setting it up, observation, recording, analyzing, concluding and generalization come under this.

Observing:

- The ability to acquire information through sensory organs
- Observing a thing, an event/incident or a phenomenon
- Discerning occurrences/events in a sequential order

Recording:

Recording observations in a table or in a notebook

Analyzing:

- Elaborating an incident or a situation in one¡¦s own words
- Ability to give logical reasons behind concepts in an orderly way
- Identifying the right and wrong notions based on proof
- Forming concepts through arduous observation of tables of information, graphs and reports

Concluding:

- Announcing the results of experiments conducted to verify the hypotheses is concluding

4. Information Skills and Projects:

- In the course of learning, children have to collect a lot of information using different methods. They should be able to classify the information thus collected; make tables of the classified information; and write their own report analyzing tables thus made
- Respecting other cultures, others¡¦ opinions, various living conditions while collecting information
- To be empathetic with the environment and to be ready to take responsibility
- Accepting his/her strengths and weaknesses. Showing initiative and participate
- Working with others, sharing and be helpful

Project work:

- Project is an activity in which children choose a problem and follow a systematic procedure to find solutions to it
- This is useful to make use of the innate abilities and creative talents of the children
- Waiting with patience and tolerance until the results are attained
- To act as a leader as well as a follower in a group
- Writing reports and exhibiting them
- Explaining analytically by showing reasons and giving examples
- To develop tolerance, patience, cooperative spirit and group work

5. Communication through Drawing/Model Making:

- Explaining by drawing pictures, expression through pictures, marking the parts of a picture come under this
- Drawing pictures showing the arrangement of apparatus and drawing pictures of what is seen through a microscope
- Drawing block diagrams, flow charts and classification tables
- Expressing innovative ideas / thoughts through creative pictures, models, and by creating alternative devices / implements /tools
- Expressing the information gathered graphically using bar graphs, pie charts, etc.

6. Appreciation and Aesthetic Sense/Values:

- Developing competitive spirit and the wisdom/courage to accept failure and success alike
- Developing characteristics like sense of appreciation and accepting reality
- Recognizing the importance of various elements of nature by discerning the relations among them through close observation
- Appreciating the uniqueness in biotic and abiotic components
- Appreciating the efforts and exertions of scientists
- Participating in science seminar and science clubs
- Designing pamphlets, writing slogans and poems

7. Application to Daily Life/ Concern to Biodiversity:

- Recognizing the importance of biodiversity in their surroundings
- Making efforts to protect environment and preserve biodiversity
- Recognizing the fact that every living being has the right to live
- To understand the harmful effects of our carelessness and exploitation on nature
- To have an awareness of nature and environment and behave responsibly
- Showing special attention on endangered species in nature
- Applying the acquired knowledge in new situations in day to day life
- To be conscious of the facts that nature is not the sole property of humans and that they are just a part of nature

While teaching non-language subjects, especially science, many teachers think that children should not look into books. But the present books are made to facilitate discussion, analysis and exploration. Unless children understand the content of the lesson, they will not be able to participate in the above activities. Moreover, studying lesson in science is not like studying lessons in languages. Every sentence carries a lot of information and elaboration based on which the essence should be grasped. Hence, it is mandatory for children to read the lesson beforehand and try to come to grips with the terminology and concepts. Then it will be possible for them to learn comprehensively through teaching learning activities. Therefore, children must read the science textbook in the science class.

PHYSICAL SCIENCE - 8th CLASS - REVISED SYLLABUS

1. Force

1.1 What is force ?

1.1.1 Identifying push or pull through different actions

1.2 Types of forces

1.2.1 Contact forces

1.2.1.1 Muscular Force

- Preparing a list of instances where muscular force is used.
- Observing the muscle while working

1.2.1.2 Force of Friction (Frictional force)

- Observing the motion of a ball on different surfaces
- Observing the motion of objects on an inclined plane

1.2.1.3 Normal Force

1.2.1.4 Tension

Lab Activity : To find the limiting force that can be borne by a string

1.2.2 Forces acting at a distance

1.2.2.1 Magnetic Force

- Observing the magnetic force

1.2.2.2 Electrostatic Force

- Observing electrostatic force

1.2.2.3 Gravitational Force

- Explaining the force acting at a distance : Concept of field
- Visualizing magnetic field

1.3 Net force

- Effects of net force acting on a table
- Effects of stretched rubber bands on fingers

1.3.1 Calculating Net force from Body Diagrams (FDB)

1.4 Effect of force on the direction of motion and state of the body

1.4.1 Effects of net force on direction of moving object

1.4.2 Effects of force on the shape of an object

1.5 Pressure

- Change in effect of force with area of contact
- What is pressure ?
- Identifying effects of force

2. Friction

2.1 Force of friction - Types

- Identifying forces acting on a body and the effect of frictional force.

2.1.1 To understand the nature of friction and the concept of staatic friction

- Definitions of friction, sliding friction, static friction
- Observing the variations in frictional force

2.2 Factors affecting friction

2.2.1 Effect of rough surface on frictional force

2.2.2 Effect of area of contact on frictional force

2.2.3 Effect of Normal force on friction

2.3 Is friction necessary ?

2.3.1 Friction produces heat

2.4 Increasing the drecreasing friction

2.4.1 How do reduce friction ?

2.4.2 Effect of rollers on friction

2.4.3 Understanding the princle of ball bearings

2.5 Fluid friction

- Observing fluid friction

2.5.1 Identifying factors influencing the fluid friction

3. Synthetic Fibres and Plastics

3.1 Making clothes from Natural fibres

3.2 What is synthetic fibres ?

3.2.1 Concepts of monomer and polymer

3.3 Identifying synthetic fibres

3.3.1 identifying synthetic fibres by burning test

3.4 Some of the synthetic fibres / examples for synthetic fibres

3.4.1 Nylon

- How is nylon made ?
- How strong is nylon ?

3.4.2 Rayon

- How is rayon prepared ?
- Why are different synthetic fibres mixed ?

3.4.3 Acrylic

3.4.4 Why synthetic fibres ?

3.4.5 Polysters

- How can you say a bottle is PET bottle ?
- Identification of various articles with recycling codes

3.5 Plastics around us

3.5.1 What is a plastic ?

3.5.2 Types of plastics

- Identifying thermoplastic and thermo setting plastic bottles by pouring hot water and notifying deformation

3.5.2.1 Thermoplastics

3.5.2.2 Thermo setting plastics

3.5.3 Why do we prefer plastics ?

3.5.4 Plastics and Environment

3.6 Bio degradable and non-bio degradable substances

3.7 Principle of 4R (Reduce, Recyle, Reuse and Recover)

3.7.1 Reduce

3.7.2 Reuse

3.7.3 Recycle

- Recycling code
- Role of codes in Recycling process
- Uncoded plastics

3.7.4 Recover

4. Metals and Non metals

4.1 Metals and non metals - an introduction

4.2 Physical properties of metals and non metals

4.2.1 Appearance

4.2.2 Lustrous nature

- Observing appearance and colour of materials

4.2.3 Sonarity

- Listening sound produced by some materials

4.2.4 Mallcability

- Identifying mallcability of metals

4.2.5 Ductility

4.2.6 Electrical conductivity

- Identifying electrical conductivity of a material

4.2.7 Conductivity of Heat

- Observing conductivity of heat of metals

4.3 Chemical properties of metals and non metals

4.3.1 Reaction with oxygen

- Rusting of metals

4.3.2 Reaction with water

4.3.3 Reaction with acids

4.4 Reactivity of metals

4.5 Some uses of metals

4.6 Some uses of non metals

5. Sound

5.1 Production of sound

- listening sound and predicting source
- identifying different sounds

5.1.1 Vibrating bodies produce sound

- Observing sound produced by a vibrating body

5.2 Sound and energy

5.3 Musical instruments

- producing sounds that resembles sound of rainfall
- observing changes in sounds

5.4 Sounds produced by human

5.4.1 Structure of voice box

- Observing movements of vocal cords during speech

5.5 Sound propogation

5.5.1 Sound needs medium to propogate

5.5.2 Propogation of sound in different media

- Observing sound propogation in Solids
- Observing sound propogation in liquids

5.5.3 Is sound propogate without medium

5.6 How do we hear sound

5.6.1 Structure and function of cardrum

5.7 Characteristics of sound

5.7.1 Loudness

- Observing relationship between vibration and loudness of a body

5.7.2 Pitch

- Observing pitch of a body

5.8 Normal sounds consists of mixed frequencies

5.9 Noice and music

5.10 Audible range

5.11 Sound pollution

5.11.1 Effects of sound pollution

5.11.2 Controlling measures

6. Coal and Petroleum

6.1 Identifying articles used for various purposes sounds of materials

6.2 Exhaustible and inexhaustable resources

6.3 Fuels - Coat, Petroleum, Natural Gas

6.3.1 Production of petroleum

6.3.2 Natural gas is an important source

6.3.3 Uses of coal, petroleum, natural gas

6.3.4 various uses of petroleum

6.3.5 How coal is formed

6.3.6 Coal and its products

- Coke
- Coal gas
- Coaltar

6.3.7 Uses of coal products

- Observing gases evolved in burning of coal

6.4 Some petrochemical products

6.5. Natural gas and petrochemicals

6.6 Versatile nature of coal and petroleum

6.7 Conserving coal and petroleum

6.8 Misuse of energy resources

6.8.1 Harmful effects of fuels

7. Combustion, Fuels and flame

7.1 Do all materials burn ?

7.2 What is required for the process of combustion ?

7.2.1 Testing of necessity of air for burning

7.3 Ignition temperature

7.3.1 Burning paper with sun rays

7.3.2 Understanding ignition temperature

7.4 Types of Combustion

7.5 Fuels

7.5.1 Fire

- Fire controll
- Observing behavour of different solid fuels

7.5.2 Structure of flame

7.5.3 Observing situations, happens in different zones of candle flame

8. Electrical Conductivity of Liquids

8.1 Testing the material to know which allows electric current to pass through

8.2 Electrical conductivity of liquids

8.2.1 Observing electrical conductivity of liquids

8.2.2 When do liquids conduct electricity

8.3 Transforming a poor electric conducter into a good one

8.4 Chemical effects of electric current

8.5 Electrolytic cell

8.5.1 Making of an electric cell

8.6 Electroplating

8.6.1 Electroplating procedure

8.6.2 Uses of electroplating

9. Some natural phenomena

9.1 Lightning

9.1.1 Sparks - issues know by greeks

9.2 Charging by rubbing

- Effects of rubbing
- Effects of charged bodies

9.3 Types of charges and their interaction

9.3.1 Find preserve of charge on a body

9.3.2 Transfer of charge

9.4 Lightning - Safety measures

9.4.1 Lightning conducter

9.5 Earthquakes

9.5.1 What is earthquake

9.5.2 Collecting information about earthquake damages

9.5.3 Causes of earthquake

9.5.4 Earthquake in our state

9.5.5 Earthquakes - safety measures

10. Stars and the Solar system

10.1 Observing changes in length of shadow

10.2 Understanding the North - South movement of Sun

10.3 Sun-dail

10.4 Phases of moon

10.4.1 Why moon shape changed

10.4.2 Moon surface

10.5 Lunar eclipse

10.5.1 Types of lunar eclipse

10.6 Solar eclipse

10.6.1 Types of Solar eclipse

10.7 Know about stars

10.7.1 Observing movements of constellation

10.7.2 Why polar star appears fixal at a point

10.8 The Solar System

10.8.1 The Planets

10.8.2 Some other members of Solar system

- Asteroids
- Comets
- Meteors and Meteorites

10.9 Artificial Satellites

10.10 How people know earth is spherical

10.10.1 How people know earth rotates on its own axis

PHYSICAL SCIENCE - 9th CLASS - REVISED SYLLABUS

1. Matter around us

1.1 States of matter

1.2 Properties of solids, liquids and gases

1.2.1 Shape and volume

1.2.2 Identifying the shape and volume of liquids

1.2.3 Do gases have definite shape and fixed volume

1.2.4 Compressibility

1.2.5 Observing compressibility of different substances

1.3 Diffusion

1.3.1 Observing diffusion of gases

1.3.2 Observing diffusion of particles of solids into liquids

1.3.3 Diffusion of two gases

1.4 Can matter change its state

1.5 What is matter made up of

1.5.1 How small are the particles of matter

1.5.2 Space between particles

1.7 How diffusion takes place

1.8 Effect of temperature on change of state

1.9 Effects of change of pressure on change of state

1.10 Evaporation

1.10.1 Effects of surface area, humidity and wind speed on evaporator

1.10.2 Experience with evaporation

2. Motion

2.1 What is relative

2.2 Motion is relative

2.2.1 Distance and displacement

- Drawing path and distinguishing between distance and displacement
- Drawing displacement sectors

2.3 Average speed and average velocity

2.3.1 Speed and velocity

2.3.2 Observing direction of motion of a body

2.4 Uniform motion

2.4.1 Non uniform motion

2.5 Observing motion on inclined plane

2.5.1 Observing uniform circular motion

2.5.2 Observing motion of an object thrown into air

2.6 Acceleration

2.6.1 Equation of uniform accelerated motion

3. Laws of motion

3.1 An introduction into laws of motion

3.2 First law of motion

3.2.1 Observing motion of pen cap

3.2.2 Observing motion of striker

3.3 Inertia and mass

PHYSICAL SCIENCE - 10th CLASS - REVISED SYLLABUS

1. Heat

- 1.1 Temperature (based on thermal equilibrium), heat
- 1.2 Specific heat capacity
- 1.3 Thermal expansion [solids and liquids only]
- 1.4 Methods of mixtures
- 1.5 Evoporation, condensation, humidity, Bioling, Melting, Freezing

2. Chemical Equations and Reactions

- 2.1 Introduction to Language of Chemistry
- 2.2 Atoms, molecules, Elements, Compounds, Mixtures, Atomic mass, Molecular mass, Gram Atomic mass, Gram molecular mass, Molar & Mole concept.
- 2.3 Some daily life examples of chemical reactions.
- 2.4 Chemical equations – writing chemical equations, skeletal chemical equations, balancing chemical equations, writing symbols of physical states.
- 2.5 Types of Chemical Reactions:
  - 2.5.1 Combinations reactions: (Exothermic chemical reactions, Endothermic reactions)
  - 2.5.2 Decomposition reactions: (Thermal, Electrolytic, Photo-chemical reactions- examples only without mentioning names)
  - 2.5.3 Displacement reactions:
  - 2.5.4 Double displacement reactions:
- 2 .6 Oxidation and Reduction:
- 2.7 Corrosion and prevention of corrosion
- 2.8 Rancidity

3. Reflection of Light

- 3.1 Theories of light
  - 3.1.1 Fermat principle
- 3.2 Reflection – its laws
- 3.3 Mirrors
  - 3.3.1 Plane mirrors – image formation
  - 3.3.2 Spherical mirrors, convex, conclave mirrors
- 3.4 Rules for Ray diagrams by sing laws of reflection
  - 3.4.1 Images formed by spherical mirrors
  - 3.4.2 Formula for spherical mirrors – focal length and sign convention
  - 3.4.3 Application of reflection

4. Acids, Bases and Salts

- 4.1 Introduction (for Recalling only) to Acids & Bases
- 4.2 Chemical properties of acids & bases
  - 4.2.1 Acids & Bases in laboratory – Indicators
  - 4.2.2 Reaction of Acids & Bases with Metals
  - 4.2.3 Reaction of Acids & Bases with each other (Neutralization)
  - 4.2.4 Reaction of Acids & Bases with Metal Carbonates and Metal hydrogen carbonates
  - 4.2.5 Reaction of Acids & Bases with Metallic oxides with acids
  - 4.2.6 Reaction of Acids & Bases with Non-Metallic oxides with bases

4.3 What do acids have in common? What do bases have in common?

4.4 Importance of **p^H** in everyday life

4.4.1 Sensitive of plants and animals to **p^H**

4.4.2 **p^H** of soils, **p^H** in digestive system, **p^H** tooth decay

4.5 Self defense by animals and plants through chemical warfare

4.6 Some naturally occurring acids

4.7 Salts

4.7.1 Nature of salts

4.7.2 **p^H** of salts

4.7.3 Sources of common salt

4.7.4 Common salt – a raw material for other chemicals (NaOH, Bleaching powder, baking soda, washing soda, and their uses)

4.7.5 NaOH, Bleaching powder, Baking soda, $NaHCO_3$ uses washing soda and its uses

4.7.6 Salt crystals – water of crystallization eg: $CuSO_4.5H_2O$, Plaster of Paris

4.7.7 Plaster of Paris

5. Refraction of light at plane surface

5.1 Refraction and its laws

5.2 Refractive index

5.3 Relative refractive index

5.3.1 Snells law

5.4 Total internal reflection and its applications (Mirages)

5.5 Applicationof total internal reflection

5.6 Reflection through a glass slab

5.6.1 Refraction through a thin slab

6. Refraction of light at curved surface

6.1 Refraction of light through lenses and prisms by using Fermat principle

6.1.1 Image formatioon

6.2 Lenses

6.3 Rules for Ray diagram

6.4 Images formed by the lenses

6.5 Formula for derived for thin lenses

6.5.1 Applications

7. Human eye and colourful world

7.1 Least distance of distinct vision

7.2 Structure of human Eye

7.3 Common defects of vision - Myopia,Hypermetropia, presbyopia

7.4 Prism

7.5 Dispersion

7.5.1 Rainbow

7.6 Scattering of light

8. Structure of atom

8.1 Electro magnetic spectrum

8.2 Atomic spectrum

8.3 Planck's theory/ Einstien's theory

8.3.1 Bohr's theory

8.4 Hiesenberg Uncertainity Principle – functions

8.4.1 Probability functions – probability diagrams - orbitals

8.5 Quantum numbers: (no mathematical derivations)

8.6 Main shells, Sub-shells and orbitals in different sub-shells

8.7 Electronic Configuration of elements in their atoms

8.8 ${}_{n}l^{x}$ rule, Energies of electronic energy levels (n+l) rule ; Aufbau Principal, Paulis principal, Hund's Rule of maximum multiplicity, Stable configurations.

9. Classification of Elements

9.1 Need for arrangement of elements in an organized manner

9.1.1 Historical background of classification of elements

9.2 Doberieners Triads

9.3 Newland's law of Octaves

9.4 Mendeleev's Periodic Table (Achievements & Limitations)

9.5 Modern Periodic Table.

9.5.1 Position of Elements in Modern Periodic Table

9.5.2 Trends in Modern Periodic Table (Valency, Atomic size, Ionization Energy, Electro-negativity, Metallic & Non-metallic properties)

10. Chemical Bonding

10.1 Chemical bond definition (brief explaination)

10.2 Electronic theory of Valence by Lewis and Kossel

10.2.1 Octet Rule

10.3 Ionic and Covalent bonds: examples with Lewis Dot formulae

10.4 Shapes and bond lengths in molecules

10.5 Valence bond theory – examples like H_2, Cl_2, H_2O, BF_3, CH_4, NH_3, C_2H_6, C_2H_4, C_2H_2 etc

10.6 Hybridisation and explaination of H_2O, BF_3, CH_4, NH_3 etc., molecules

10.7 Properties of Ionic and Covalent Compounds

11. Electricity

11.1 Electric charge

11.1.1 Electric force

11.1.2 Electric field

11.1.3 Electric potential, potential difference

11.2 EMF

11.3 Electric current

11.4 Ohms law, resistance, specific resistance, factors influencing resistance, electric shock

11.4.1 Kirchoff's Laws

11.5 Series and parallel connection of resistances

11.6 Heating effect of electric current, safety fuses

11.7 Electric power

I2. Magnetic effects of electric current

12.1 Magnetic field – field lines

12.2 Magnetic field due to currents

12.2.1 Duet to current carrying wire

12.2.2 Due to circular loop

12.3 Solenoid

12.4 Magnetic force on moving charged particle and long straight conductors

12.4.1 Fleming's left hand rule

12.5 Electric motor

12.6 Electromagnetic induction – Faraday's law (including magnetic flux)

12.7 Generators and Alternating Currents

12.8 Latent heat; changes of phases, condensation, fog and cloud, boiling, melting

13. Metallurgy

13.1 Occurance of Metals

13.2 Extractions of metals – activity series and related metallurgy, flow chart of steps involved in the extraction of metals from ore.

13.3 Enrichment of ores

13.4 Extracting metals low in the activity series

13.5 Extracting metal in the middle of the activity series

13.6 Extracting metal in the top of the activity series

13.7 Refining metals

13.7.1 Electrolytic refining

13.8 Corrosion – Prevension of Corrosion

14. Carbon and its compounds

14.1 Introduction

14.2 Bonding in Carbon including Hybridization

14.3 Allotropes of Carbon (Diamond, Graphite and C_{60})

14.4 Versatile nature of carbon

14.4.1 Catenation and tetravalency

14.4.2 Chains, branches and rings

14.5 Saturated and Unsturated carbon compounds

14.5.1 Bonding of carbon with other elements

14.6 Functional groups in carbon compounds (alcohols, ketones, aldehydes, halo and esters)

14.7 Homologous series (Alkanes, Alkenes and Alkynes)

14.8 Nomenclature of Carbon compounds

14.9 Chemical properties of carbon compounds

14.9.1 Combustion (Blue and Sooty flame observed in carbon compounds, exothermic)

14.9.2 Oxidation (Alcohol to Acids)

14.9.3 Addition reaction

14.9.4 Substitution reaction

14.10 Important carbon compounds

14.10.1 Ethanol

14.10.2 Ethanoic acid

14.10.3 Properties of Ethanol – General properties, reaction of ethanol with sodium, reaction with hot concentrated sulphuric acid.

14.10.4 Properties of Ethanoic acid – General properties, Esterification reaction, Reaction with a base, sodium hydroxide, sodium carbonate and sodium hydrogen carbonate

14.11 Soaps – Saponification, Micelles.

ACADEMIC STANDARDS - VIII CLASS - PHYSICAL SCIENCE

CHAPTER - I : FORCE

I. Key Concepts

- Force
- Identifying push or pull in different actions
- Types of forces
- Field Forces
- Stationary forces
- Net force
- Free Body Diagram

II Learning outcomes

(i) Defines force

- Identifies push and pull in different activities
- Knows types of forces
- Identifies situations where different forces are used.
- Knows friction and its uses
- Explains the similarities and difference between scenery and field forces.
- Finds out net force based on FBD.

(ii) Questioning and hypothesis

- Imagines what happens if there is no force of friction.
- Makes hypothesis about what happens if earth does not possess gravitational force.
- Questions for comprehension and examples of types of forces.

(iii) Experiments- Field observations

- Observes electrostatic forces through the experiment where charged balloon attracts pieces of paper.
- Observes magnetic field force through the experiment of bar magnets.
- Observes force of attraction through the experiement in which a comb pieces of paper after combing.

(iv) Information skills, Project works.

- Collects pictures representing contact forces and field forces from newspapers and inter net and exhibit them.
- Tabulates different actions in which push and pull are there/present.
- Tabulates the effects of force on shapes of objects.

(v) Drawing Pictures - Making models.

- Identifies in the diagram the force of gravitation and normal force acting on a book.
- Draws the diagram indicating the forces acting upon a person standing still.

(vi) Aesthetic sense of appreciation, concern to biodiversity, daily life application.

- Knows different types of forces in daily life situations.
- Appreciates the utilities bestowed upon human race, by force of friction and force of gravitation.

CHAPTER - 2 : Friction

I. Key Concepts

- Friction
- Sliding friction
- Rolling friction
- Static friction
- Factors affecting friction
- Fluid friction

II Learning outcomes

(i) Defines force of friction- know types of frictin- explains the advantages and disadvantages of force of friction to human beings -Give examples to static friction.

- Gives examples to sliding friction - Explains how to avoid force of friction and to avoid energy wastage- explains how to measure force of friction.

(ii) Makes hypothesis on what happens if there is no friction on earth and the tasks that cannot be done in different situations

- Questions the happenings if the friction in machines is not not decreased Imagines those and answers.

(iii) Conducts the experiements with trolley and wooden block to know the nature of friction, nature of static friction and static friction

- Conducts the experiement of stirring water in a glass with a spoon.

(iv) Records in a tabular form the tasks that we cannot do in our daily life in absence of friction.

- Records in a table what do we use to avoid friction in different situations.

(v) Draws pictures if forces acting on a moving abject on an inclined surface.

- Draws picture of forces acting on a book on a table.

(vi) Realizes that wastage of energy can be reduced and also bio diversity can be conserved by using different methods.

- Appreciates the benefits bestowed on humanity by friction.

Chapter - 3 : Synthetic Fibres and Plastics

I. Key Concepts

- Acrylic
- Synthetic fibres- Bakelite - Cellulose - melamine - nylon.
- Polymer - recycling - thermoplastic - thermosetting plastics.

II Learning outcomes

(i) Knows about clothes made from natural resources.

- Knows about the fibres we get from plants and animals.
- Knows what are synthetic fibres
- Knows what is nylon and gives examples for things made of nylon
- Explains what is rayon and similarities and differences between rayon and natural silk fibres.
- Explains about acrylic, synthetic fibres and polyester fibres
- Can say that the type of bottle based on the symbol.

- Explains what is plastic, its types, uses and differences.
- Explains differences and uses of thermoplastic and thermosetting plastic.
- Can say the effect of plastic on environment.
- Classifies things into bio-degradable and non-bio-degradables.

(ii) Makes hyprothesis on how human life would have been if plastic and synthetic fibres were not discovered.

- Imagines the harm caused to the world by increased use of non-biodegradable plastics.

(iii) Finds out the type of fibre by conducting burning test

- identifies thermoplastics and therosetting plastics by flame test
- Knows the strength of fibres by experimenting (hanging the thread from champ)
- Knows the type of plastic by pouring hot water in plastic bottles
- Visits a nearby cotton mill / textilemill to know how textiles / clothes are made from natural / synthetic fibres.

(iv) Lists out different objects, appliances at home and classifies them as made from natural / synthetic fibres.

- Records the strength of the fibres based the type of fibre
- Classifies and records the type of bottles collected by the.

(v) Draws a picture explaining the differences in the arrangement of monomers in thermoplastic and thermosetting plastic.

- Draws the recycling symbol
- Draws the symbols representing resins.

(vi) Appreciates how synthetic fibres and plastics change human life.

- Explains how plastics cause harm to biodiversity
- Explains how synthetic fibres and plastics are useful to humans.
- Explains the usefulness of recycling process.

Chapter 4 : Metals and Non-Metals

I. Key Concepts

- Metals - Non metals - lustre - sonority - ductility - malleability - displacement reaction.

II. Learning outcomes.

(i) Explains physical and chemical properties of metals.

- Explains physical and chemical properties of non metals.
- Explains the mettalic properties such as lustre, sonority, ductility malleability, electric conductivity and heat conduction.
- Gives examples of metals which exhibit the above properties.
- Classifies the given substances as metals and nonmetals.
- Gives examples of metals used in making of different objects.

(ii) Questions why gold doesn't lose its shine.

- Questions why iron is not used in handles of pans and cookers
- Imagives human life without metals.
- Questions why diamond is hard in spite of being a non metal and why mercury is soft in spite of being a metal.

(iii) Explains the acidi and basic nature of metals and nonmetals through experiment.

- Expllains the reaction of metals with oxygen through experiment
- Proves electric conductivity of metals and non metals through experiment using battery, bulb circuit

(iv) Records in the table, whether the collected objects are shining or clourful.

- Recoreds in the table whether metals selected produce sound or not
- Records the ductility of certain chosesn metals by testing
- Draws a picture explaining the conduction of heat in metals.

(v) Appreciates the metals and their usefulness to humanbeings.

- Explains the harm caused to the environment by metallic and non metallic substances.
- Explains the uses of metals.

Chapter - 5 : Sound

I. Key concepts

- Vibration, vocal cords, eardrum, ampliturde, decible, pitch, shrillness, frequency

II. Learning outcomes

(i) Knows that vibrating body produces sound.

- Defines sound
- Differentiates between the sounds produced by different musical instruments.
- Knows the structure of laryus.
- Explains that sound needs a medium to propogate.
- Edplains the differences in propagation of sound in solids, liquids and gases

(ii) Makes hypothesis on the conditions that arise when sound pollution increases.

- Questions why human beings can't hear certain sounds as bats and dogs.
- Imagines what happens if sound is not propagated in air

(iii)

- Proves through an experiment using cell function and bottle that sound possesses emergy
- Explains through an experiment that sound needs a medium to propagate
- Proves through an experiment that sound travesl in solids and liquids.
- Explains through an experiment the relation between the intensity of sound and vibration of objects.

(iv)

- Records in a talbe the vibrating part of different musical instruments
- Collects the pictures of different musical instruments and exhibits them in a scrap book.

(v)

- Draws and lables the picture of larynx
- Draws labels and explains the picture of eardrum
- Makes models of musical instruments using the things available in surroundings.

(vi)

- Explains the impact of sound pollution on biodiversity.
- Gives examples of methods to reduce sound pollution
- Appreciates the mental peace provided by the musical instruments and their music.

Chapter - 6 : Coal and Petroleum

I. Keyconcepts

- Natural resonrces - exhaustible resources - inexhaustible resources - petroleum.
- Fractional distillation - Compressed Natural Gas - Coke, Coal, Coaltar - fossilfuels

II. Learning outcomes

(i)
- Explains inexhaustible and exhaustible energy resources
- Differentiates between inexhaustible and exhaustible energy nesources
- Gives examples for inexhaustible and exhaustible energy resources
- Expllains the uses of coal, petroleum and natural gas.
- Explains fractional distillation of petroleum
- Explanis the bye products of fractional distillation and their uses.
- Explains with examples the accidents - results occuring during the usage of find resources

(ii)
- Emagives what happens the earth if petroleum resourcs are exhausted
- Questions what alternative resources can be used as fuels.

(iii)
- Proves through an experiment that the gas that is evolved when coal is heated, burns.
- Observes the making of petroleum products in a nearby factory

(iv)
- Makes a flow chart on uses of exhaustible and inexhaustible resources
- Records different petroleum products and their uses in a table.
- Records in a table, the vehicles run by petrol, diesel and CNG based on their mileage.

(v)
- Draws and labels the picture of the experiment showing that the gas released on heating coal, burns.
- Points out in the map, the areas in Andhra Pradesh where different petrolium products, coal and natural gas are found.

(vi)
- Appreciates people who save fuel to provide it to future genvations.
- Explains the loss incurred by letting the petroleum products and crude oil into rivers and seas.
- Congratulates the efforts of humans to find alternatives to petol & coal.

Chapter - 7 : Combustion, fuels and flame

I. Key concepts

- combustion - combustible materials - noncombustible materials - ignition temperature - spontaneous combustion, rapid combustion - colorific value.

II. Learning outcomes

(i) Defines Combustion

- explains that oxygen is necessary for burning
- defines igrition temperature
- gives examples for rapidly combustible substances
- defines and gives examples for combustible and non combustible substances.
- defines fuels and classifies the calorific value of different fuels and substances.

(ii) Imagines the conditions that arise in future when fuels are exhausted

- imagines what happens if oxygen doesn't support combustion.
- questions whether combustion takes place in vaccum

(iii) Proves through an expriment that oxygen is needed for combustion.

- explains through an experiment whether all substances are combustible
- infers through an experiment that air is needed for combustion of substance

(iv) Records in a tabular form how different substances burn, burns immediately and doesn't burn.

- classifies and records the information in tabular form about solid, liquid and gaseous fuels.

(v) Draws and labels the structure of frame.

- prepares a graph of the consumption of petrol, diesel and natural gas across the state.

(vi) Appreciates that fuels facilitate human life.

- Explains the different forms and / uses of fuels.
- Explains the precautions to be taken in fuel consumption so as to protect biodiversity.

Chapter - 8 : Electric conductivity of liquids I Key concepts

I. Electric conductors - electrodes - electrolyte - electrolysis - electroplating

II. Learning outcomes

(i)
- defines electric conductors - gives examples to electric conductors
- defines poor conductors - explains how a poor conductor can be converted into good conductor - explains the chemical effect of electric current - explains how an electric cell is made.
- defines electroplating -explains the uses of electroplating

(ii)
- questions what happens due to electric shock
- imagines what happens if poor conductors of electricy become good conductors

(iii)
- infers through an experiment the electrical conductivity of liquids
- proves through an experiment the chemical effect in a potato by electric current
- infers through an experiment, coating an iron key with copper by electroplating method.

(iv)
- Classifies and records good and poor conductors of electricity
- records good and poor conductors in an electric circuit
- records the chemical effect of electric current on different vegetables

(v)
- draws and labels the electric conductivity of liquids
- makes the model of a tester using magnetic comppass

(vi)
- Appreciates the efforts of scientists in making the cel that reserves electricity
- explains the situations where good conductors and poor conductors are used and tabulates the information

Chapter - 9 : Some natural phenomena

I. Key concepts

- Crust - earth's plates = Earthquake - electroscope - lightening conductor - discharge - Richter scale - tsunami - seismograph - lightening conductor - discharge - Richter scale - tsunami - seismograph

II. Learning outcomes

(i) Explains how lighterings are caused tells that friction produces electric charge

- comprehends different tgypes of charges
- explains the precautions to be taken during lightining
- explains what is lightening conductor and why it is used.
- explains what are earthquakes and why they are caused.
- Explains about seismagraph
- Explains the precautions to be taken during earthquakes

(ii)
- questions can electric charges be got from lightenings
- quesses what to do when earth quakes occur suddenly.

(iii)
- infers through an experiment that friction produces charge
- infers and explains through an experiment how to find out charge of an object

(iv)
- identifies in a map the earthquake prone areas in the world
- identifies ina map the earthquake zone in Andhra Pradesh

(v)
- colours the earthquake zone or seismic areas in Andhra Pradesh in the map of
- prepares a model of seismograph

(vi)
- Appreciates the efforts of scientists in inventing the instrument that measures the intensity of the earthquake and finds its root cause.
- Explains the loss incurred by earthquakes to biodiversity

Chapter - 10 : Stars and the solar system

I. Key Concepts :

- Celestial bodies - Local nool - sundial - Dakshinayanam - Uttarayanam - Phases of moon - constellation - galaxy - polestar - asteroids - comets - meteors - meteorites.

II. Learning outcomes

(i)
- understands the north south movement of the sun
- explains making of a sundial
- Explains what are phaseds of moon and why the shape of the moon
- Explains the differences in the formation of solar and lunar eclipses
- explains the similarities and differences between the plants in the solar system
- explaine the artificial satellites and their uses.

(ii)
- makes hypothesis through the feelings that arise when looked at the sky at night
- questions how to tell time during night
- makes hypothesis if there happens to be earth like atmosphere on any other planet.

(iii)
- prepares a report report by observing the north south movement of the sun.
- prepares a report by observing the way the moon appears daily after no moon day.

(vi)
- makes a scrap book collecting the information from newspapers and internet about different planets in the lolar system.
- exhibits the pictures and information collect from internet about waste materials in space.

(v)
- Draws the picture of solar system and identifies planets
- makes model of solar system with differently coloured balls.

(vi)
- explains how the biodiversity is impacted by radiation caused by artificial satellites
- explains how to conserve life bearing earth and its atmosphere
- appreciates the beauty of the organised arrangement of the universe.

ACADEMIC STANDARDS - IX CLASS - PHYSICAL SCIENCE

UNIT - I : MATTER AROUND US

I. Key Concepts

1. States of matter - properties
2. Change in the state of matter

II. Learning outcomes

(i) Conceptual understanding

- Explains the 3 states of matter, cites examples for materials found in these states.
- Identifies the differences between solids, liquids and gases.
- Imagines the meterials in solid, liquid and gases.

(ii) Questioning and making hypothesis

- Observes and tells how to identify volume of liquids and gases

(iii) Experimentation and field investigations

- Experiments in the classroom to identify compression and diffusion.

(iv) Information skills and projects

- Tabulates the properties of solids liquids and gases

(v) Communication through drawing, model making

- Makes model showing the arrangement of molecules in solids liquids and gases.

(vi) Appreciation, aesthetic sense and values

- Appreciates the process of controlling body temperature through sweating.
- Appreciates evaporation in daily situations

(vii) Application to daily life, concern to biodiversity.

- Identifies the daily life situations where the effect of evaporation is felt. (Sweating on doing physical exercise, cooking of water in an earthen pot, animals spending more time in water)

Chapter - 2 : Motion

I. Motion relative motion - distance - displacement - speed - velocity - uniform motion - non uniform motion - acceleration uniform acceleration - equations of uniform acceluated motion.

II. (i)
- Differentiates between speed and velocity - can explain aculeration
- Differentiates between distance and displacement - explains the relation between various slopes and acceleration.

(ii)
- Conducts an activity to observe uniform circular motion makes hypothesis that object moving in a circle changes its direction and velocity.
- Observes and predicts the ball moving up the clined plane

(iii)
- Conducts activity in cab to measure velocity and acceleration of an object moving on an inelined plane.
- Observes and reports the concept that motion is relative after the field visit with friend.

(iv)
- Tabulates the details of the experiment to find the acceleration of an object moving on an inclined track

(v)
- Draws / graph based on the information given in table - 1 for awareness of uniform motion and in table - 2 for non uniform motion.
- Draws time distance graph for the experiment of moving object on an inclined plane.
- Draws the displacement rectors for a cell moving in crooked path between two points.

(vi)
- Appreciates the idea of acceleration and deceleration by experiencing it when the train stops and when the bus changes its velocity while travelling in a curved path.

(vii)
- Solves the problems and situations in daily life.

Chapter - 3 : Laws of Motion

I. Laws of motion - Conservation of momentum - impulse

II.(i) Explains laws of motion with examples
- gives reasons to the daily life incidents
- Ex.: Motion of a pen cap kept on thick paper ring
- Motion of the coins hit by a striker
- balloon rocket activity

(ii) Qustions imagines and makes hypothesis through the activity of pushing two wooden boxes with same force.

- Makes hypothesis that the momentum is unchanged before and after collisions.

(iii)
- Proves the forces acting on two different objects.
- Explains inertia through an activity
- understands the concept of motion in different slopes of an inclined plane

(v)
- Draws FB showing all the forces actiing on the body on a plane surface.

(vi)
- Appreciates the rules told by the scientists, Galileo & Aristotle.

(vii)
- Observes that a passenger in moving train cannot catch the ball throwing it up as it falls back based on this tells motion of the train.
- Solves the daily life problems using principles of physics.

Chapter - 4 : Is Matter Pure ?

I. Pure substances - mixture - types of mixtures

- Solutions ; saturated, unsaturated, suspensions coll oidal solutions.
- Tyndall effect.
- Separating the components of a mixture - Chromatography.
- Misible and immisible solutions
- Distillation and fractional distillation.

II (i)
- Explains the methods of separating compunds from differerent substances (mixutre, solutions)
- Explains with examples pure substances, soulutions, colloids and suspensions.
- Classifies giving reasons heterogenous and homogenous mixtures, misible and immisible soulutions.

(ii)
- Makes hypothesis discussing to understand the tyndall effect
- Makes hypothesis on how to separate homogenous and heterogenous mixtures.

(iii)
- Separates the components of ink through paper chromatography
- Tests tyndall effect by taking a solution, suspension and colloidial dispersion in separate beakers.

(iv) ● Collects information in regard with identifying heterogenous mixtures as suspensions and colloidal solutions .
● Collects and tabulates the information in regard with elements compounds, homogenous mixtures and heterogenous mixtures.

(v) ● Draws a picture fot the experiemental activity if choromatography method
● Draws pictures of separating the components of air, distillation fractional distillation.

(vi) ● Appreciates the fact that the components of a heterogenous mixture can be separated based on their density.
● Appreciates the dependence on difference between the boiling points to separate the misible liquids through fractional density

(vii) ● Prepares tea and explains its making

Chapter - 5 : Atoms and Molecules

I ● Law of conservation of mass - law of constant proportion - Dalton's atomic theory - Atoms of elements - symbols - molecules of elements compounds Formulae - Valency - Crisscross method - Atomic mass - Molecular mass - formula unit mass - mole - molar mass.

II (i) ● Explains what are atoms and molecules and differentiates them.
● Writes symbol for atom and formula for molecule.
● Writes formulae for compounds using valency.
● Calculates atomic mass and no-of particles.

(ii) ● Imagines the standard symbols of elements and writes
● Imagines the information conveyed by the formula of a molecule

(iii) ● Experiements to observe the law of conservation mass in all chemical reactions.

(iv) ● Collects information off symbols of different elements in the periodic table and their mass.

(v) ● Draws the picture of experiment showing law of conservation of mass.

(vi) ● Appreciates the efforts of scientific knowing the troubles if the elements are not named and give any symbols.

(vii) ● Uses symbols in equations and also in daily life.

Chapter - 6 : What is inside the atom

I
- Atoms, sub atomic particles (e-, p+,n) -atomic structure - 1)Thompson's atomic model 2)Rutherford's atomic model 3)Bohr's atomic model -valency atomic number, atomic mass, molecular mass, isotopes.

II (i)
- Tells what are atoms, subatomic particles - compares the properties of atoms and sub atomic particles- tells the different atomic models.
- Writes electron configuration of elements- compares the isotopes of an element.

(ii)
- Imagines the arrangement of subatomic particles in an atom- questions the importance of valency- tells the valency if atomic number is known.

(iii)
- Writes electronic configuration for different elements- concludes from observations that atomic mass is the sum of protons and neutrons.

(iv)
- Collects and tabulates information about, symbols of elements, atomic number atomic mass, no :of neutrons and no:of electons.
- Collects brief information about atomic models of Dalton, Thompson, Rutherford and Bohr.
- Writes about the efforts, ecperiements and proposed theories from Dalton to Bohr.

(v)
- Draws Rutherford's atomic model.

(vi)
- Appreciates the atomic structure and arrangement of subatomic particles.
- Appreciates the efforts of scientists to explain the atomic structure.
- Will be sensible to the uses of isotopes.

(vii)
- Knows the applications of isotopes.

Chapter - 7 : Gravitation

I
- Uniform curcular motion- Centripital accleration - centripital force - weigh centre of gravity - acceleration due to gravity -stability

II (i)
- It gives examples for uniform circular motion
- Explains Neutrons Law of universal gravitation, Identifies it different situations
- Comprehends the concept of centripital acceleration
- Explains the concept of stability

(ii)
- Questions the analysis of Newton's law of Universal gravitation.
- Questions stability and its need.

(iii) ● Experiements to test the concept of stability.

(iv) ● Collects infiormation regarding Newton's life history
● Prepares wall magazines.

(v) ● Collects and exhibits the information on the conditions prevalled before law of gravitation

(vi) ● Appreciates Newton's law an its effects

(vii) ● Applies the concept of stability in daily life.

Chapter - 8 : Floating Bodies

I. ● Relative density- atomspheric pressure, pressure in liquids
● Archimedes principle - Pascals principle

II (i) ● Differentiates between density and relative density.
● Derives Archimedes principle
● Analyses Pascal's Principle.
● Explains atmosphere pressure

(ii) ● Questions in the situations where Archimedes principle is used
● makes hypothesis for the formation of Toricelli's vaccum.
● Questions to know the atmospheric pressure and the reasons for it.

(iii) ● Experiements to find realtive density of liquids
● observes and proves experiementally why things made of higher density than water float in water Ex: Making iron float on water.
● Proves experiementally that the reason for force of buoyancy is the difference in the pressures at different heights.

(iv) ● Classifies substances into two categories as more than 1 relative density and less than 1 relative density.
● Collects the relative densities of different substances and writes them in ascending order.
● Collects information on how oil brakes/air brakes work in vehicles.

(v) ● Draws the picture of mercury barometer
● makes the model of lactometer with ball pen refill.

(vi) -Appreciates Pascal's invention that is being used in hydraulic jacks.

- Appreciates the Archimedes principle that explained buoyancy.
- Appreciates the technology making floating and sinking bodies.

(vii) - Tells the daily life situation where Archimedes principle is used

- Tells the daily life situation where Pascal's principle in ised and gives examples.

Work and Energy

Chapter 9

I 1) Work- scientific definition of work .

2) Energy: energy transfer and the work, FOrms of energy, mechanical energy conservation of energy - Power.

II (i) -Defines work and tells its standards.

- Tells what is mechanical energy
- Tells the law of consevation of energy
- Tells what is dynamic energy and gives examples.

(ii) -Gives reasons to claim that work has been done in our object

- Observes to understand the scientific definition of work.

(iii) -Conducts different activities and experiements to know kinetic energy and potential energy (Ex: Bow-arrow, Pull out rubber band.)

(iv) -lists energy resources

- Collects the information to know whether the work done in different situations is positive, negative or zero.
- Collects pictures to show that an object possess potential energy by virtue of its state and makes a crap book.

(v) -Draws picture showing the mechanical energy in freely falling bodies.

(vi) - Appreciates the energy transfer in different forms to conserve nature.

- Appreciates that energy is stored in the form of potential energy when work is done on the object.
- Appreciates the law of conservation of energy.
- Appreciates the energy of freely falling body in different situations.

(vii) ● Discisses on need for energy and energy conservation.

● Indentifies the forms of energy and conservation of energy.

Chapter - 10 : Sound

I. ● Sound, production of sound - Propagation of sound -Sound waves types, sound waves -characteristics sound waves -uses

II. (i) ● Understands that sound is a form of energy.
- Explains the characteristics of sound like wave length, amplitude frequency, speed of sound waves
- Calculates time period of wavelength and frequescy are known
- Tells which waves have more energy that produced from the sources that have same amplitude and different frequencies.
- Explains how SONAR works.

(ii) ● Questions about the types of sound waves.
- Tell the changes in the medium caused by longitudinal and transverse waves.
- Imagines the reasons for loudness of sound.

(iii) ● Experiements on reflection of sounds.
- Selects a suitable field to observe echo and experiments.

(iv) ● Collects information regarding the relation between frequesncy speed of sound and wave length.
- Collects and tabulates the information on range of hearing of different animals.
- Collects information about the uses of sound.

(v) ● Draws pictures of propogation of longitudinal and transverse waves.
- Draws the show wave length, amplitude, frequency, compressions, rarefactions crest and troughs.
- Draws pictures showing the working of SONAR.

(vi) Appreciates the efforts of a musician in producing pleasant sounds
- Appreciates the uses of sound.
- Be sensitive to the uses of ultra sound (medicine, industry) in different situations.

(vii) ● Knows the uses of multiple reflections of sound to doctors and engineers.
- Knows the characteristics of sound/music - quality of sound, loudness of sound.

ACADEMIC STANDARDS - X CLASS - PHYSICAL SCIENCE

CHAPTER - I : HEAT

I. Key Concepts

Temperature, Heat, Thermal equilibrium, Specific heat evaporation, Condensation, humidity, dew, fog, boiling, latent heat of vaporization, melting, freezing.

II. Learning outcomes

1. Conceptual Understanding:

- Explains in own words the concepts of heat and temperature.
- Differentiates between the concepts of heat and temperature.
- Gives reasons why thermal equilibrium is explained through temperature.
- Explains specific heat.
- Cites examples for specific heat.
- Explains in own words method of mixtures.
- Gives examples for evaporation and condensation.
- Differentiates between evaporation and condensation.
- Explains boiling, melting and freezing.

2. Asking questions and making Hypothesis

- Makes hypothesis to understand the concepts of heat and temperature.
- Questions to understand the relation between temperature and KE.
- Questions on “Concept of specific heat”
- Questions to understand the difference between boiling and evaporation.
- Questions the reasons of condensation.

3. Experimentation- Field Investigation:

- Experiments to find out specific heat of solids.
- Reports the results.

4. Information skills and Project:

- Collects the uses of specific heat.
- Collects the reasons for using water in nuclear reactors.
- Collects Information on reasons for the harm caused by using dew.

5. Communication through drawing Pictures :

- Draws the graph between time and temperature changes in different states of water.
- Explains drawing pictures whereever necessary.

6. Appreciation and aesthetic sense - values.

- Appreciates explaining daily life situation relevent to temperature.
- Appreciates the wat heat is useful.

7. Application to daily life and concern to bio-diversity

- Applies the knowledge gained in daily life.
- Applies the uses of specific heat - water.
- Takes up the responsibility of conserving biosphere.

CHAPTER - II : CHEMICAL REACTIONS

I. Key Concepts

- Reactants, Products, Exothermic reaction, endothermic reaction, Chemical combination, Chemical decomposition, Displacement reaction, Double displacement reaction, Oxidation, Reduction, Corrosion, Rancidity, Autioxidants.

II. Learning outcomes

1. Conceptual Understanding:

- Explains the types of chemical reactions like chemical combination chemical displacement, Chemical decomposition, Double decomposition etc.
- Explains the methods to be followed in writing and balancing the chemical equations.
- Gives examples for different chemical reactions.
- Gives reasons for chemical reactions taking place between defenite materials.

- Compares and contracts between, Chemical combination, Chemical oxidations and reduction.
- Solves problems based on chemical reactions.

2. Asking questions and making Hypothesis:

- Imagines the products of chemical reactions.
- Questions about the products formed during various chemical reactions.
- Questions about precautions to be taken against corrosion of iron etc.

3. Experimentation- Field Investigation:

- Conducts experiments on formation of baria sulhate precipitate, hydrogen gas, producing Co_2, Electrolysis of water, formation of lead iodide, reduction reaction in copper oxide.
- Conducts experiments to explain concepts of chemical combination, displacement, decomposition, double decomposition, oxidation and reduction.

4. Information skills and Project:

- Collects information related to prepare various substances using different types of chemical reactions.
- Collects information and prepares reports about the methods followed to prevent corrosion of iron.

5. Communication through drawing Pictures:

- Draws pictures showing the arrangement of experiments related to chemical combination, displacement, decomposition, double decomposition, electrolysis, oxidation, reduction.
- Makes models and prepares flow charts to explain the rules followed while balancing chemical equations.

6. Appreciation and aesthetic sense - values:

- Appreciates the chemical nature exhibited by different substances and the products formed by chemical reactions.
- Identifies the wonders in chemical reactions that occur as and in oxidation. reduction, exothermic and endothermic.

7. Application to daily life and concern to bio-diversity:

- Identifies the diversed chemical reaction of substances.
- Applies the results of different chemical reactions in daily life.

CHAPTER - III : REFLECTION OF LIGHT BY DIFFERENT SURFACES

I. Key Concepts

- Angle of incidence, angle of reflection, normal, plane of reflection, lateral inversion, centre of curvature, radius of curvature, pricipal axis, pole, focus/ focal point, focal length, object distance, image distance, virtual image, real image, magnification, fermal principle, mirror formula.

II. Learning outcomes

1. Conceptual Understanding:

- Explains the reflection of light on plane mirror.
- Explains the method of formation of images on a plane mirror with reasons.
- Explains spherical mirron and the terms used in it in own words.
- Explains with reasons the method of formation of images on a sherical mirror.
- Explains the mirror formula.
- Derives mirror formula.
- Explains the need of praxial approximation gives reasons.

2. Asking questions and making Hypothesis:

- Questions about normal and its importance in plane mirror and spherical mirror.
- Imagines drawing normal.

3. Experimentation- Field Investigation:

- Experiments to find out focal length of spherical mirrors.
- Follows the precautions during the experiment.
- Tabulates the information.
- Prepares reports.

4. Information skills and Project:

- Collects information on the impact of spherical mirrors in daily life.

5. Communication through drawing Pictures:

- Draws ray diagrams.

- Makes solar cooker.
- Draws graphs(between u,v)

6. Appreciation and aesthetic sense - values:

- Respects the efforts and method of finding mirrors.
- Appreciates the uses and impact of mirrors.

7. Application to daily life and concern to bio-diversity:

- Applies the knowledge in daily life.
- Uses the formula properly.

CHAPTER - IV : ACIDS, BASES AND SALTS

I. Key Concepts

- Indicator, acid, base, chemical properties of acids and bases common properties of acids and bases, strength of acid or base p^H scale, importance of p^H, common salt, plaster of paris.

II. Learning outcomes

1. Conceptual Understanding:

- Explains different properties of acids and bases, their reactions with metals and non metals.
- Gives examples to acids bases salts and their products.
- Compares and contrasts the reactions of acids and bases with metals and non metals.
- Gives reasons for the strength of different acids and bases. Gives reasons for the formation of salts.
- Analyses the reactivity of acids and bases with metals and non metals.

2. Asking questions and making Hypothesis:

- Understands the p^H scale of acids and bases, neutralisation reaction, strength of acids and bases, products of salt.
- Makes hypothesis regarding the reactivity of acids and bases with metallic and non metallic oxides.
- Makes hyposthesis on the effect of decreasing and increasing of p^H value on different substances.

3. Experimentation - Field Investigation:

- Conducts experiments like reaction of acids and bases with metals, with carbonates, nuetralisation reactions, electrical conductivity of acids, preparation of HCL, identifying p^H.
- Suggest the alternative instruments and their arrangements to conduct the above experiments, prepares the report based on the results and displays.

4. Information skills and Project:

- Collects information about p^H scale, uses of various salts, effect of acids and bases.
- Analyses the tables containing results of reactions of different acids and bases with litmus.

5. Communication through drawing Pictures:

- Draws pictures of reactions of Zn pieces with aqueons HCL, chemical reactions od carbonates, electrical conductivity in salts, crystallization.
- Makes the model of p^H scale.

6. Appreciation and aesthetic sense - values:

- Appreciates the reactivity shown by different substances based on their acidic and basic strengths.
- Appreciates that various acids and bases form salts through neutralisation.
- Identifies that various chemical substances exhibility specially the effects of acids and bases.

7. Application to daily life and concern to bio-diversity:

- Identfies the diversity in the behaviour of different substances as acids bases and neutral substances.
- Uses the reactions of various acids bases, salts and neutralisation in daily life, suggests solution to the problems faced.

CHAPTER - V : REFRACTION OF LIGHT THROUGH PLANE SURFACE

I. Key Concepts

- Refraction, incident ray, refracted ray, angle of incidence, angle of refraction, absolute refractive index, relative refractive index, Snell's law, critical angle, Total internal reflection, Mirage, shift optical fibre.

II. Learning outcomes

1. Conceptual Understanding:

- Explains the concept of refraction
- Explains Fermat's Principle.

- Derives snell law from Fermat's principle.
- Explains the reasons for the formation of mirage.
- Elaborates the reasons for the method of formation of mirage.
- Gives examples for refraction.
- Explains the need for refraction through a glass plate/slab
- Explains the need for Snell's rule.
- Explains with examples Total Internal Reflection.

2. Asking questions and making Hypothesis:

- Questions to clear the doubts arised while deriving snell's law.
- Makes hypothesis before analysing the results of experiments.
- Makes hypothesis about the refraction through glass slab estimates the results.

3. Experimentation- Field Investigation:

- Proves through experiment that the values of Sin i/ sin r is constant.
- Takes necessary precautions to conduct the experiments.
- Prepares the report on the results of experments.

\4. Information skills and Project:

- Conducts some projects (Refractive index, total internal reflection)
- Collects information related to the results of refraction.

5. Communication through drawing Pictures:

- Draws pictures explaining refractions.
- Draws pictures explaining Total Internal Reflection.
- Expresses the glass experiment through a picture.

6. Appreciation and aesthetic sense - values:

- Appreciates the method of formation of mirage.
- follows values.

7. Application to daily life and concern to bio-diversity:

- Uses the knowledge of refraction refractive index, Total Internal reflection.

CHAPTER - VI : REFRACTION OF LIGHT THROUGH CURVED SURFACE

I. Key Concepts

- Lens, Focal length, focus, optic centre, Principal axis, radius of curvature, centre of curvature.

II. Learning outcomes

1. Conceptual Understanding:

- Explains refraction of light through curved Surfaces based on the knowledge of refraction of light through plane surfaces.
- Explains the terms to be used for refraction through curved surfaces.
- Explains lens and its types.
- Explains the principles involved in drawing ray diagrams for lens.
- Elaborates the reasons behind principles of drawing ray diagrams.
- Explains in his own words how to draw a ray diagrams.
- Gives reasons for the characteristics of images in ray diagram.
- Derives lens formula.
- Derives Lens makers formula.

2. Asking questions and making Hypothesis:

- Questions the derivation of formula at curved surface.
- Imagines the approximation while deriving
- Predicts the results of experiments with lens.
- Questions on drawing of ray diagrams.
- Questions to clear the doubt that the focal length of an object immersed in water depends on its surroundings.

3. Experimentation- Field Investigation:

- Finds out the focal length of lens through an experiment.

- Follows the precautions while experimenting with lens.
- Submits the report with the results.

4. Information skills and Project:

- Collects the information regarding lens
- Analyses the information.
- Prepares new projects.

5. Communication through drawing Pictures:

- Draws ray diagram of lens formula.

6. Appreciation and aesthetic sense - values:

- Appreciates the lens maker formula
- Conserves values

7. Application to daily life and concern to bio-diversity:

- Applies the knowledge of lens to overcome daily life problems.

CHAPTER - VII : HUMAN EYE AND COLOURFUL WORLD

I. Key Concepts

- Least distance of a distinct vision, Angle of vision, Accomodation of eye lens, myopia, Hypertropia, Presbyopia, Power of lens, Prism, Angle of Prism, Angle of minimum deviation, Dispersion, Scattering.

II. Learning outcomes

1. Conceptual Understanding:

- Explains angle of vision, accomodation and structure of an eye.
- Explains least distance of distinct vision.
- Explains defects of vision with reasons.
- Explains accomdation of lens.

- Explains dispersion with reasons.
- Explains with reasons how to avoid deflects of vision.
- Explains the method of formation of RAINBOW.
- Explains scattering.

2. Asking questions and making Hypothesis:

- Questions how the eye works.
- Questions to know the reasons for colour in RAINBOW.
- Questions to get a clear idea of scattering.

3. Experiments with prism to find out refractive index.

- Does new activities on dispersion

4. Information skills and Project:

- Collects information regarding scattering dispersing and other reflections.
- Collects the information on uses of prism.
- Collects information about C.V. Raman's research.

5. Communication through drawing Pictures:

- Draws diagram showing structure of eye.
- Draws diagram on deflects of eye and the methods preventing them.
- Expresses understanding with the help of above diagrams.
- Draw diagrams of prisms experiment.
- Draws graph based on the values got in prism experiment.
- Analyses the graph.

6. Appreciation and aesthetic sense - values:

- Appreciates the working of an eye.
- Avoids the behaviour that affects other eyes.
- Sympathises people with vision defects

- Appreciates the formation of RAINBOW and its explanation with concept of waves.
- Shows interests in aspects related to light.

7. Application to daily life and concern to bio-diversity:

- Solves daily life problems with efficiency. -Realises the responsibility of donating eyes.
- Ds
- Realises the responsibility of donating eyes.
- Explains scattering.
- Explains accomodation of lensExplaExplainsd

CHAPTER - VIII : STRUCTURE OF ATOM

I. Key Concepts

- Wave, Spectrum, intensity, discrete energy, line spectrum, orbital quantum numbers, shell, sub-shell, electron spin, electronic configuration, the Pauli's exclusion principle, Aund's rule, stable electronic configuration

II. Learning outcomes

1. Conceptual Understanding:

- - Explains wave nature of light, electromagnetic spectrum, atomic models of Bohr. Sommerfield, Quantum theory, structure of electron (Principles Explaining in it)
- Gives examples of different quantum numbers.
- Uses the Paul's Aufbau's and Hund's rules as per the situation.
- Compares and contrasts the atomic models of Bohr and Sommerfield.
- Gives reasons for light exhibiting wave nature.
- Writes electronic configuration based on Mohler's chart imagines energy levels.
- Explains the equations of electronic spectrum _____

2. Asking questions and making Hypothesis:

- Questions to about electromagnetic spectrum, different atomic spectra and quantum numbers.

- Imagines the electronic configuration and energy levels based on the values of n.l.m.
- Imagines the next energy leves as per the rules of Aufbau, Pauli, Hund.

3. Experimentation- Field Investigation:

- Comments on structure of atom based on electro magnet and hydrogen spectrum.
- Discusses the highlights and results of ecperiments related to the atomic theories proposed bt Bohr and Sommerfield.

4. Information skills and Project:

- Collects and prepares a news report about the experiments of Bohr, Sommerfield, Max planck.
- Fills the table of electronic configuration of various elements.
- Prepares tables of electronic configuration of various elements.

5. Communication through drawing Pictures:

- Draws rough diagrams of Bohr and Sommerfield models of atomic structure.
- Prepares flowcharts to know the electronic configuration.

6. Appreciation and aesthetic sense - values:

- Appreciates the wonders in electromagnetic spectrum.
- Appreciates the discoveries explaining the internal structure of the tinies atoms.
- Appreciates the aspects not proved by experiments are proved using mathematical principles.

7. Application to daily life and concern to bio-diversity:

- Identifies the diversity in the micro world.
- Uses Mohler;s diagram to write electronic configuration of other elements based on quantum number.

CHAPTER - IX : CLASSIFICATION OF ELEMENTS : PERIODIC TABLE

I. Key Concepts

- Trial, Octave, Periodic law, Periodic table, Period group, Lanthanides, Actinides, Element family, Metalloids, Periodicity, Atomic radius, Ionisation energy, Electron affinity, Electronegativity, Electropositivity

II. Learning outcomes

1. Conceptual Understanding:

- Explains Dobernair's law if Triads, Newland's law of Octaves, characteristics of Modern periodic table.
- Classifies elements on the basis of atomic number and electronic configuration.
- Explains the difference between Mendeleef's periodic table and the modern periodic table.
- Gives reasons why different exhibit same characteristics as per Dobernair's and Newland's theories.
- Analyses the changes in atomic radius, atomic volume, ionisation energy, electron affinity in the periodic table.
- Analyses equation.

2. Asking questions and making Hypothesis:

- Quesitons why elements exhibit common characteristics though they are special when compared to other elements.
- Discusses Mendeleef's hypothesis and proof's in a later period.
- Makes hypothesis on the properties of elements based on periodicity.

3. Experimentation- Field Investigation:

- Discusses Dobernair's triads Newlands Octaves, Mendeleef's Periodic law.
- Discusses the basis for the changes across a group-period.

4. Information skills and Project:

- Collects and analyses the information on elements hypothesised by Medeleef.
- Tabulates and displays the information related to the characteristics exhibited by different elements to periods and groups based on periodic table.
- Collects and displays the additional information needed to explain ionisation energy and electron affinity.

5. Communication through drawing Pictures:

- Prepares flow charts to explain periodic rules of Dobernair, Newlands and Mendeleef
- Prepares block diagram, flow charts to show the characteristic of modern periodic table.

6. Appreciation and aesthetic sense - values:

- Appreciates that different elements in nature exhibit diversified characteristics.
- Appreciates that Mendeleef's hypothesis became true that elements are arranged in an order.

7. Application to daily life and concern to bio-diversity:

- Identifies the diversity displayed in the arrangement of elements having different characteristics.
- Identifies the relation between groups and periods in periodic table and also the properties of elements
- Uses rules of periodic table in solving chemistry problems.

CHAPTER - X : CHEMICAL BONDING

I. Key Concepts

- Electrons, nobles gases, lewis dot structures, octet rule, chemical bond, Ionic Bond, Covalent Bond, cation, anion, electro static force, electrovalent polar solvent, formula of molecules, ionic compounds, covalent compounds, electro positive character, electro negative character, polar bonds, bonded pair of electrons, Ionic pairs, bond length, bond energy, shape of the molecule, linear, tetrahedral, properties of ionic and covalent compounds.

II. Learning outcomes

1. Conceptual Understanding:

- Explains Lewis dot structure, rules of ionic and covalent bond, properties of matter, octet rule, molecular structure of water, ocygen valence bond theory, hyridisation.
- Differentiates between molecules of water and ammonia, ionic bond and covalent bond, sp-sp^2 and hybridisation.
- Explains the reasons for bond angle of molecules and their properties.
- Explains giving reasons for the stability of molecules, following the Octet rule and to participate in chemical bond.
- Comments on the molecular structure through the concept of hybridisation.

2. Asking questions and making Hypothesis:

- Questions to understand Lewis dot structure, properties of ionic and covalent substances and molecular structure.
- Makes hypothesis on the shapes of orbitals and the resultant molecular strucuture when participated in chemical bond.

- Imagines the shape of hybridised orbitals formed through hybridisation.
- Makes hypothesis on the consequences if bond angle of water is 108^{o}

3. Experimentation- Field Investigation:

- Uses rules of chemical bonding to explain molecular structure through hybridised orbitals.
- Discusses the fundamentional aspects of Lewis dot method.
- Discusses Chemical bond and the resultant shape molecules and bond angle.

4. Information skills and Project:

- Collects the information about nature of substances, arrangement of molecules, bond angles and reasons for the bonds formed by bond angle.
- Collects the necessary information on relation between hybridisation and the shape of orbitals, prepares reports on it.

5. Communication through drawing Pictures:

- Draws pictures of molecular structures, method of formation of ionic and covalent bond through Lewis dot method.
- Analyses the molecular structures based on hybridisation.
- Makes models of shapes of molecules using sticks and beads.

6. Appreciation and aesthetic sense - values:

- Appreciates the formation of molecules through ionic and covalent bond.
- Appreciates that fact that some basic atoms in nature combine.
- Observes the special properties and nature like salt dissolves in water and not in kerosene, visualising the rules of chemical bonding.

7. Application to daily life and concern to bio-diversity:

- Identifies the diversity in substances being ionic or covalent.
- Uses the rules of chemical bonding in writing, balancing the chemical equation - solves the problems.

CHAPTER - XI : ELECTRIC CURRENT

I. Key Concepts

- Charge, potential difference, Electric current, multi-meter, Ohm's law resistance, Resistivity, Kirchoff's law's, Electric power, Electric energy.

II. Learning outcomes

1. Conceptual Understanding:

- Explains electric current in his own words
- Explains the difference between electric conductors and non conductors.
- Explains Drude and lorentz theory to explain electric current.
- Elaborates the reasons for electric current.
- Explains the difference between electric current and potential difference.
- Explains ohm's law.
- Explains on what values does the value of resistance depends.
- Explains series and parallel connections.
- Explains equivalent resistance.
- Explains electric shock, overloading, electric unit.

2. Asking questions and making Hypothesis:

- Quesitons method of wiring a house.
- Questions on overload.
- Makes hypothesis on how to solve problems on kirchoff's rule.

3. Experimentation- Field Investigation:

- Experiments to prove that resistance depends on temperature, nature of substance, length of the conductor and cross section area.
- Follows the precautionary measures while conducting experiments.

4. Information skills and Project:

- Collects information related to the reasons for resistance.
- Collects additional information on electric shocks.
- Collects information on role and making of fuse.

5. Communication through drawing Pictures:

- Draws diagrams showing the method of working of a battery communication through them.
- Draws diagrams of series and parallel connections.
- Draws diagrams showing the movement of electrons in conductor.

6. Appreciation and aesthetic sense - values:

- Appreciates the behaviour of electron which causes electric energy.
- Tries to prevent loss of electric energy.
- Implies aesthetic sense to the behaviour of conductors.

7. Application to daily life and concern to bio-diversity:

- Uses the concepts of electricity in daily life.
- Selects the proper to be used for fuse.
- Search and follows the ways to use electricity properly as it is the backbone of nation's development.

CHAPTER - XII : ELECTRIOMAGNETISM

I. Key Concepts

- Magnetic flux, magnetic flux density, electric motor, slip rings, induced current, induced EMF, electric generator, DC and AC currents, Rms values.

II. Learning outcomes

1. Conceptual Understanding:

- Explains Oersted's experiment.
- Explains electro magnetic field and the importance of its features.
- Explains magnetic flux density using the concept og magnetic lines of force.
- Elaborates that electric wires can induce magnetic field.
- Explains right hand rule.
- Explains that a charged, electrical wire moving in magnetic field is acted upmE by force.
- Derives F=BIL.

- Elaborates the working of electric motor and electric generator.
- Explains through a situation relation between Faraday's principle and law of conservation of energy.
- Explains how to derive Faraday's principle from law of consevation.

2. Asking questions and making Hypothesis:

- Makes hypothesis and questions to explain Dersted's experiment.
- Maked hypothesis on how magnetic field induces force on moving charges.
- Questions on law of conservation of energy, Faraday's principle.
- Questions on what to do to make the electricity move round the wire in a motor.
- Questions about electric generator.

3. Experimentation- Field Investigation:

- Experiments to explain Faraday's principle.
- Conducts experiments to show that magnetic field induces force on electrified wire.

4. Information skills and Project:

- Collects information about Faraday's experiment.
- Collects information about Oersted's experiments.
- Collects additional information regarding electric motor and electric generator.

5. Communication through drawing Pictures:

- Draws picture on electric motor.
- Draws pictures of electric AC and DC.
- Draws necessary graphs to explain AC DC generators.

6. Appreciation and aesthetic sense - values:

- Appreciates the experiments of Oersted and Faraday.
- Appreciates working of electric motor and generator.
- Appreciates usefulness of law of conservation of energy.

7. Application to daily life and concern to bio-diversity:

- Uses generators and motors properly and also their theory.
- Solves the given problems.
- Puts efforts to save the labour of persons who invented electric motor and generator.

CHAPTER - XIII : METALLURGY

I. Key Concepts

- Minerals. ores, froth flotation, thermite process, distillation, poling, liquation, electrolutic refining, smelting, roasting, calcination blast furnace, reverberatory furnace.

II. Learning outcomes

1. Conceptual Understanding:

- Explains the basic forms(minerals) in which metals are avaible, methods of seperating the metals, refining them and processes like smelting and roasting used in extraction of metals.
- Classifies minerals based on their reactivity, methods of separating and methods of refining.
- Explains the reasons for non-availability of free metals in nature separating them using mechanical methods, conducting reduction reactions to get metals and for using furnace.
- Differentiates between metal and minerals, blast furnace and reverbatory furnace.
- Analyses the chemical reaction in chemical extraction.

2. Asking questions and making Hypothesis:

- Questions the stages in separating and refining the metals.
- Makes hypothesis on the reasons for the appearance of mineral in many forms in nature.
- Predicts the results of oxidation and reduction reactions of metals.

3. Experimentation- Field Investigation:

- Experiments on rusting and using electrolysis in purification of copper.
- Discusses the separating the ore through mechanical methods stages and methods of using different types of furnaces.

4. Information skills and Project:

- Collects information about the areas in out state and India as where various ores are found prepares a report.
- Prepares reports analysing the reasons for the occurence of ores in different forms and their stability.
- Prepares a scrap with particulars of the minerals available in their surrondings like coal, limestone etc.

5. Communication through drawing Pictures:

- Draws the pictures of separating the minerals, electrolysis, furnaces etc. and comments on them.
- Draws pictures blowing the actions taking place in reverberating.

6. Appreciation and aesthetic sense - values:

- Appreciates that metals are present in the form of ores in nature.
- Shows interest in knowing the details of methods and equipments designed to extract different types of minerals.
- Appreciates persons and systems who are involved in extracting and refining minerals, production of metals and making many instruments and objects from them.

7. Application to daily life and concern to bio-diversity:

- Discusses on the process of extracting and its impact on environment.
- Suggest the measures for conserving bio-diversity by analysing mining and movements and struggles related to it.
- Co-ordinates the information from the lessons, chemical bonding and chemical equations to understand the chemical reactions taking place in a furnace, reactivity of metals and repeating the ores.

CHAPTER - XIV : CARBON AND ITS COMPOUNDS

I. Key Concepts

- Hybridisation, allotropy, diamond, graphite, buckminsterfullerene, nanotube, catenation, tetravalency, hydrocarbons, alkanes, alkene, alkynes saturated hydrocarbone, unsaturated hydro carbons, functional group, isomerism, homologous series, nomenclature, combustion, oxidation, addition reaction, substitution reaction, ethanol, ethanoic acid, ester, esterification, saponification, micelle.

\II. Learning outcomes

1. Conceptual Understanding:

- Explains about cantenation property exhibited by carbon method of hybridisation, allostsopes of carbon, graphite, diamond, buckmisnsterfullerene, nanotubes, hydrocarbons, their reactivities, functional group in carbon compounds method of nomenclature, products of soaps.
- Gives examples for different forms of carbon alkanes, alkenes, alkynes.
- Gives examples for carbon exhibiting catenation property and the functional groups changing the nature of substances
- Differentiates between different carbon forms their oxidation and reduction reactions sp, sp2, sp3 identifies similarities between diamond graphite, alkened alkanes.
- Analyses addition and substitution reactions of carbon compunds.

2. Asking questions and making Hypothesis:

- Questions to understand clearly nature of carbon catenation, method of nomenclature forms and structure of hydrocarbons.
- Makes hypothesis abour different hydro carbons based on functional groups and steps in nomenclature.
- Imagines the discoveries in future through catenation nature of carbon.

3. Experimentation- Field Investigation:

- Conducts activities to understand foam of a soap cleansing micelle and its nature.
- Experiments on esterification.
- Names carbon compounds following the 11 steps, writes formula based on the name.
- Discusses the methods and stages of hybridisation exhibited by carbon based on energy levels.

4. Information skills and Project:

- Tab prepares tables on catenation of carbon, formation of plenty of products like alkenes, alkynes etc.
- Prepares reports on modern aspects like nanotubes, their uses and discovery of graphic.
- Prepares a news letter about preparation and uses of ethyl alcohol displays and discusses.

5. Communication through drawing Pictures:

- Draws pictures of carbon catenation, hybridisation, micelle, preparation of estes and explains about them.
- Prepares shapes of different hydrocarbons using beads and sticks based on nomenclature and exhibits them.
- Prepares flow charts on the preparation of hydrocarbons.

6. Appreciation and aesthetic sense - values:

- Appreciates formation of many substances by an element carbon through its nature of catenation.
- Congratulares the specialities of different atoms in reacting with carbon (Keeping in view the nomenclature)
- Identifies the greatness of carbon in producing a new substance and by products through a slight change.

7. Application to daily life and concern to bio-diversity:

- Identifies the importance and diversity of carbon displaying different types of reactivities bestowing many benefits.
- Applies the concepts of chemical bonding and electronic configuration wherever necessary to understand carbon catenation.
- Co-ordinates the principle behind cleansing by soaps and the usefulness of bond angle and shape of water in cleansing.

6 Teaching Learning Strategies

However best the textbook may be made, the key factor for effective teaching is the method adopted by the teacher to teach it. The teaching learning activities designed by the teacher to achieve the targeted academic standards affect the learning process of the children. Hence, they should be designed in such a way that they make learning science an enjoyable activity. Let us see what a teacher should do in teaching a lesson and what a student should do in learning it.

What should the teacher do before teaching a lesson?

The teacher should:

- Identify the targeted academic standards of the unit
- Get ready to conduct the activities given for the achievement of the targeted academic standards and also develop some supplementary activities if required
- Collect or ask children to collect required information/material to conduct the activities
- Collect additional information through internet and reference books and be ready with good understanding of the concepts
- Prepare required worksheets, tables, information, etc., related to experiments or field visits. S/he should identify the information centres, areas and people and be ready with phone numbers and mail addresses. Permissions from appropriate authorities should also be obtained beforehand.
- Develop interesting problems / thought provoking questions that motivate children to learn the lesson
- Allocate some periods (while allocating periods for the unit) for the practice session given towards the end of the unit

What should the teacher do / bear in mind while teaching a lesson?

The teacher should:

- Conduct the class in such a way that children participate in all the activities in the lesson voluntarily and happily with a lot of interest
- Give priority to simple experiments, activities, field visits, etc., which develop thinking skills and observation skills in children.
- Link the concepts in the lesson with the real life situations / events
- Bear in mind the following while teaching a lesson

The teacher should:

- Write the name of the lesson on the blackboard and let children do mind-mapping
- Make children read individually the introduction(story, situation, question) of the unit
- Conduct discussion on the items given in introduction through probing questions
- Make children envisage solutions to the problems by encouraging them to read and discuss the activities
- Encourage children to do activities on their own to check the validity of their assumptions. The results of such activities should also be discussed
- Discuss the tables or worksheets meant for the collection of data/material and give children opportunities to fill them in individually
- Conduct discussion among children based on the analysis of the tables so as to enable them to make conclusions
- Encourage children to draw pictures, to mark the parts, to discuss what each part does, to elaborate a process, etc., wherever required
- Make children develop models / working models, wherever necessary, and encourage them to exhibit them. The required materials for this can be supplied by the teacher, or, the children can be asked to collect them.
- Make children read sections like 'Think and Discuss', 'Do You Know', 'annexure', 'stories', etc., and discuss their contents enabling them understand and appreciate science concepts
- See that children talk and elaborate the key words and concepts
- Discuss with children each item under ¡¥What we have Learnt¡¦
- Encourage children to think, participate voluntarily and to respond individually to the items given under the heading ¡¥Improve Your Learning¡¦. The projects can be given as a group work and enough time should be given to do them. The teacher should cooperate with the children by giving suggestions, guidance and by giving additional information through experiments and other things
- Use the information given in the annexure according to the situation

What should the teacher do after teaching a lesson?

The teacher should:

- See that children do the activities and projects given at the end of the lesson
- See that children collect information related to the lesson from library, magazines, and their surroundings
- Record children¡¦s thoughts, interesting things, doubts, etc., related to various concepts of the lesson
- See that the above items are exhibited on the wall magazine
- Give suitable instructions to children so as to enable them to apply what was learnt to real life situations
- Identify the concepts that children did not understand, and develop suitable activities to enable them learn those concepts
- See that all children achieve the targeted academic standards

Let us observe some of the important teaching learning stratagies :

- Discussions - Responses
- Reading the lesson
- Asking questions
- Conducting experiment
- Enquiry and problem solving
- Project work
- Field investigations
- Information skills - Data collection, Analysis - Tabulation
- Report writing
- Quiz
- Seminar
- Symposium
- Puzzles

- Drawings, making models, plotting graph
- Collection of scientific stories, Rhymes
- Preparation of cartoons
- Conducting lecture the eminent personalities
- Interviews
- Preparation of substitute aparatus, conducting substitute experiments
- Utilization of library and internet.

What steps should be followed while teaching a lesson?

To achieve the targeted academic standards in science, children should be made partners in learning activities. Process skills and scientific thinking should be developed in them by motivating them. They should be motivated towards learning the lesson by asking them some probing questions. Then they should be encouraged to do mindmapping. Simple experiments, activities and projects should be conducted to help them have a good understanding of the concepts. Science concepts should be linked with the real life situations and events. Let us see what steps are to be followed while teaching a lesson.

Steps:

1. Mind mapping – Probing Questions
   - A. Greeting
   - B. Mind mapping
   - C. Motivating/Probing questions
2. Reading the textbook – Recognising the key words
   - A. Reading the lesson – recognizing the key words
   - B. Discussion in groups, teacher's explanation on the board
   - C. Motivating children to ask questions on the lesson
3. Comprehension of concepts – Doing Activities – Discussion

4. Demonstration – Discussion

5. Conclusion – Evaluation

> The importance of the lesson, the objectives of the lesson or the targeted academic standards of the lesson should be discussed only in the first period.
>
> Targeted Academic standards: Efforts should be made to achieve the seven academic standards specified for science, so the objectives should be decided keeping in view the components the lesson focusses on.
>
> Importance of the lesson: The importance of the lesson should be made clear to children answering the questions 'Why should they learn this lesson?' and What use is it to them?' This helps children understand why they are learning that lesson.

1. Mind mapping:

The teacher should write the title of the lesson on the blackboard and invite the children's concepts, opinions, examples, characteristics, properties, etc. S/he should ask probing questions, make children think about the key concepts of the lesson and contribute to mind mapping through interaction. The teacher should motivate children and get them ready to learn the lesson through this activity

2. Reading the textbook – Recognising the key words

The teacher should ask children to read that part of the lesson which is to be taught in that period according to the syllabus. As they read the lesson, the teacher should make them identify difficult to understand new concepts and terms, write them on the blackboard and encourage children to discuss them. S/he can explain wherever necessary.

3. Comprehension of concepts – Doing Activities – Discussion

Children have to ask a lot of question to understand the concepts of the lesson and to clear their doubts. They have to make assumptions/hypotheses to solve problems and then do experiments to verify whether they are valid or not. They have to take up projects that call for process skills in collection as well as analysis of information.

Children should express their comprehension of the concepts in a multiplicity of ways: by drawing pictures and marking the parts, by drawing the arrangement of apparatus in the experiment and describing the process, by drawing flowcharts and pictures showing processes and observations, and by making models, alternative apparatus / improvised apparatus. These should be used to enable children to develop appreciation towards scientific principles,

real life situations, scientific inventions / discoveries, recognize the importance of biodiversity and an awareness to protect the environment. The activities should help children apply the scientific knowledge acquired to real life situations. To make children comprehend concepts of the lesson, the following activities should be conducted in the classroom:

1. Experiments
2. Projects and field visits
3. Data collection and tabulation
4. Analysis of the data and making conclusions
5. Conduct of interview, quiz, seminar, symposiums
6. Writing reports on the observations/experiments conducted
7. Drawing pictures / graphs related to observations/experiments
8. Drawing diagrams, marking the parts and explaining
9. Making models
10. Reading stories, historical events, researches
11. Making posters, logos, cartoon and writing essays, songs, stories
12. Conduct of wall magazine, children's diary, school magazine, theatre day, meeting of the cultural society

(Note: The teachers should collect and get ready before hand with all apparatus, tools and other things required to conduct activities)

4. Demonstration - Discussion

Children participate in various activities to comprehend the concepts. They also design/develop/prepare a number of items. All these items should be discussed and displayed in the classroom. The main points should be written on the blackboard and children's work should be analyzed based on them. A number of thought provoking questions that help to do analysis and discussion should be written on the blackboard.

5. Conclusion - Evaluation

Towards the end of the lesson, the teacher should give scope for children to revise what they have learnt in the unit. This can be done in many ways. S/he can revise and conclude herself/himself or ask a student to do it individually. Alternatively, s/he can ask children to take turns and revise the items one by one.

Evaluation should be done in two ways - as an intricate part of the teaching learning process and at the end of the lesson.

- Evaluation should give scope for a wide variety of responses /answers
- The activities under the headings 'Discuss in groups', 'write what you have observed', 'Fill the table', etc. should be done as integral part of lesson (Formative Assessment) which means teaching a lesson and evaluation go hand in hand
- Evaluation should be done according to the situation but not according to a fixe schedule
- Children should be asked to give their opinions and conceptual understanding and explain
- The contents under the heading 'What we have learnt' regarding the lesson taught should be discussed in groups. Then children should be asked to write their responses individually
- The children should be asked to do the contents under 'Improve your learning' individually
- The notebooks and worksheets of children should be checked/verified either by the teacher or by the other students
- The teacher should design/develop some activities for homework

VIII CLASS - PHYSICAL SCIENCE - SYLLUBUS

Theme : Moving objects **Name of the Lesson : Force**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
1.	Force Types of forces A) Contact forces 1. Muscular force 2. Force of friction 3. Normal Force 4. Tension B) Field Forces 1. Magnetic force 2. Exlectro staticforce 3. Gravitational force ● Field concept ● Net force ● Effect of force on the state and direction of an object ● Other effects of force ● Pressure	● Filling the talbe of daily life incidents ● Listing daily life situations where muscular force is used. ● Observing the changes in muscles while doing different works ● Observing the motion of a ball on different surfaces. ● Observing the motion of objects on an inclined plane ● Conducting an experiment to find the limiting force that can be borne by a string ● Conducting an experiment to make ● Needle magnets ● Observing electrostatic forces with the help of charged balloon and pieces of paper ● To identify gravitational force in daily life situations ● Making magnetic field with a barmagnet ● Identifying net force on an object in different situations ● Inferring netforce with the thelp of FBD ● Observing the effect of force on state and direction of objects in daily life situations in daily life situations ● Completing the table whether the change in shape of an object is temporary or permanent when force ● Observing the relation between force and area when acted upon by force	● Recording, giving examples observing ● Making a list ● Observing analysing ● Observing analysing ● Experimenting making hypothesis ● Observing ● Experimenting ● Inferring ● Observing ● Observing ● Inferring ● Observing ● Inferring ● Analysing ● Recording ● Analysing

Name of the Lesson : Force

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
2.	- Force of friction types - Varoatopm pf froctopm - Factors affecting fraction - Increasing and decreasing friction	- Concting an activity to show sliding friction - Conducting experiment to understand - Static friction - Conducting an activity - To conduct experiments to identify the effects of irregular surface are of contact and normal force. - To discuss the daily life incidents through which force of friction is increases or decreased. Slidingfriction through - To discuss the / daily life incidents	- Conducting periments - Analysing - Observing - Analysing, Making hypothesis and Conducting experiments - Analysing and inferring giving examples - Analysing - Analysing

Theme : Substances **Name of the Lesson : Synthetic fibres & Plastics**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
3	Natural and synthetic fibres, objects made by them Making of senthetic fibres Symbols of recycling 6 types of plastic Uses of plastic Plastics and environment	- Tabulating the different / objects in our classifying them on the basis of their resource - Conducting burning test to identify fibres - Discussing how nylon is made - Experimenting to know how strong is nylon - Discussing how rayon is made. - Discussing how acrylic and polyster are made and their uses. - Collecting various articles with recyding - Conducting flame test to identify thermo Observing and discussing thermo plastic and thermo setting plastics things we use. - Discussing uses of plastic - Discussing the impact of plastic wastes on on environment - Discussing the measures to decrease the harmful effects of plastic waste	- Collecting information - Classification, observation - Experimentation, Analysis - Inference - Experimentation, Recording the result - Inference - Collecting informath experimentation - Analysis, recording the results - Inference - Observation, Discussion Analysis - Discussion, Analysis Collecting - Collecting information Analysis, - Discussion - Analysis, Discussion collecting information

Theme : Substances		Name of the Lesson : Metals and Nonmetals	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
	Physical Properties of metals and non metals		
	● Appearance	● Recording the colour and appearance of metals and nonmetals by observing them	Observing comparing recording
	● Sonority	● Observing and tabulating the sounds produced by different substance.	● Recording ● Comparing
	● Malleability	● Conducting the experiment to test the malleability of different substances by beating them with a hammer.	● Experimenting
	● Ductility	● Tabulating the observations on different materials whether they can be used to make wires.	● Reconding analysing comparing
	● Electrical conductivity	● Conducting the experiment to test the electrical conductivity of different materials	● Experimenting ● Analysing, inferring
	● Conduction of heat	● Experimenting to observe the heat conductivity ● Tabulating and analysing the physical properties of metals and non metals	● Experimenting, analysing ● Recording analysing inferring
	● Chemical properties of metals and non metals		
	● Reaction with oxygen	● Observing by experimenting the reactions of metals and non metals with oxygen	● Experimenting observing recording discussing
	● Reaction with water	● Experimenting to know the reaction of metals and non metals with water	● Experimenting observing, discussing inferring.
	● Reaction with acids and non metals with acids	● Experimenting to know the reaction of metals inferring	● Experimenting observing, discussing
	● Reactivity of metals	● Experimenting to understand the reactivity of metals	● Experimenting, recording, analysing omferromg
	● Uses of metals and non metals	● Discussing the uses of metals and non metals ● Completing the table by identifying metals and non metals among the chemicals in the lab	● Discussing ● Observing, inferring recording

Theme : How things work **Name of the Lesson : Sound**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
6.	● Articles - Materials used in making them	● Duscussing and preparing a table on what were the materials used in past and what are the materials usedrow to make different articler used in different situations.	● Collecting information ● Recording ● Analysing
		● preparing and exhibiting the table showing the sources of different substances	● Collecting information ● Recording
	● Exhaustible energy	● Identifying and classifying various energy resources available in our surroundings as exhaustible and nonexhausble. Tabulating and displaying them.	● Classifying recording
	● Coal, petroleum natural natural gas as fuels	● Discussing the situations where coal petroleum and natural gas are used as fuels	● Collecting information
		● Discussing various uses of petroleum and natural gas, displaying the information	● Collecting infromation recording discussing
		● Tabulating & displaing uses of various petroleum products.	● Collecting information recording
	● Coal Coke, Coaltar	● Tabulationg and displaying the uses of cake coaltar and coal gas	● Collecting information recording
		● Conductng an experiment to prove that the gas	● Experimenting observing inferring
	● Natural gas, petrochemical products	● Discussing uses of petro chemical products	● Analysing the information
	● Formation of coal and Petroleum	● Discussing the formation of coal and petroleum	● Analysing the information
		● Discussing misure of energy resources - consequences, methods of conservation	● Colleting information, analysis
	● Precautions while using	● Discussing the precautions to be taken while using fuels for various purposes.	● Collecting information, discussing

Theme : Natural Resources	Lesson Name : Bio diversity its conservation

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
	● Combustilde substances	● Experimenting to the combustible nature of different substances - recording the results	● Experimenting observing ● Recording
	● Combustion	● Conductly an experiment to prove that oxygen fair is necessary for burning	● Experimenting, observing, inferring
	● Ignition temperature	● Experimenting to understand ignition temperature	● Experimenting observing inferring
	● Combustion - types	● Observing and discussing various types of combustion in daily life situations.	● Collecting information
	● Fuels	● Tabulating different fuels by classifying them into solid, liquid and gaseous fuels	● Collecting information ● Classifying, recording
	● Fire control	● Discussing various methods of controlling fire discussing various materials used to control fire	● Collecting information ● Discussing
	● Flame	● Observing and tabulating the burning nature of different solids.	● Observing, recording analysing
	● Structure of a flame	● Observing, drawing the labelling the structure of a flame ● Observing through an experiment what happens in different zones of a flame	● Observing drawing ● Experimenting observing analysing

Theme : Theme	Name of the Lesson : Electrical conductivity of liquids

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
8.	● Electrical conductivity of solids ● Electrical conductivity of liquids ● Converting poor ● Chemical effect of electric current ● Making of a cell ● Electroplating-leses	● Knowing through an experiment the electrical conductivity of different solids and recording ● Knowing through an experiment the electrical conductivity of different liquids and recording ● Experimenting to convert poor conductor into good conductor, recording the results ● Experimenting to understand the chemical effect of electric current ● To know the method of making of a cell through an experiment ● Discussing the uses of electroplating	● Conducting experiment ● Observing, inferring recording. ● Conducting experiment ● Observing, inferring recording ● Conducting experiment ● Observing, inferring recording ● Experimenting observing observing ● Experimenting observing, discussing

Theme : Theme	Name of the Lesson : Some natural phenomena

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
	● Lightiening	● Discussing the aspects known to ancestors about lighteining	● Collecting information discussing
	● Electrical charges	● Knowing the changes due to friction in various objects through an experiment and recording the changes.	● Experimenting observing recording
		● Knowing the effect of charge formed on objects through an experiment and recording the results	● Experimenting observing recording
	● Charge	● To know the attraction and repulsion between charges through an experiment	● Experimenting observing, inferring
		● Finding the cahrge on an object through an experiment	● Experimenting observing, inferring
	● Transfer of charge	● Realising the transfer of charge from an object to another object through an experiment	● Experimenting observing, inferring ● Experimenting observing, inferring
		● Discussing the precautions to be taken during lighting	● Collecting information discussing
	● Lighting conductors	● Discussing the working of lighting conductors	● Collecting information discussing
	● Earth quakes	● Collecting infromation about the losses incurred due to earthquaces happen	● Collecting information discussing
		● Identifying the earthquake effected areas in a map	● Collecting information
		● Discussing the method of confirming the intensity of earth quakes	● Discussing
	● Earthquakes precautions	● Discussing the precautions to be taken during earth earthquakes - displaying the information	● Collecting information ● Discussing

Theme : Theme **Name of the Lesson : Some natural phenomena**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
10.	Identifying the season and time by shadows	● Observing the changes in the length of shadow of objects formed due to sunlight	● Experiment observing, inferring
		● Observing the North - South movement of the sun and drawing pictures	● Experimenting drawing pcturers observing inferring
	● Sundial	● Making sun dial	● Making models
	● Phases of moon	● Observing phases of moon, drawing pictures experimenting to know why phases of moon are formed	● Observing, drawing pictures ● Experimenting, comparing observing & drawing pictures
	● The surface of the moon	● Discussing about the surface of moon	● Discussing
	● Eclipses-types	● Discussing about the types of eclipses	● Discussing
		● Discussing the reason for occurence of solar eclipse with the help of a picture	● Analysing the information drawing the picture
	● Stars	● Observing the constellations - identifying the shapes	● Experimenting observing
		● Experimenting to observe the movements of stars and constellations	● Experimenting observing
		● Conducting an activity to understand the reason why the polestar appears fixed at one point	● Observing comparing
	● Solar system plants	● Understanding the arrangement of solar system planets - the method of observing them - discussing the specialities of planets	● Analysing the information ● Drawing pictures ● Discussing
		● Discussing about other objects in the solar system	
		● Discussing and displaying the artificial	● Collecting information
	How our concestons came to know aout the earth the sun and the moon	● Discussing how our ancestors came to know about the earth, the sun and the moon	● Collecting information discussing

IX CLASS - PHYSICAL SCIENCE - SYLLUBUS

Theme : **Name of the Lesson : . Matter around us**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
1.	**Matter – States**	● Giving examples for different states of substances	● Giving examples
	● Properties of Solids, Liquids and gases	● Observing an activity and indentifying the shape and volume of liquids	● Identifying
	● Shape – Volume	● Discussing the Shape and fixed volume of gases	● Analysis
	● Compressibility	● Trough an activity observing the compressibility of liquids and gases substances	● Conducting activity Analysis
	● Diffusion	● Discussing the diffusion of gases	● Analysis
		● Conducting an experiment to understand the diffusion of liquids	● Conducting an experiment ● Analysis
		● Conducting an experiment to understand the diffusion of particles of solids into liquids	● Conducting an experiment ● Analysis
		● Throw an experiment to understand the speed of diffusion of two gases	● Conducting an experiment ● Analysis
		● Preparing a table to distinguish properties to Solids, liquids and gases	● Information ● Analysis
	● Matter have ting particle there exists space between particles	● By conducting an Experiment to understand matter have ting parkcles	● Conducting an experiment ● Analysis ● Inference
	● Particles of matter attract each other – How diffusion takes place	● Observing the force of attraction between the particles - Discussing how diffusions take place	● Discussing ● Analysis
	● Effect of temperature on change of state	● Conducting an Experiment to understand effect of temperature on change of state	● Conducting an experiment inferences

Theme : **Lesson Name : Motion**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
	● Effect of pressure on change of state	● Discussing the effect of pressure on change of State	● Analysis
	● Evaporation	● Discussing the process of Evaporation	● Analysis
	● Effect of surface area, humidity and wind speed on evaporation	● Discussing effect of surface area , Humidity and wind speed on evaporation	● Analysis
2.	**Motion**	● Discussing the concept of relative by various situations	● Giving example, Explaining, Questioning
	● Motion – relative	● By Hypothetical Activity to show Motion is relative	● Discussing, Analysis
	● Distance - Displacement	● Drawing path and distinguishing between distance and displacement	● Cause and effect
			● Drawing the Diagram, Diagram analysis
		● Discussing Vectors and Scalar	● Identify in their differences
		● Drawing displacement vectors	● Analysis
	● Average Speed and Average velocity	● Discussing by daily life situations to understand the concept	● Making Hypothesis Giving examples
		● of Average Speed, Average velocity, and their limitations	● Inference, Generalizations
	● Speed – Velocity	● Analysising by daily life situation of Speed, Velocity	● Analysis Synthesis
		● By Deferring the speed by drawing a graph	● Explaining Graphical Analysis
	● Uniform Motion	● Drawing distance is time graph for the given table	● Drawing a Graph Analysis
	● Non uniform notion	● Analyzing the motion of a ball on a inclined plane, uniform circular motion, the motion of an object thrown into air	● Analysising Tables Experimental skills
			● Difference ate
	● Acceleration	● Based on non uniform motion recognizing the importance of acceleration and Discussion	● Discussion, Giving example
			● Generations
	● Equations of uniform Acceleration	● Deriving the Equations of uniform acceleration	● FunctionalRelation Drawing diagram
		● Experimentally uniform acceleration Equations are definite	● Model mating
		● Finding the uniform accelerated motions and comparing with equations	● Experimental Skill
			● Recording the values

Theme :		Lesson Name : Laws of Motion	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
3.	**Laws of Motion**		
	● First law of motion	● By doing an activity of Galileo Experian and understanding the concepts Analyzing the relation between Net force, Motion	● Analysis ● Observation ● Analysis, observation ● Doing Experiment ● Taking precautions
	● Inertia - Mass	● By doing Activity to understands the concepts of Inertia, Mass	● Conclusion
	● Second law of motion Linear momentous	● To understand necessity of linear momentous by recalling our observations from our Daily life ● By doing some Activities and Analyzing the relation between Net forces acceleration and mass ● To Differentiate between Fnet = ---------- ● Discussing in what situation they have to use ● And Solving some problems	● Analysis ● Discussion ● Analysis ● Conclusion ● Problem salving ● Analysis ● Inference ● Drawing, Diagram
	● Third Law of Motion	● By Doing some activity to understand third Law of motion (Baloon Rocket activity, Lab Activity)	● Discussing, Observation ● Explaining, Conducting, Experiment
	● Conservation of momentum and impulse	● Deriving the conservation of momentum ● By Doing an activity to understand necessity of impulse ● Solving Some Problems	● Analysis ● Discussion, Analysis ● Conformation

Theme : **Lesson Name : Is matter pure ?**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
4.	**Is Matter Pure ?**		
	● Mixtures, Homogeneous Mixtures, Heterogeneous Mixtures	● Doing Activities Discussing the results and analysis the difference between them	● Conducting Experiments ● Observation ● Analysis
	● Solutions	● Analyzing information by reading ● By Doing Activities to understand different types of solutions	● Discussion ● Observation ● Analysis
	● Suspensions	● By Doing Activity, Analysis the properties of Suspension	● Discussion ● Analysis
	● Colloidal Solutions	● Doing Activities Discussion ● To understand the properties of tyndall effect colloidal Solutions ● Discussing the Formation of Colloidal Solutions in Daily life situations, and from some examples	● Experiment Skill ● Discussion ● Analysis ● Discussion ● Analysis
	● Separating the components of a mixture	● By Doing Activity to Discuss how to separate the component of mixture	● Discussion, Analysis ● Inference
	● Sublimation	● Separation of Mixtures by Sublimation (Ammonium Chloride and salt)	● Experiment
	● Evaporation	● Evaporation of water in ink	● Experiment ● Observation
	● Paper Chromatography	● Separating the components of ink using paper chromatography	● Experiment ● Observation
	● Separation of immiscible liquids	Separating oil and water with separating funnel	● Experiment ● Observation

Theme :		Lesson Name : Atoms and Molecules	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
	● Separation of a mixture of two miscible liquids ● Boiling points of the two liquids are close to each other	● Separating the mixture of acetone and water by distillations ● Fractional distillation of air, with flow diagram separating mixture of copper salphate and aluminum by an activity to analysis types of pure substances and their properties	● Experiment ● Observation ● Analysis, Discussion ● Analysis ● Inference
5.	**Atoms and Molecules**		
	● Weight of reactants weight of products	● By doing Activity with lead nitrate and Potassium iodide and compare weight of reactants and weight of products	● Experiment ● Inference
	● Law of conservation of mass	● Discussion on Law of conservation of mass	● Discussion ● Analysis
	● Law of constant Proportions	● Analysis the information in the table	● Discussion ● Analysis
	● Dalton's atomic theory	● Discussion Dalton's atomic theory	● Discussion ● Analysis
	● Atom - Molecules	● Discussing the information of a substance of the atoms and molecules	● Analysis
	● Symbols of elements	● Discussing on how the symbols have been decided for the elements ● Writing the symbols for the given elements	● Discussion ● Analysis
	● Atomicity	● Based on Number of molecules in atomicity mono atomic Di atomic, triatomic, Tetra atomic, OC tatomic discussion through tables	● Discussion ● Analysis
	● Valency	● Analysis and discussion on atoms of the elements have power to combine with atoms of other elements is known as its valency	● Discussion ● Analysis

Theme :		Lesson Name : What is Inside the atomic	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
	● An Jon	● Identification of the charged species are known as ions. Analysis and Discussion on table which shows variable valency.	● Discussion ● Analysis
	● Atoms mass	● Analysis the information of atomic masses of a few elements	● Analysis ● Discussion
	● Molecular of compounds formula	● Writing Chemical formula by using valency of elements	● Analysis
	● Molecular mass - Formula unit mass	● Discussion on molecular mass - Formula unit mass Analysis the comparison and differences between them	● Analysis
	● Mole concept molar mass	● Discussion of mole concept molar mass	● Discussion ● Analysis
6.	**What is Inside the atomic**		
	● Sob atomic particles	● Discussion and Analysis the information of Electrons, proton and Neutrons	● Analysis ● Discussion
	● The structure of an Atom	● Imagining and drawing arrangement of subatomic particles in the atom	● Making hypothesis ● Drawing, Diagram ● Conformation
	● Thomson's model of the	● Discussion on Plum pudding model Atom	● Comparison ● Explanation ● Drawing, Diagram
	● Ruther fords alpha particles scattering experiment	● Discussion of Experimental Set up and understanding Ruther for us experiment ● Analysis of Scattering of alpha particles ● Analysis of Features of nuclear model of an atom ● Discussion on limitations of Rutherford's atomic model	● Discussion ● Analysis ● Analysis ● Analysis ● Discussion

Theme :		Lesson Name : Gravitation	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
	● Bohr's model of the Atom ● Distribution of electron in different orbits (Shells) ● Valency ● Atomic number Atomic mass number ● Symbols of atoms ● Isotopes	● Discussion on Energy levels of an atom ● Analysis of Arrangement of electrons for the elements through table and figures ● Discussion on valecency of elements and the importance of valency of the first eighteen elements in the table ● Discussion and Analysis of atomic number and Atomic mass ● Discussion and writing symbols of atoms ● Analysis of determinately the atomic mass of an element with Isotopes	● Reasoning ● Observation ● Analysis ● Analysis ● Conformation ● Discussion ● Discussion ● Analysis ● Observation ● Analysis ● Conformation
7.	**Gravitation**		
	● Uniform Circular motions ● Universal law of gravitation	● Observing the motion of an object moving in a circular path ● Analysis of Velocity vectors at different points Analysis of transformed velocity vectors ● Comparing the motions of the moon and apple Analysis the time period of satellite near the earth surface	● Analysis, Observation ● Conformation ● Drawing, Diagram ● Analysis of Diagram ● Giving Examples ● Analysis - Inference ● Observation ● Variation ● Presenting ● Values ● Comparison ● General statistics

Theme :		Lesson Name : Floating Bodies	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
	● Free Fall	● Analysis of Acceleration is Independent of masse	● Analysis ● Conducting ● Experiment
		● Analysis the direction of 'g'	● Analysis
		● Solving the problems	● Conformation
		● Measuring the weight of free fall body	● Analysis, Conducting ● Experiment
		● Observing the changes during the free - fall of a body	● Conformation, Observation
	● Centre of gravity	● Conducting Activity of Balancing of Spoon and fork,	● Conducting ● Experiment
		● Balancing of ladder, locating centre of gravity of a meter scale	● Analysis, Observation ● Conformation
		● Identifying the center of gravity of a ring	● Experiment ● Analysis
	● Stability	● Observation of shifting the center of gravity and its effects	● Observation ● Analysis
8.	**Floating Bodies**		
	● Relative density	● Comparing density - relative density on an object	● Experimental Skill
		● Finding the relative density of different objects in Experimental methods	● Observation ● Discussion ● Conformation
		● Finding the relative density of milk, groundnut oil and kerosene and recording the values in the table	● Description ● Making table coloum

Theme :		Lesson Name : Floating Bodies	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
		● Making of lactometer ● Conducting an lab activity and analysis on when doe objects float on water	● Preparing Models ● Conducting Experiment ● Recording values in Table
	● Upward force in liquids	● Observing the upward force of liquids throw an Activity ● Observation air pressure than an activity (Glam and Cottons) ● Measuring atmospheric pressure with Barometer ● Finding pressure at or depth 'h' in a liquid ● Analysis of pressure different at different levels of depth in fluids	● Conformation ● Conducting Experiment ● Analysis ● Experimental ● Analysis ● Analysis
	● The force of buoyancies ● Archimedes's principle ● Pascal's Principle	● Measuring the weight of the water displaced by the immersed stone ● Analysis the above activity and discuss the Archimedes principal ● Analysis on application of Pascal's principle (Brahn ha press) ● Discussion of principle is used in the design and working of hydraulic jack	● Experimental Skill ● Analysis ● Discussion ● Analysis ● Conformation ● General -------- ● Explanation ● Giving example

Theme :		Lesson Name : Work & Energy	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
9.	**Work and Energy**		
	● Work	● Discussion of 'work' in our daily life in various situations	● Observation ● Giving Examples, Analysis
		● Understanding the meaning of work was per science	● Formatting table
		● Solving the problems using mathematical Equations of work	● Analysis
	● Energy	● Discussion of Sources of Energy	● Discussion
		● Understanding the increase and decrease in energy of an object	● Analysis ● Observation
	● Forms of Energy	● Discussion Energy inside a human bad	● Discussion
		● Understanding the energy of moving objects	● Analysis
		● Writing Numerical Expression for Kinetic energy	● Conformation
	● Potential Energy	● Understanding potential energy in on arrow	● Analysis
		● Observing the energy in stretched rubber band	● Exhibits ● Inference
		● Discussion of Potential energy of an object at height	● Collecting informer
	● Mechanical Energy	● Analyzing the information	● Analysis
	● Conversion of Energy	● Listing the energy conservation in nature and in day to day life situations and costing the information in a given table	● Analysis
		● Understanding the conservations of mechanical energy in a bob.	● Reorganization
		● Calculating the total energy of free fall at different height	● Formatting Table
	● Power	● Understanding the concepts of power using Examples from our daily life situation Using the mathematical formula of power and Solving the problem	● Conformation

Theme :	Lesson Name : Bio diversity its conservation

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
10.	**Sound**		
	● Sound is a form of energy	● Observing vibration of light after sound is made in the tin	● Experiment
	● Production of sound	● Observing the vibration of tuning fork.	● Explanation, Discussion ● Generalism
	● Propagation of Sound	● Analysis the Information of Compression pulse and Rarefaction pulse	
	● Types of waves	● Understanding compressions and rarefactions in a slinky ● Discussion on sound waver are longitudinal	● Analysis, Discussion ● Explanation
	● Wave length Amplitude Time period and frequency Speed of sound waves		
	● Characteristics of a musical sounds	● Analysis the information of Tables, pictures and understanding characteristics of sound (Pitch, Loudness, Quality)	● Generalization ● Analysis ● Conformation
	● Reflection of Sound	● Listening to reflected sound through a plastic pipe	● Observation, Analysis
	● Echo	● Understanding the concept of echo in daily life situations	● Analysis
	● Reverberation	● Understanding relations between Echo and reverberation ● Understanding uses of multiple reflection of sound 1. A mega phone and a horn 2. Stethoscope 3. Designing of concert halls and cinema halls	● Analysis ● Analysis ● Making made
	● Range of hearing	● Understanding the information audible range	● Analysis
	● Application of Ulter sounds	● Understanding application in industrial sector and medical sector	● Analysis
	● SONAR	● Understanding the working of SONAR system in ships	● Discussion, Analysis

X CLASS - PHYSICAL SCIENCE - SYLLUBUS

Theme : **Lesson Name : Heat**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
1.	Thermal equilibrium heat energy temperature	● Conducting an activity to introduce the primary concepts of heat and temperature discussing on imaginary aspects ● Conducting an activity to bring charity ● On the concept of heat - discussing	● Conducting activity ● Discussing ● Conducting activity
	Temperature and Kinetic kinetic Energy	● Conducting activity, questioning - eliciting answers (observation) ● Conducting an activity to show that heat flow is due to difference in heat, observing and discussing	● Observing ● Questioning ● Conducting activity ● Observing discussing
	Specific heat	● Introducing the concept of specific heat through on activity ● Conducting an activity to explain Q=mT ● Observing daily life application	● Conducting activity ● Observing
	Method of mixture	● Explaining method of mixtures through an activity ● Finding the specific heat of solids through experimentation	● Explaining ● Conducting activity
	Evaporation condensation	● Discussion, conducting activity	● Discussing analysing
	Boiling melting	● Conducting activity - discussion and analysis on results	● Discussing analysing
	Humidity	● Conducting activity - discussion and analysis on results	● Discussing analysing

Theme :	Lesson Name : Chemical Reactions and Equation

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
2.	Chemical euation ● Some chemical reactions ● Write a chemical equations	● Discussing giving examples how to write a chemical equation ● Practicing through examples how to balance a chemical equation	● Discussing ● Giving examples
	● Balancing equation ● More information ● Solving problems	● Analysing to make chemical equations more informative solwing problems based on the interpretations of chemical equation	● Analysing ● Solving problems
	Types of chemical reactions	● Conducting activities to explain chemical combination, chemical displacement, decomposition and double decomposition. ● Discussing the differences between the above reactions ● Giving examples to the different types of chemical reactions.	● Experimenting conducing activity ● Discussing ● Giving examples
	● Oxidation and reduction	● Conducting an experiment to know what are oxidation and reduction reactions ● Giving examples for the above reacitons	● Experimentation
	● Corrosion rancidity	● Discussing the effects of oxidations reactions ● Understanding corrosion, rancidity ● Discussing rancidity as an oridation reaction	● Description

Theme : **Lesson Name : Reflection of Light by different Surfaces**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
3.	● Fermat Principle ● Reflection of light bye plane mirror ● Image formed by plane mirror. ● Spherical mirrors-reflection of light. ● Finding normal to a curved surface Focal point reporting ● Measuring distance of image formed by spherical mirror. ● Ray diagrams of concave and convex mirrors ● Mirror formula ● Applications	● Analysing with an example ● Checking the rules of reflection, conductivity experiment, discussion display. ● Discussing to understand the images formed by plane mirrors. (through the given pictures) ● Conducting activity, discussion, analysis discussing analysing. ● Conducting activity, discussion, analysis ● Finding focal point, conducting activity reporting ● Conducting experiment ● Discussing ● Tabulating ● Drawing ray diagrams through, discussion ● Reading the book ● Deriving mirror formula, dicussion ● Making solar cooker	● Analysing ● Discussing conducting experiment. ● Discussing. ● Conducting experiment ● Conducting experiment ● Conducting activity ● Conducting experiment ● Discussing ● Tabulating ● Drawing picture. ● Discussing ● Model making

Theme :	Lesson Name : Acids bases and Salts

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
4.	Chemical Properties of acids and bases Laboratory indicators	● Experimenting to find out the changes that acids and bases undergo with indicators : Ex: litonus ● Observing the changes in litmus papers ● Completing the table with reactions of different acids and bases with various indicators	● Different acids, bases ● Observing ● Tabulating
	Reactions of acids and bases with metals	● Conducting exp[eriment to show the reactions of acids with metals carbonates and metal hydrogen carbonatges conducting on activity to explain neutralisation (Acidbase reaction)	● Conducting experiments ● Inferring ● Conducting
	Common properties of acids and bases ● Strength of acid or base	● Conducting experiments to explain the properties of acids and bases ● Condictomg am actovotu tp test tje stremgtj pf am acid or a base (Exo thermic or endo thermic reations)	● Experimenting inferring ● Conducting activity
	● PH scale	● Discussing PH scale ● Completing the table based on observations ● Giving Examples of Importance of PH in our daily life ● Applying the knowledge of PH in daily life (Discussion, activity)	● Discussing ● Tabulating ● Exemplifying ● Applying in daily life
	Common Salt ● Salts - PH value ● Chemicals for Commonsalt carbonate and washing soda	● Discussing the important products of Common Salt ● Drawing picture of chlor - Alkali Process ● Listing out the uses of bleaching powder sodium hydrogen conducting activity ● Discussing plaster of paris and its uses	● Discussing ● Drawing pictures in listing ● Discussing

Theme :	Lesson Name : Refraction of Light through Plane surface

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
5.	Refraction	● Conducting experiment to understand refraction, discussing, analysing.	● Experimenting discussing ● Analysing
	Refractive index	● Analysing a table to realise the necessity of an index to understand refraction analysing discussing	● Analysing ● Discussing
	Snell's Law	● Testing the law of refraciton through an experiment ● Conducting an activity to understand the situation where light travels from denser to rarer medium ● Derivisnell's Law	● Experiments inferring ● Analysing ● Deriving
	Total internal reflection	● Conducting experiment ● Discussing, explaining ● Conducting experiment, observing discussing, ● Discussing, analysing, questioning to understand total ● Understand total internal reflection	● Conducting experiment ● Discussing ● Observing ● Analysing ● Questioning
	Mirages	● Introducing mirages through questioning and daily life situations - discussing	● Questioning ● Discussing
	Refraction - through a	● Conducting experiment ; analysis of tables discussion	● Conducting experments ● Analysing ● Discussing

Theme :	Lesson Name : Refraction of light through curved surface

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
6.	● Refraction through Curved surfaces	● Conducting activity, questioning, discussing analysing	Conducting activity, questioning discussing analysing
	● Mehtod of formation of image	● Drawimg the ray diagram ● Discussing paraxial approximation ● Discussion about need for sign convention questioning to derive the formula - discussing	● Drawimg ● Discussing ● Questioning ● Discussing
	● Lens (Convex concave) ● Ray diagrams	● Drawimg picture of focal discussing importance of laws of refraction ● Drawimg and displaying the ray diagrams showimg the the image formation of an object kept in different places in front of lines.	● Discussing
		● Experimenting with concane lens -analysing the table ● Discussing the relation between object distance and ● Image distance based on the above experiment ● Need for lens formula	● Experimenting ● Analysing ● Deriving
	● Lens formula 1/f = 1/v - 1/4 ● Lens maker's formula	Deiving ● 1/f = 1/v - 1/4 through analysing ● Conducting activity to know focal length, nature of the substance, nature of surroundings discussing to decide the geometrical shape of lens	● Analysing activity ● Discussing
		● Deriving lens makers formula analysing daily life situations through lens makers formula	● Analysing

Theme :	Lesson Name : Human Eye and colourful world

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
7.	Eye ● Structure ● Angle of vision ● Accomodation of eye	● Conducting activity to find out least distance of distinet vision, analysing ● Conducting activity to know the angle of vision ● Vision - analysing and discussing	● Conducting activity ● Analysing ● Discussing
		● Know the structure of eye, its parts; connecting science; Analytical discussion	● Discussing
		● Finding the maximum and minimum focal lengths - analysing usage of lens formula	● Analysing
	Defects of vision i) myopia	● Defects, reasons discussing the methods to remove them	● Discussing
	ii) hypermetropia	● Discussion and analysis on the need of power of less	● Analying
	iii) preshyopia power of lens prism -	● Conducting an experiment to find out the refractive index of the lens, preparing a table, analysing the values, preparing a table, analysing the values, deriving the formula finding refractive index using the values and derived formula	● Conducting an experiment ● Tabulating ● Analysing ● Derving
	Light dispession of light	● Creating an artificial rainbow through conducting activitities ● Understanding the wave concept ● Questioning to understand the concept of rainbow, discussing drawimg diagrams ● Conducting activities	● Conducting activity ● Understanding ● Questioning ● Discussing ● Drawimg diagrams
	Reflectionm of light	● Observing and analsing daily life ● Conducting activity ● Conducting activity	● Observing ● Analysing

Theme :	Lesson Name : Structure of Atom

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
8.	Spectrum - wave nature of light	● Conducting an activity to know the need to understand the nature of light coloured flames and their characteristics ● Discussing the formation of Rainbow ● Conducting activity to know that each element emists its its own characteristic colur - discussing	● Conducting activity ● Discussing ● Observing ● Conducting activity
	Bhor's Model Bohr - Sommerfeld Model	● Discussing and analysing so as where did Bohr go wrong? ● Discussing how this model succeeded in accounting for the structure of hydrogen atomic spectra ● Making hypothesis on the general structure of atam	● Discussing analysing ● Discussing ● Making hypothesis
	Quantu mechanical model of an atom	● Discussion of how elctrons follow defined path along the ucleus ● Analysis	● Discussing ● Analysing
	Quantum numbers	● Discusssing the quantum numbers to know their importance and the things they demote - ex: 'n' - The Principal quantum number represents the shape of an atmic orgbital.	
	Electronic configuration	● Explaining electronic configuration. ● Doing an activity (writing electronic configuration of different elements.	
	Aufban Pauli and Haud's rule	● Discussing the rules and principles framed lay Aufbace. ● Questions about usefulness of the three principles. ● Discussing how each element in the nature tries to achieve stable electronic configuration.	

Theme :	Lesson Name : Classification of Elements the Periodic Table

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
9.	Need for the arrangement of elements in an organised manner ● Doberin 'r's triads Newlands law of actaves	● Observing daily life experiences to conclude that for any system organisation is essential ● Discussing the relation about elements that dobereiner wanted to establish ● Discussing the reason why newlands proposed the law of octaves.	● Observing ● Inferring ● Discussing ● Giving reasons
		● Analysing whether the reason is right	● Analying
	Mendeleef's periodic table	● Discussing the salient features and achievements of the mendeleef periodic table	● Discussing
	Modern Periodic table	Explaining the concepts of group period etc ● Explaining to understand the physical and chemical properties of elements are theperiodic functions of their electronic configration	● Explaining
	Periodic properties	● Discussing Salient features of Modern Merialir falla, identify now this over come merdalen table	● Conducting activity
	Valency atomic radius	● Conducting an activity to show the trend of valency in a period and own the group.	● Observing giving examples
	IE	● Observing examples of variation in atomic radil in a group / period	
	EA	● Discussing the factors IE is dependent on ● Making hypothesis, discussing why EA Values differ	● Discussing ● Making hypotheries
	Electronegativity metallic and non metallic - properties	● Anlycing the factors fluencing eletro negativities ● Observing the examples that the metallic character increases in a group from top to bottom.	● Analysing ● Observing

Theme : **Lesson Name : Chemical Bonding**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
10.	Chemical bonding	● Discussing the ned for bonding, how does bonding take place. why some elements are more reactive and some others less reactive	● Discussing
		● Discussing why certain reactions are exothermic and others endothermic	● Discussing
	Lewis dot symbols	● Explaining lewis dot symbols.	● Explaining
		● Doing an activity to write the lewis dot structures of given elements.	● Conducting activity ● Observing discussing
		● Observing the number of E in the outermost orbits	● Observing discussing
		● Discussing octet rule	
	Electronic theory & Valence	● Discussing the electronic valence theory by giving examples	
	Octet rule	● Stating the octet rule	
	Ionic bond	● Discussing kossel's proposals on ionic bond.	
		● Explaining what is ionic bond.	
		● Explaining through examples the formation of ionic bond	
	Covalent bond	● Discussing the proposals of G.N. Lewis	● Discussing
		● Observing and analysing the examples of cavalent bond.	● Observing giving examples
		● Explaining the formation oxygen molecule Nitrogen molecule, methare molecule Ammonia molecule and water molecule	● Explaining
	Drawbacks of electronic theory of valence	● Discussing the draw backs of electronic theory of valence	● Discussing
		● Giving examples	● Giving examples
	valence bond theory - hybridisation	● Explaining valence bond theory and hybridisation	● Explaining
		● Discussing the formation and shapes of BF^3, NH_3 and H_2O (bond angle, bond length etc)	● Discussing
	Properties of ionic and cavalent	● Comparing Ionic and covallent compounds	● Comparing
		● Analysing the properties of ionic and cavalent compounds	● Amalysing

Theme : **Lesson Name : Electric Current**

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
11.	Electricity	● Conducting activity : analysing the results to identify the role of conductors. discussion ● Discussing the concept of electric current based on electron motion. analysing electron motion with the help of achart ● Explaining the principle of electric current ● Discussing analysing to recognise the concept of electric current through the importance of drift speed	● Conducting activity ● Activity ● Analyzin discussing analysis
	Potential difference	● Need; disussion Emf analysis, questioning and drawing pictures, how /does a batlery work	● Discussing ● Questioning ● Drawing pictures
	Ohm's law	● Conducting experiment, analysis of results, drawis graph, display, dividing the substances based on discussion ● Explaining the concept of resistance	● Conducting ● Experiment analysing ● Discussing drawing graphs
	● Electric shock	Explaining electric shock based on olmis law	● Explaining
	● Resistance and the factors influencing		
	1. Temperature -	Conducting activity - discussion	● Conducting activity discussion
	2. Nature of the material	Conducting activity - analysis	● Conducting activity discussion
	3. Length of the conductor	Conducting activity - analysis	● Conducting activity discussion
	4. Cross section area	Conducting activity - analysis	● Conducting activity discussion
		Deriving R = sl/A based on above activities	● Deriving
	Electric cricuit	● Conducting activity, cheeking the results discussiing, observing, questioning.	● Conducting activity ● Observing
	● Connection insereis		
	● Krrchoff's rules	● Understanding and discurring electric energy, need,	● Questioning
	● Electric energy	● Understtanding and discussing electric energy, need, current bill overload etc.	● Discussing

Theme :	Lesson Name : Electro magnetism

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
12.	Oersted Experiment	● Conducting experiment discussion	● Conducting experiment, discussing
	● Magnetic field	● Drawing (activity) magnetic lines of force	● Drawing
		● Discussing the concept of magnetic field	● Discussing
		● Questioning and discussing magnetic flux and density of magnetic flux	● Questioning
	● Magnetic fieild due to electric current	● Explaining magnetic field due to straight wire carrying current	● Explaining
		● Conducting activity discussing the results	● Conducting activity
		● Magnetic field due to circular coil - Conducting activity	
		● Magnetic field due to solonoid	
		● Identyfing that magnetic field lines are perfect lines.	
	● Moving charges magnetic force on a current carrying wire	● Conducting acticity-discussion- Right hand rule.	● Conducting activity
		● Conducting activity, discussing to understand f = ILB, using right hand rule	● Discussing
	● Electric motor	● Discussing the need - Drawing pictures analysing and analysin	● Discussing, Drawing picture
	● Electro Magnetic induction, Faraday's law Lenz's law	● Conducting activity, introducing Faraday's law	● Conducting activity
		● Analysing through discussion - Analysing Lenz's law :	● Analysing
		● Deriving Faraday's law through law of conservation of energy analysing, drawing pictures.	● Discussing
			● Drawing Pictures
	Electric Generator	● Discussing AC DC generators their importance, drawing graphs analysing discussing the need of slip ring	● Discussing
			● Drawing Graphs

Theme :		Lesson Name : Metallurgy	
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
13.	● Occurence of metals in nature	● Recall Metallic characters and discussion concept of metallurgy	
	● Characteristics of metals - review	● Conducting an activity to identity the metal present in each ore given in the table, differentiate into chlorides, oxides etc.	● Conducting activity
	● Definition if metallurgy		
		● Discussing the statement all ores are minerals but all minerals need not be ores.	● Discussing ● Inferring
		● Classifying them as oxides sulphides chlorides carbonates based on reactivity	● Classifying
	● Extraction of metals	● Discussing the three stages involved in the extraction of metal	● Discussing
		● Preparing a flow chart : Analysis	● Analysing
	● Electrolytic refining	● Drawing a picture of experimental setup for the electrolytic refining of copper	● Drawing Picture
	● Corrosion	● Doing an activity to investigate the condition under which iron rusts	● Conducting activity
	● Prevention of corrosion	● Discussing the methods of preventing corrosion	● Discussing
	● Important processes used in metallurgy	● Explaining the processes smelting roasting, calcination	● Explaning
		● Describing the blast furnace and reverbaratory furnace	● Describing
		● Drawing pictures of furnaces (blast and reverbaratory)	● Drawing Pictures.

Theme :			Lesson Name : Metallurgy
No.	**Key Concepts**	**Teaching / learning stratagies**	**Teaching learning process / sources**
14.	Bonding in Carbon	● Discussing how carbon forms a large variety of compounds because of its tetra valency	● Discussing
		● Discussing to explain the four orbitals of carbon containing unpaired electrons are energitically equal (hybridisation)	● Discussing
	● Allotropes of Carbon	● Discussing that carbon exhibits allotropic properties	● Discussing
		● Understanding the term allotropes	● Classifying
		● Classifying allotropes	● Giving examples
		● Giving examples for allotropes	● Discussing
		● Discussing diamond and graphite as allotropic forms of Carbon - analysing	● Analysing
	● Versatile nature of carbon	● Explaining the property of catenation	● Explaining
		● Explaining formation of hydrocarbons	
		● Classifying hydrocarbons	● Classifying
		● Giving examples for hydrocarbons	● Giving examples
		● Observing the instances where carbon binds with other elements	● Observing
	● Functional groups	● Explaining functional groups	● Explaining
	● Isomerism	● Discussing functional goups as the basis for classifying	● Discussing
		● Classifying organic compounds	● Classifying
		● Defining isomerism	● Defining
	Homologons series	● Explaining that carbon compounds differing by CH_2 form homelogons series	● Explaining
		● Giving examples for homologs	● Giving examples
		● Observing the information of alkanes, alkenes alkynes	● Observing

No.	Key Concepts	Teaching / learning stratagies	Teaching learning process / sources
	● Nomenclature of carbon compounds	● Discussing different aspeets of nomenclature of carbon compounds like, word rool, prefix suffix, punctuation etc. ● Giving reasons for the names ● Completing the table (activity) ● Citing examples and solving them ● Observing and analysing the suffixes and profixes of Ketones, esters, amines and such important functional groups.	● Discussing ● Giving reasons ● Conducting an activity ● Giving examples ● Observing and analysing
	● Chemical properties of carbon compounds	● Discussing combustaion, oxidation, addition and substitution reactions ● Explaining the properties of combustion oxidation ● Differentiating between addition and substitution reactions ● Giving examples to addition, substitution, combustion, oxidation	● Discussing ● Explaining ● Differentiating ● Giving examples
	● Some important carbon	● Explaining the preparation and properties of ethanol, ethanoic acid ● Conducting an activity to show esterification ● Collecting information on the uses of carbon compounds ● Explaining the role of carbon compounds in daily life & appreciates it	● Explaining ● Conductiong activity ● Collecting information ● Appreciating
	● Soaps-Saponification	● Understanding the chemical nature of soaps through dissussion ● Observing the formation of micelle through an activing ● Representing the cleansing action of soap through a diagram	● Discussion ● Conducting an activity ● Conducting an activity ● Drawing pictures

7

Science Resources

Science changes continuously and brings in development. This development helps human beings to better their life styles, to properly use nature and environment and protect them. Hence, teachers need to understand the advances/changes in science. For this s/he has to depend on a number of resources of which reference books are most important.

The works of Galileo and Kepler helped Newton in discovering 'The law of gravitation'. In discovering 'The theory of relativity', Einstein was benefited from the books written by Riemann. The reference books should not only be used to get information but also to know the frontiers of science and to find solutions to unsolved questions and to search for explanations to inexplicable phenomena. Usually, reference books pose many questions. Good results can be achieved if they are understood and used appropriately in the teaching learning activities.

There are a number of institutions, schools, individuals and governments who are trying to bring science to the reach of everybody. For this, they have put in their websites a lot of information about the procedures to conduct various experiments and the techniques to prepare various tools and apparatus. Also, there are some good magazines that serve the same purpose.

These resources guide you, and help you in furthering your zeal to acquire knowledge, so the list of some resources is given below for your use.

Publications / Magazines

1. Chekumuki, H.No. 3-78, B.C. Colony, Gudlasingaraam, Vidyanagar, Hanumkonda, Warangal – 501009
2. Resonance (English), Indian Academy of Sciences, C.V. Raman Avenue, P.B. No. 8005, Bangalore – 560080
3. Science Reporter (English), CSIR, Dr. K.S. Krishnan Marg, Near Pusa Gate, New Delhi - 110012.
4. Vipnet - News (English), Vigyan Prasar, BGVS, C-18, Saket, New Delhi-16

5. Jantar Mantar, Children Science Observatory, 130/3; Avvai Shanmugam Salai, Gopalapuram, Chennai – 600086, Pub - Tamilanadu Science Forum
6. Down to Earth, Centre for Science and Environment, 41; Tughlakabad Institutional Area, New Delhi - 110062

TEACHERS' RESOURCE BAG

Some Resource Books that Help make Science Fun

1. The Third Book of Experiments, Leonard De Vries, Carousel Books
2. Science Works, Ontario Science Centre, Ontario
3. Toying Around with Science, Bob Friedhoffer, Franklin Watts, New York
4. The Science Explorer, P. Murphy, E. Klages, L. Shore, An Owl Book
5. 700 Science Experiments for Everyone, Compiled by UNESCO, Doubleday
6. 100 Amazing Science Fair Projects, Glen Vecchione, Goodwill Publishing House, New Delhi
7. 365 Simple Science Experiments with Everyday Materials, Richard Churchill, Sterling Publishers
8. The Book of Experiments, Leonard De Vries, Carousel
9. Joy of Learning, (Standards 3 to 5), Center for Environmental Education, Ahmedabad, India
10. Experiments for You, John Tollyfield, Evans Brothers, London
11. How to Turn Water Upside-Down, Ralph Levinson, Beaver Books, London
12. Experiments with Everyday Objects, Kevin Goldstein-Jachson, Granada Publishing, New York
13. Simple Science Experiments, Batstord, Hans Jurgen Prees
14. Let's Discover Science, David Horsburgh, Oxford University Press
15. Chai Ki Pyali Mein Paheli, Partho Ghosh & Dipandar Home (Hindi) National Book Trust, New Delhi 110016
16. UNESCO Source book for Science in the Primary School, Harlen & Elstgeest, National Book Trust, New Delhi 110016

17. Soap Bubbles, C.V. Boys, (Eng/Hin), Vigyan Prasar, C-24 Qutub Institutional Area, New Delhi 110016
18. The Chemical History of a Candle, Michael Faraday (Eng/Hin), Vigyan Prasar, New Delhi, info@Vigyanprasar.gov.in
19. Science in Everyday Life, J.B.S. Haldane, Vigyan Prasar, New Delhi, info@Vigyanprasar.gov.in
20. VSO Science Teacher's Handbook, Andy Byers, Ann Childs, Chris Lane (Hindi) Eklavya, Bhopal, pitara@eklavya.in
21. Environment & Self-Reliance, Yona Friedman, Eda Schaur (Eng/Hin), Vigyan Prasar, New Delhi
22. Energy & Self-Reliance, Yona Friedman, (Eng/Hin) Vigyan Prasar, New Delhi, info@vigyanprasar.gov.in
23. The Story of Physics, T. Pammanabhan (Eng/Hin) Vigyan Prasar, New Delhi,info@vigyanprasar.gov.in
24. On the Various Forces of Nature, Michael Faraday, Vigyan Prasar, New Delhi, info@vigyanprasar.gov.in
25. The Insect World of J. Henri Fabre, Vigyan Prasar, New Delhi, info@vigyanprasar.gov.in
26. The Autobiography of Charles Darwin, Vigyan Prasar, New Delhi, info@vigyanprasar.gov.in
27. The Bicycle Story, Vijay Gupta, Vigyan Prasar, New Delhi, info@vigyanprasar.gov.in
28. Aakash Darshan Atlas, Gopal Ramchandra Paranjpe, NCERT, Sri Aurobindo Marg, New Delhi 110016
29. Preparation for Understanding, Keith Warren, illus. by Julia Warren, UNESCO
30. Resonance Journal of Science Education, Indian Academy of Sciences
31. Balvignanic, Eklavya, Bhopal

Courtesy : Aha! Activities, Eklavya, Bhopal

Websites & E-Resources for Middle and Primary School Science

1. LET'S DISCOVER SCIENCE PART I By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/david1.pdf)
2. LET'S DISCOVER SCIENCE PART II By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/david2.pdf)

3. LET'S DISCOVER SCIENCE PART III By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/david3.pdf)

4. LET'S DISCOVER SCIENCE PART IV By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/david4.pdf)

5. LET'S DISCOVER SCIENCE PART V By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/david5.pdf)

6. LEARNING ABOUT LIVING PART ONE By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/D6.pdf)

7. LEARNING ABOUT LIVING PART THREE By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/D7.pdf)

8. THINKING AND DOING By David Horsburgh (out of print but downloadable as a pdf file from the link: http://vidyaonline.org/arvindgupta/ thinkanddo.pdf)

9. SMALL SCIENCE for Classes I to V (with the accompanying Workbooks and Teachers' Books) Homi Bhabha Centre for Science Education,TIFR, Mumbai. http://www.hbcse.tifr.res.in/smallscience.

10. http://www.arvindguptatoys.com/ contains an enormous list of books on enlivening science learning, rated by Arvind Gupta. Many of them can be downloaded for free.

11. LOW COST EQUIPMENT FOR SCIENCE AND TECHNOLOGY EDUCATION - Vol. 1 - Compiled by UNESCO http://unesdoc.unesco.org/images/0010/001023 /102321eb.pdf Provides ideas on how to make school science equipment using inexpensive materials.

12. LOW COST EQUIPMENT FOR SCIENCE AND TECHNOLOGY EDUCATION - Vol. 2 - Compiled by UNESCO - http://unesdoc.unesco.org/images/0007/000728/072808eb.pdf Provides ideas on how to make school science equipment using inexpensive materials.

13. http://www.exploratorium.edu/ is a fascinating website with tons of resources, activities and continuous updating to reflect the latest developments in the field.

14. http://www.johnkyrk.com/ has links to animations of cell structure, cell biology, DNA, etc.

15. http://www.bbc.co.uk/schools/scienceclips/ages/8_9/circuits_conductors_fs.shtml has an interactive tutorial on conductors.
16. http://www.primaryschool.com.au/science results.php?kla=Science%20and%20Technology& unit=Switched%20On has links to several interactive lessons like the one above.
17. http://www.juliantrubin.com/bigten/pathdiscovery.html allows the user to simulate online repetitions of famous experiments or inventions.
18. http://www.freeindia.org/biographies/greatscientists/has biographies of Indian scientists.
19. http://www-gap.dcs.st and.ac.uk/~history/Indexes/Indians.html has info on ancient Indian mathematicians.
20. http://www.calcuttaweb.com/people/snbose.shtml has some more biographies of Indian scientists.
21. http://www.shodor.org/succeed/curriculum/FOR/observation.html contains an interactive module to test one's observation powers.
22. http://www.scienceclass.net/PowerPoints/NOS_Test_Review.ppt contains a PPT that talks of the nature of science.
23. http://www.scienceclass.net/PowerPoints/NOS_Test_ReviewGT.ppt contains a second such PPT.
24. http://www.scienceclass.net/Teachers_Lessons.htm contains many valuable links to lessons on science topics for middle school level.
25. http://www.science-class.net/TAKS/taks.htm has many links to PPTs that elaborate specific concepts for middle school.
26. http://teachers.net/lessons/posts/1228.html (a website leading from http://www.curriki.org/xwiki/bin/view/Coll_rml ucas/LabClassificationofShoes?bc=; Coll_rmlucas.10 Classification) describes an activity wherein children have to classify shoes, so as to understand the importance of classification. (Useful in all branches of science, particularly chemistry and biology.)
27. http://www.encyclomedia.com/videoarctic_food_chain.html has a video on the arctic food chain.
28. http://www.kbears.com/ocean/octopus/index.html has a presentation and info on the octopus.
29. http://magma.nationalgeographic.com/ngexplorer/0309/articles/mainarticle.html contains rich info on underwater life.
30. http://www.seaworld.org/animal-info has a plethora of links and info on animals.
31. http://www.seaworld.org/fun-zone/coloringbooks/pdf/emp-penguin.pdf has a colouring page for kids to have fun, when learning about animals.
32. http://kids.nationalgeographic.com/Animals/CreatureFeature/ is a superb site where you can click on an animal to find out more about it. The 'more' includes facts, a video with sound, a map of places where it can be found, etc.

33. Resources for Teaching Middle School Science (1998) - http://books.nap.edu/catalog.php? record_id=5774 (ISBN 0309057817) National Science Resources Center of the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and the Smithsonian Institution

34. Resources for Teaching Elementary School Science (1996) - http://books.nap.edu/catalog.php? record_id=4966 (ISBN 0309052939) National Science Resources Center of the National Academy of Sciences and the Smithsonian Institution

35. http://www.exploratorium.edu/explore/handson.html contains many online as well as hands on activities for children of this age group and younger.

36. http://fi.edu/tfi/activity/act-summ.html contains many online as well as hands on activities for children of this age group and younger.

37. http://www.bbc.co.uk/schools/scienceclips/ages/10_11/science_10_11.shtml contains activities listed alphabetically, topic wise.

38. http://www.bbc.co.uk/schools/scienceclips/ages/9_10/changing_sounds.shtml contains simple sorting and tabulation exercises for Class V and below.

39. http://www.bbc.co.uk/schools/scienceclips ages/10_11/forces_action.shtml contains more complicated tabulation and interpretation exercises for Class VI/VII.

40. http://www.bbc.co.uk/schools/teachers/ks4/bitesize_chemistry.shtml contains chemistry assessment worksheets for Classes VIII and IX.

41. http://www.bbc.co.uk/schools/gcsebitesize/chemistry/classifyingmaterials/ contains exercises for assessing classification of matter, atomic structure, bonding and formulae/equations for Class VIII and above.

42. http://www.bbc.co.uk/schools/gcsebitesize/physics/electricity/ has some thinking-type questions for Class VIII and above.

43. http://www.bbc.co.uk/schools/gcsebitesize/physics/forces/ has excellent questions for Classes VII, VIII and above.

44. http://cse.edc.org/products/onlinecurr/catalog.asp has an online catalogue of web-based resources for middle and elementary school science.

45. http://www.explorelearning.com/index.cfm? method=cResource.dspView&ResourceID=491 has a beautiful animation of the photoelectric effect, can be shown to Class VIII.

46. http://www.explorelearning.com has a number of interactive simulations to learn science, appropriate for this age group.

47. http://cse.edc.org/products/onlinecurr/WBMISearchResults.asp has a complete list of topics and the modules available therein, for students of this age group and a little older as well.

48. http://www.blupete.com/Literature/Biographies/Science/Scients.htm has links to biographies of scientists.

49. http://www.juliantrubin.com/bigten/pathdiscovery.html is a website with a collection of links for discovery and invention.
50. http://www.fordham.edu/Halsall/science/sciencesbook.html is an Internet Sourcebook for the History of Science.
51. http://www.middleschoolscience.com/tunefork.htm has a good activity for learning about the tuning fork and sound vibrations, suitable for Classes VII and VIII.
52. http://www.pbs.org/benfranklin/exp_shocking.html has a lovely interactive simulation of the kite experiment performed by Benjamin Franklin.
53. http://www.pbs.org/teachers/sciencetech/ has grade-wise, topic-wise lesson plans for middle and primary school science teaching.
54. http://www.learner.org/resources/series90.html has a set of videos on the science of teaching science.
55. http://www.outlookindia.com/scriptur11w2.asp?act=sign&url=/full.asp?fodname=20050328&fname=Science&sid=1 has Nobel Prize-Winning Science Discoveries made palatable for children.
56. http://www.teachernet.gov.uk/teachingandlearning/subjects/science/science_teaching_resources/ provides links to a number of e-teaching learning resources for primary science.
57. http://www.firstscience.com/home/ is a leading online popular science magazine featuring articles on important breakthroughs, the latest science news, video clips, blogs, poems, facts, games and a whole lot more science-related content.
58. Chakmak: Science magazine for children http://www.eklavya.in/go/index.php?option=com_content&task=category&sectionid=13&id=57&Itemid=84
59. Sandarbh: A resource bank for teachers http://www.eklavya.in/go/index.php?option=com_content&task=category&sectionid=13&id=51&Itemid=72
60. Srote: Science and Technology features -http://www.eklavya.in/go/index.php?option=com_content&task=category&sectionid=13&id=56&Itemid=81
61. http://www.gobartimes.org/20090315/20090315.asp is a bi-monthly children's magazine highlighting news and views on environment and development through comic strips, cartoons, quizzes, essay competitions and interactive pages. It also serves as a useful teaching aid in classroomsfor teachers.
62. http://edugreen.teri.res.in/index.asp is a website for children that makes environmental learning fun
63. http://www.nuffieldcurriculumcentre.org/go/Default.html provides links to websites of various science projects that undertake to enliven science teaching
64. http://www.exploratorium.edu/ifi/resources/workshops/teachingforconcept.html provides a link to the paper “Teaching for Conceptual Change: Confronting Children's Experience; Watson, Bruce and Richard Kopnicek; Phi Delta Kappan, May 1990”.

Some Important Organisations in Science Education

S.No.	Name of the Organisation	Contact Details
1.	Agastya International Foundation	Address : Kataria House, 219 Kamaraj Road, Bangalore - 560042. Phone : 080-25548913-16 Website : www.agastya.org E-Mail : Maagastya@vsnl.com
2	Avehi-Abacus Project	Address : Third floor, K.K. Marg Municipal School, Saat Rasta, Mahalaxmi, Mumbai- 400 011 Phone : (022)2307 5231, (022) 2305 2790 Website : http://avehiabacus.org E-mail : avcab@vsnl.com
3	Bangalore Association for Science Education (BASE)	Address : Jawaharlal Nehru Planetarium, Sri. T. Chowdaiah Road, High Grounds, Bangalore-560001 Phone : 080-22266084, 22203234 Website : http://www.taralaya.org E-Mail : taralaya@vsnl.com
4	Bharat Gyan Vigyan Samiti/ Indian Organisation for Learning and Science	Address : Basement of Y.W.A. Hostel No. II, Avenue - 21, G-Block, Saket, New Delhi-110 017. Phone : 011-2656 9943, Website : http://www.bgvs.org E-Mail : bgvs_delhi@yahoo.co.in, bgvsdelhi@gmail.com
5	Center for Environment Education	Address : Nehru Foundation for Development, Thaltej Tekra, Ahmedabad - 380 054, Gujarat Phone : 079-26858002 Website : http://www.ceeindia.org E-Mail : cee@ceeindia.org
6	Center for Science and Environment	Address : 41, Tughlakabad Institutional Area, New Delhi-110062, INDIA Phone : 011-29955124/25, 29956394, 29956401, 29956399 Website : http://www.cseindia.org E-Mail : cse@cseindia.org
7	C.P.R. Environmental Education Centre (CPREEC)	Address : The C. P. Ramaswami Aiyar Foundation No.1, Eldams Road, Alwarpet, Chennai Tamilnadu, India-600 018 Phone : 044-24337023, 24346526, 24349366 Website : www.cpreec.org E-Mail : cpreec@vsnl.com, ecoheritage_cpreec@vsnl.net
8	Eklavya	Address : E-10, BDA Colony, Shankar Nagar, Shivaji Nagar, Bhopal - 462 016 Madhya Pradesh Phone : 0755-267 1017, 255 1109 Website : http://eklavya.in

S.No.	Name of the Organisation	Contact Details
9	Eklavya Institute of Teacher Education (EI)	Address : Eklavya Education Foundation, Core House, Off. C.G.Road, Ellisbridge, Ahmedabad-6 Phone : 079-26461629, Website : www.eklavya.org E-mail : eklavya@ekalavya.org
10	Homi Bhabha Centre for Science Education Research,	Address : Mr. H C Pradhan, Tata Institute of Fundamental, V.N. Purav Marg, Mankhurd, Mumbai, 400088 Phone : 022-25554712, 25580036 Website : www.hbcse.tifr.res.in E-Mail : postmaster@hbcse.tifr.res.in
11	Indian Science Congress Association	Address : 14, Dr. Biresh Guha Street, Kolkata - 17 Phone : 033-2287 4530 Website : http://sciencecongress.nic.in E-mail : iscacal@vsnl.net
12	Kalpavriksh Environment Action Group	Address : 134, Tower 10, Supreme Enclave, Mayur Vihar, Phase 1, Delhi 110 09 Phone : 011-22753714 Website : http://www.kalpavriksh.org
13	Kerala Sastra Sahitya Parishad	Address : Parishad Bhavan, Chalappuram PO, Kozhikkode - 673 002, Kerala, India Phone : 0495-2701919, 9447038195 Website : http://www.kssp.org.in E-Mail : gskssp@gmail.com
14	National Council for Science & Technology Communication (NCSTC)	Address : Department of Science & Technology Technology Bhavan, New Mehrauli Road, New Delhi-11001. Phone : 011-26567373, 26962819 Website : www.dst.gov.in E-Mail : dstinfo at nic dot in
15	Navanirmiti	Address : Navnirmiti, 301,302,303, 3rd floor, A wing, Priyadarshani Apartment, Padmavati Road, IIT Market Gate, Powai, Mumbai- 400 076. Phone ; 022-25773215, 25786520 Website : www.navnirmiti.org E-mail : contact@navnirmiti.org

S.No.	Name of the Organisation	Contact Details
16	Nuffield Foundation	Address : 28 Bedford Square London WC1B 3JS Phone : 020 7631 0566, 020 7580 7434 Website : www.nuffieldfoundation.org E-mail : info@nuffieldfoundation.org
17	Rajiv Gandhi Foundation	Address : Jawahar Bhawan, Dr. Rajendra, Prasad Road, New Delhi - 110 001, INDIA Phone : 011-23755117, 23312456 Website : www.rgfindia.org E-mail : info@rgfindia.org
18	State Institute of Science Education	Address : S.I.S.E (Rajya Vigyan Sansthan), P.S.M Campus, Jabalpur, M.P. 482001 Phone : 0761-2625776 Website : http://sisejbp.nic.in
19	Sutradhar	Address : 59/1, 3rd Cross, 10th A Main, Indiranagar 2 Stage, Bangalore 560038. Phone : 080-25288545 Website : www.sutradhar.com E-Mail : sutra@vsnl.com
20	Tamil Nadu Science Forum	Address : Balaji Sampath, C2 Ratna Apts. AH 250, Shanti Colony, Annanagar, Chennai-600040, TAMIL NADU Phone : 044-26213638 Website : bsampath@eng.umd.edu
21	Tamil Nadu State Council for Science and Technology,	Address : Directorate of Technical Education Campus, Chennai 25. Phone : 022-22301428 Website : www.tanscst.org E-mail : enquiry@tnscst.org
22	Vidya Bhawan Society	Address : Fatehpura, Udaipur, Rajasthan 313001 Phone : 0294 2450911 Website : http://www.vidyabhawan.org E-Mail : info@vidyabhawan.org, vbsudr@yahoo.com
23	Vikram A Sarabhai Community Science Center	Address : Opp. Gujarat University, Navrangpura, Ahmedabad - 380 009 Phone : 079-26302085,26302914 Website : www.vascsc.org, E-Mail : info@vascsc.org

8

Teacher Preparation

Readiness to do a job and believing in oneself are essential for a person to do a job successfully. No job will be successful when the people involved in doing it are not ready for it. That is why we often say that only those jobs / assignments will be successful which are done with commitment in word and deed. This can be called 'readiness'.

Why Readiness?

When we want to go to another place or when we want to conduct a programme either in the school or in the house, we plan for it at least two or three days in advance. We look for answers to questions like How to conduct? What do we need? Who to meet? How to sequence various activities? Which place is suitable? etc. Then, we make a list of all that has come out of this planning and thinking. Shall we call it readiness?

In the same way, as a teacher of physical science, we too need such readiness. Let us have a look at the present state of affairs in our schools. On the pretext of heavy syllabus, and showing the urgency of covering the syllabus within the allocated time, the science teacher is attending the class without any plan or schedule. That is why the teaching learning activities are 'passive' and teaching is restricted to 'lecturing'.

Experiments in laboratory or classroom has become a rare sight in our schools, so the teaching learning process is not able to develop in children any scientific outlook. In the name of science, children's brains are filled in with information. No opportunities are given to them for knowledge construction. It is high time that the physical science teacher learnt how to get ready to face these challenges and be an effective teacher.

Readiness in the teaching of Physical Science"

- Teaching Physical science without readiness is useless
- Since readiness is essential, the Physical science teacher should get ready in the following way. S/he should :

- Read the lesson to be taught thoroughly
- Prepare plans according to teaching strategies/methods (year plan, unit plan and lesson plan)
- Have complete understanding of the nature of children in class and their strategies of learning
- Design teaching learning activities to develop required process skills and to achieve targeted academic standards
- Get ready to elaborate on key concepts, mind-mapping, activities and experiments in the lesson
- Get ready with all the materials and resources required to conduct activities, experiments, field visits, projects identified fort the lesson
- Get ready to demonstrate the experiment and then guide children to do it either in groups or individually.
- See that children analyze the results of the experiments, make generalizations and thus construct knowledge
- Encourage and give suitable instructions / precautions to children when they are involved in doing activities and experiments
- Develop in children good comprehension of the key concepts through thought provoking questions. While preparing these questions the teacher should keep in view the previous knowledge of children and the phenomena they come across in day to day life.
- Encourage children to collect information / write answers on their own for questions given under the heading 'Think & Discuss'
- Make children read the contents of 'Do you know' and encourage them to collect and exhibit similar information in the classroom
- Do the experiments beforehand to make sure everything goes well
- Get ready with all the required materials to teach the lesson before going to the class
- Raise awareness in children about biodiversity and lead them to appreciate her/his surroundings and the beauty and diversity embedded in them
- Identify the possible project work / field visit in the lesson and get ready with worksheets / instruction sheets / information
- Check the observations sheets / worksheets and records of children regularly
- Get ready with assessment tools to check whether the targeted academic standards have been achieved in the classroom or not
- Inform children about their performance soon after marking the answer papers
- Develop /design remedial measures and additional teaching learning activities for slow learners
- Keep pace with the changes in the fields of science and technology and adapt his teaching accordingly
- Collect additional information through internet and reference books and pass it on to children

Let us hope that teachers will get ready to teach as shown above, and try to give children quality education, which brings out the creativity in children and make them future scientists

Additional activities to be taken up by the Physical science teacher

The teacher should:

- Get the laboratory ready to conduct experiments
- Get the classroom ready to conduct experiments If there is no laboratory or if it is not in a good condition
- Exhibit the photographs of scientists in the laboratory and celebrate their birthdays
- Conduct school exhibition, science quiz and science day during every academic year without fail
- Visit the place selected for field visit at least a few days in advance, collect required information and obtain necessary permissions
- Work as a guide in conducting project works by dividing children into groups and giving them suitable instructions / worksheets/ material
- Collect the names, addresses and phone numbers of important people in the society around the school with a view to make them partners in school development. The teacher should also establish science club in the school and conduct interesting programmes to arise curiosity and the zeal to learn among children

9 Continuous Comprehensive Evaluation

From RTE Act - 2009, we know that children should achieve all-round development, and that schools should take responsibility for this. Children should develop physically, mentally, morally and emotionally. For this, children's interests, attitudes and values should be developed along with school subjects.

The curriculum gives equal importance to teaching learning experiences and the evaluation of the achievement of children. If the evaluation conducted in schools evaluate not only the children's ability to construct knowledge, but also their personality development, and is done on a continuous basis throughout the year, it can be called Continuous Comprehensive Evaluation.

Here,

CONTINUOUS means: not limited to any particular teaching learning process or any event or any situation, but to observe all components of learning on continuous basis. This is to say that observing/evaluating children's physical and cognitive development in an orderly manner on a continuous basis in the school and outside the school without letting them know that they are being evaluated. By identifying the gaps in learning and by taking up remedial measures, the teacher as well as the student should be able to do self-assessment.

COMPREHENSIVE means:

'All-round development'- development in the children's physical, mental, ethical and cognitive domains. For this, equal importance should be given to scholastic and co-scholastic areas in the curriculum without looking at them as two separate areas. This means treating arts, work, values, health and life skills on par with language, mathematics, science and social studies. This way, it looks at the children's development not just from the standpoint of scholastic achievement but also from the view point of their interests, competencies and attitudes too. This is to say that comprehensive evaluation gives equal importance to creativity, analytical skills and rational thinking in addition to knowledge, understanding and application.

The Need for Evaluation

For us evaluation means conducting examinations. Teachers, parents and the society as a whole used to look at evaluation from the examination point of view. Forcing the children to memorize the information given in the textbooks, making them write it in the examinations and finally awarding marks for that has become the main aim of education. These examinations, conducted in the name of evaluation, instead of forming positive attitude towards learning and school, subject children to fear, anxiety and stress.

The marks and ranks that are used to measure the progress of children are putting children continuously under pressure, so their physical and cognitive development is hampered. The teaching learning processes have changed targeting the achievement of marks. Evaluation has become a big examination programme that is conducted ignoring the children's interests, attitudes and competencies. In this mad race for marks, undesirable happenings are taking place giving way to meaningless competition leaving no scope for the children's emotional development and the achievement of life skills. The unit and terminal examinations conducted in the name of evaluation are only good for stamping children 'pass' or 'fail' but not to identify the learning gaps and to remediate them.

The present evaluation system is teacher centered. The information given in the name of 'progress cards' contain evaluation done on scholastic areas only. On many occasions, though we claim to conduct Continuous Comprehensive Evaluation, in fact, only scholastic areas are given importance.

The co scholastic areas like art education, work experience, value education, life skills, etc., are not given due importance. Moreover, we misunderstand that Continuous Comprehensive Evaluation means conducting more examinations. Therefore, there is an urgent need for the policy makers, experts in the field of education and teachers to have a closer look at Continuous Comprehensive Evaluation and try to understand its true meaning.

Aims of Continuous Comprehensive Evaluation

Evaluation is not meant for memorizing information and reproducing it in examinations. It should assess the behavioural changes in children's cognitive, psycho-motor and affective domains which have been brought out by the learning experiences provided in the classroom, and help children to improve. The information given to children in the form of various lessons is not enough for them. NCF - 2005 indicated that it is the responsibility of the school to develop in children the skills and competencies necessary for their future life, like analytical skills, creative thinking, logical reasoning; and life skills, like self-discipline, patience, tolerance, social adjustment and facing and solving problems with tact. So far these have been treated as extra-curricular activities or co-curricular activities, and little or no importance has been given to them. This is detrimental to the all-round development of children. Hence, the state curriculum framework - 2011 has indicated that all these components should be treated as curricular activities, erasing the divide between them. Therefore, it is decided to evaluate the children's physical, cognitive, emotional and social development giving equal importance to each of them. Let us have a look at the objectives of Continuous Comprehensive Evaluation from this angle.

- To help develop cognitive, psychomotor and affective domains
- To lay emphasis on thought processes and de-emphasize memorization
- To make evaluation an integral part of teaching-learning process
- To use evaluation for improvement of students' achievement and teaching-learning strategies, on the basis of regular diagnosis followed by remedial instructions
- To use evaluation as a quality control device to maintain desired standards of performance
- To determine social utility, desirability or effectiveness of a programme and take appropriate decisions about the learner, the process of learning and the learning environment
- To make the process of teaching and learning a learner-centered activity

Continuous Comprehensive Evaluation should be organized as a part of teaching learning processes. This helps us to know how efficient are the learning experiences provided in the school in developing the children. In Continuous Comprehensive Evaluation, all components are evaluated equally without maintaining the distinction between curricular and co-curricular areas.

The evaluation procedures followed in school as a part of Continuous Comprehensive Evaluation should be such that they observe children completely in all aspects and record them. It is also necessary to assess children through examinations conducted periodically along with the evaluation done through observation of children inside and outside the classroom in tandem with the teaching learning processes. However, whatever may be the evaluation procedure, its results should not be used to compare two children.

Evaluation should not only observe how children learnt, and what was learnt but should also help them retain what was learnt. Interests, attitudes, emotions, special interests, physical growth and health related components should also be assessed along with knowledge, understanding, application, analysis and adjustment to new situations. This evaluation is of two types:

1. Formative Evaluation
2. Summative Evaluation

1. Formative Evaluation

Working towards improving the children's learning through observing and recording their performance while they are participating in teaching learning processes is called Formative Evaluation(assessment).It is used by the teacher to continuously monitor children's progress in a non-threatening, supportive

environment. It involves regular descriptive feedback, rather than marks and grades, which gives a chance for the students to reflect on their performance, take advice and improve upon it.

The teacher can estimate what the children have learnt; and how they are learning based on the discussions in the classroom, their answers to questions in the middle and at the end of the lessons, their notebooks, class work and homework, group activities and project work, etc. This is called formative evaluation.

Formative evaluation gives continuous feedback to the teacher as well as the children all along the teaching learning processes, so it helps them make necessary changes in their teaching/learning strategies. If used effectively, it can improve children's performance tremendously while raising their self-esteem and reducing the work load of the teacher. Let us have a look at the features of this formative evaluation.

Formative Evaluation

- Is a process to observe the progress of the child and how s/he is learning
- Is diagnostic and remedial
- Makes the provision for effective feedback on how children are learning
- Provides the platform for the active involvement of children in their own learning.
- Enables teachers to adjust teaching by taking into account the results of evaluation
- Recognizes the profound influence evaluation has on the motivation and self-esteem of students, both of which are crucial influences on learning
- Recognizes the need for students to be able to assess themselves and understand how to improve
- Builds on children's prior knowledge and experience in designing what is taught.
- Incorporates varied learning styles based on how and what to teach.
- Encourages children to understand the criteria that will be used to judge their work
- Offers an opportunity to children to improve their work after feedback,
- Helps children to support their peers, and expect to be supported by them.
- This is conducted in a natural environment free from stress and fear and without making the children aware of being tested
- The teacher can have an understanding of the children's progress while they participate in teaching learning processes

How to do Summative Assessment?

This is similar to an examination that assesses the achievement children in acquiring certain competencies specified for the class. But this should be stress free and should not encourage rote memorization and mechanical writing. Summative assessment should be done in the form of a written examination after the completion of syllabus or a part of the syllabus. Let us have a look at the important points in conducting summative assessment

- The teacher should prepare a question paper based on the specified syllabus
- Question papers prepared by external agencies/people should not be used
- Question papers should be firmly based on the academic standards of the class
- The teacher need not prepare a scoring key since most of the questions in the paper are open ended and since there is a scope to get a multiplicity of answers. We should not assume that all children come up with the same answer for a question.
- The question paper should give space for children to think creatively and write answers which are quite different from those given in the textbook. These answers may have come out of their experience or out their critical thinking/opinion. Such answers should be rewarded appropriately
- Since every section is a unit of 5 marks, the teacher should read the answer carefully and award marks

విజ్ఞాన శాస్త్రం - ప్రశ్నల వారీగా భారత్వం

విద్యా ప్రమాణాలు	వ్యాసరూప ప్రశ్నలు	స్వల్ప సమాధాన ప్రశ్నలు	సంక్షిప్త ప్రశ్నలు	లక్ష్యాత్మక ప్రశ్నలు	మార్కులు	శాతం
విషయావగాహన	2 (10)	2 (5)	-	20 (1/2)	40	40%
ప్రశ్నించడం, పరికల్పనలు	-	2 (5)	-	-	10	10%
ప్రయోగాలు - క్షేత్రపరిశీలనలు	1 (10)	-	-	-	10	10%
సమాచార నైపుణ్యాలు ప్రాజెక్టు పనులు	1 (10)	-	5 (1)	-	15	15%
పటనైపుణ్యాలు, బొమ్మలు గీయడం నమూనాలుచేయడం ద్వారా భావప్రసారం	-	2 (5)	-	-	10	10%
ప్రశంస, విలువలు జీవవైవిధ్యం పట్ల స్పృహ కలిగి ఉండడం	-	2 (5)	5 (1)	-	15	15%

సూచన: బ్రాకెట్‌లోని సంఖ్యలు మార్కులను, బ్రాకెట్ బయటి సంఖ్యలు ప్రశ్నల సంఖ్యలను సూచిస్తాయి.

సామాన్య శాస్త్రం - 6-9 తరగతులు

అంశం	ఫార్మేటివ్					సమ్మేటివ్						
	పిల్లల భాగస్వామ్యం, ప్రతిస్పందనలు	రాత అంశాలు	ప్రాజెక్టు పనులు	లఘు పరీక్ష	మొత్తం	విషయావగాహన	ప్రశ్నించడం	ప్రయోగాలు	సమాచార నైపుణ్యాలు	బొమ్మలు/పటాలు	ప్రశంస, నిత్యజీవిత విలువలు, వినియోగం, జీవవైవిధ్యం	మొత్తం
భారత్వం	20%	20%	20%	40%	100%	40%	10%	10%	15%	10%	15%	100%
మార్కులు	10	10	10	20	50M	40	10	10	15	10	15	100M

- If there are two 2 marks questions and one 1 mark question in a section, total marks out of 5 should be noted (however, s/he can give marks to the questions separately)
- Since all questions related to a certain academic standard appear in a single section, it is easy to know the weightage given to that standard and to know the children's performance in it
- The teacher can mark the answer papers in the manner used hitherto. However, s/he should be careful in doing that since the answers differ from student to student
- After marking the answer scripts, marks and grades should be tabulated according to the academic standards as shown below
- To give a grade, the teacher should consider the marks of the students and the range they fall into as shown in the table.

Look at the following example. Ravi is in class 8. Given below are his marks in various academic standards in the first summative assessment in biology. Here, the teacher gave a question paper for 100 marks in 6 sections (In science we have 7 academic standards, but we have to club 6 and 7 and give it under one section). Marks are distributed among the sections according to the weightage given to each academic standard.

Academic Standards						Marks	Grade
1	2	3	4	5	6		
40	10	15	10	15	10	100	B+
20	8	10	6	11	7	62	

The answer scripts are marked and the scores are tabulated as shown. From the table, we know that Ravi secured 62 marks out of 100. Since his marks fall in the range 51 – 70, and the corresponding grade is B+, he is given that grade.

Percent	Grade
91 - 100	A+
71 - 90	A
51 - 70	B+
41 - 50	B
Below 40	C

Summative Assessment

Model Test Paper Class – 8 Physical Science

8th Class Time:

Name of the Student ..... Section ..... No.....

I	II	III	IV	V	VI	Marks	Grade

I. Conceptual Understanding

a) Answer any two of the following **2x10 = 20**

1. We know that metals allow themselves to be drawn as wires. Explain, with suitable examples, the chemical properties of such metals.
2. What are the factors responsible for sound pollution in your area? What are the problems faced by people because of this pollution? Give your suggestions to prevent this?
3. When Rangayya was grazing his cattle in a field, suddenly, there were lightning and thunder. What precautions should Rangayya take in such circumstances? How do lightning and thunder happen?

b) Answer the following questions

4. Zavid said, “Friction is not only a friend, but also an enemy to humans.” How will you support him?
5. You have read about Solar System, haven’t you? If you have to write an essay about it, what five important points do you choose? Write them and elaborate them?

c) Give one-word answers to the following Questions?

6. Example for combustible material?
7. Electrolysis means……...
8. In which direction does Polar star appear?

9. One difference between contact force and field force…….

10. Rapid combustion means…….

d) Fill in the blanks with suitable words.

11. Artificial fibres are made from …… materials through synthesis.

12. To reduce friction in a machine, you use ……..

13. When Sudheer put a lighted match at the mouth of a test-tube, it gave out a popping sound, so the gas in test tube can be ……

14. The instrument used to measure the intensity of sound …….

15. The meteors that fall on the Earth from the sky are called……..

16. Seismograph is used to measure ……

e) Write what you understood about the following words. **2x1 = 2**

17. Carbonization

18. Electrostatic Cell

f) Choose the correct answer for each of the following questions. **5 x ½ = 2½**

19. Choose the material which cannot be charged using friction

a) Plastic Scale b) Copper Rod c) Balloon filled with air d) Wooden Piece

20. What is Rayan made from?

a) Coal b) Oxygen c) Coir d) Cellulose

21. What is the important constituent in coal?

a) Carbon b) Oxygen c) Air d) Water

22. Which of the following is an electric conductor?

a) Distilled water b) Drinking water c) Coconut Oil d) Kerosene

23. Which of the following is a non-metal?

a) Iron b) Zinc c) Copper d) Sodium

II. Asking Questions and making Hypothesis **2x5=10**

24. Imagine and write about our life in future when all the fuels in the Earth are used up?

25. Deepak had so many doubts about the various forces that act upon the roller used to roll the cricket pitch. What doubts do you have on this? List them.

III. Experimentation and field investigation

26. On the occasion of the celebration of Science day in your school, you got a chance to make and exhibit the electrolytic cell. Elaborate on the materials you gather and the procedure you follow to do it.

(or)

Santhi gave a copper coating to her iron key. What do you think is the process she followed to do it. Write the stages sequentially.

IV. Information skills and projects

27. The following table gives details about the short fall of energy in India during the period 1991 – 1997. Study the table and analyze the data. 1 x 10 = 10

S.No.	Year	% short fall of energy
1	1991	7.9
2	1992	7.8
3	1993	8.3
4	1994	7.4
5	1995	7.1
6	1996	9.2
7	1997	11.5

a) Did the short fall of energy increase or decrease?

b) How was the availability of energy in 1997 compared with 1991?

c) In which year were the energy needs less?

d) What does the increase in short fall of energy indicate?

e) On what aspect of energy do we have to focus on as per the indications of this table?

28. What information do you have to gather to write a report on the use of petroleum products in your village / town? Prepare a table to record the information collected.

V. Communication through Drawing / Model making

29. Draws a figure to explain the experiment you do to know the gases that come out when coal is heated. Also write the precautions to be taken to do the experiment.

30. Draw a figure showing the procedure to make a tester using a magnetic compass, battery and wires. Write the uses of it.

VI. Appreciation, Values, Bio-diversity and real life applications

31. If you have to speak on the effects of radiation from artificial satellites revolving round the Earth on Bio-diversity, what points do you focus on?

32. Hari said to his father, “We can save a lot of fuel if we use a cycle instead of a motorbike to do errands.” What suggestions do you give on this?

33. Write answers in a sentence.

a) What is the use of recycling process?

b) Damage/Harm when exposed to blasting sounds

c) A situation in which you use frictional force.

d) How do you appreciate the extensive use of plastic?

e) What is your advice to prevent sound pollution?

Summative Assessment

Model Test Paper Class – 9 Physical Science

9th Class Time:

Name of the Student ..... Section ..... No.....

I	II	III	IV	V	VI	Marks	Grade

I. Conceptual Understanding

a) Give elaborate answers to any two of the following **2x10 = 20**

1. Deduce the equations of uniform acceleration?
2. What are the features and limitations of Rutherford's atomic model?
3. Deduce a formula for pressure difference at different levels of depth in fluids. Explain Buoyancy from this.

b) Answer the following questions **2x5 = 10**

4. Distinguish between echo and reverberation?
5. Why does not the moon fall on the Earth due to gravitation?

c) Write what you understood about the following words. **5x1 = 5**

6. Compressibility
7. Fractional distillation
8. Formula unit mass
9. Inertia
10. Isotope

d) Fill in the blanks with suitable words.

11. The characteristic that shows the difference between shrill and growl voice is ……..
12. The energy of a body which is at a certain height from the Earth is …….

13. The mass in unit volume is ……

14. The acceleration of a free falling body does not depend on ……

15. The Atom without neutrons is ……

e) Choose the correct answer. **5 x ½ = 2½**

16. In Na_2Co_3 the valency of sodium is

17. 1 b)2 c) 3 d) 4

18. Which of the following is a is pure
    Air b) Soda 3) Distilled water d) Steel

19. Which of the following can be used to explain the law of conservation of mass?
    a) Newton 2nd law of motion b) Newton 3rd law of motion
    c) Newton 2nd and 3rd law of motion d) All of Newton's laws of motion

20. A man travelled from A to B with a velocity 40 km/h and returned from B to A with a velocity 50 km/h. What is his average velocity in km/h……

21. Change in the state of a substance depends on……

II. Asking Questions and making hypothesis **2x5 = 10**

22. Aravind asked some questions on seeing an empty glass floating on water in a tub. What questions will you ask?

23. Sudhakar observed how water coming out of a pipe scatter into water drops on hitting the ground. He made some assumptions on this phenomenon. Try to guess and write them down.

III. Experimentation and field investigation **10M**

24. Is the marker pen ink a mixture or a compound? How can we know this? Describe the experiment you did to verify this?

(or)

Indicate a practical method to find out the special characteristic of floating objects. What are the points to be borne in mind while doing the experiment? What are the precautions to be taken?

IV. Information skills and projects **2x5 = 10M**

25.(i) To collect information about the working of airbrakes in vehicles, whom should you meet? On what areas/aspects do you have to collect information?

(ii) Study the following table and write your comments/interpretations.

S.No.	Element	Valency	Compound
1	O	2	H_2O
2	N	3	NH_3
3	C	4	CH_4
4	S	2	SO_2
5	H	1	H_2SO_4

V. Communication through drawing/ Model Making **2x5 = 10**

26. Draw a distance-time graph for the story about the race between a hare and a tortoise.

27. Explain, with the help of a diagram, the arrangement of apparatus in the experiment that proves the law of conservation mass.

VI. Appreciation, Values, Bio-diversity and real life applications **3x5 = 15**

28. We see the application of Newton's laws of motion in our daily life. Write any five such instances where these laws are applied.

29. In nature, we see energy transforming from one form to another. How do you appreciate the role of 'the law of conservation of energy' in preserving/maintaining the equilibrium in nature?

30. You have studied about sound. With that knowledge, what advice do you give to your friend who is learning music?

Bringing the Laboratory into the Classroom: Bringing Inventive Thinking into the Mind

Neeraja Raghavan

There is no doubt that a good laboratory will enrich the learning and teaching of science. While this is undisputable, it is possible to transform the teaching and learning of science even without a full-fledged laboratory, provided one can draw upon everyday experiences, commonly asked questions, easily available materials and just a few tools that may need to be purchased.

If we map the journey of a typical science class, we will probably see something like what is shown below:

1. Teacher first reads through the syllabus

↓

2. Teacher reads the relevant portion of the text

↓

3. Teacher plans the lesson(s) to cover that particular topic

↓

4. Teacher covers the topic in the allotted number of periods

↓

5. Teacher gives worksheets and/or a test to assess learning levels

In the above work flow, the role of the teacher is that of a lecturer, and (s)he will doubtless cover the topic efficiently, if (s)he moves as planned. The role of the child is largely that of a passive recipient, who is called upon to listen to and absorb whatever was taught, only to repeat it (preferably verbatim) during the assessment. Conspicuous by their absence are the following: experiential learning, the triggering of curiosity, the articulation of questions, the performing of experiments, the noting down of observations, the 'seeing' of a pattern in data collected, the drawing of logically consistent conclusions and finally, the shift in thinking that results from a transformative experience.

In order to show that none of these processes is too far - fetched - even in Class IV - in a school without a laboratory, I shall first draw upon a research paper which describes a very simple experiment. A fourth grade teacher had to teach 'heat' to her students, and she chose not to adopt a route such as the one delineated above. Instead, she began by asking the nine-year-old children (in cold Massachusetts) about their experience of warmth and heat, in the nine winters that they had faced so far. (See text box below)

"Sweaters are hot," said Katie.

"If you put a thermometer inside a hat, would it ever get hot! Ninety degrees, maybe," said Neil.

"Leave it there a long time, and it might get to a hundred. Or 200," Christian added.

Confronted with the children's preconceptions in so direct a manner, this talented teacher decided to have the class test out each one of them. She did this by having the class place thermometers in hats, sweaters and even a rolled up rug. When children found that the first few readings on the temperatures did not show any difference, they were convinced that they needed to leave the thermometers in longer. (Here, the resistance that we normally encounter in giving up a pet premise is palpable!) So they left the thermometers overnight and came back the next day, sure that the temperatures would be soaring! Instead they found no demonstrable change. Still, they were not yet ready to abandon their ideas. A less talented (or more harried) teacher would probably have stopped at this point, corrected them and explained the reason why the temperature did not rise. Instead, this teacher empowered her students to 'own the problem' and continue pondering, testing and discussing their ideas until they were themselves ready to give up their erroneous belief and incorporate new knowledge.

What is remarkable about this class? First, the teacher was less focused on covering the syllabus than on uncovering students' preconceptions. Next, she was wise enough to allow the learning to unfold at its own pace, by testing the premise of each child, and waiting for them to give up their incorrect preconceptions only when they were convinced of their incorrectness. I can almost hear the teacher's lament: “But we can't possibly do this for each and every topic! We will never finish the syllabus in this way!” Yes, you probably won't. But to your surprise, you may find that you won't need to. Because in the process of nudging the children to think through their own preconceptions, the immense learning that has been effected will stand the class in good stead when the next topic has to be DIScovered! (not covered.) [Besides, by covering the entire syllabus under the thick hood of efficient transaction, one is not effecting a change in thinking at all: and how, then, can one claim to be teaching science?] Thirdly, the link between scientific thinking and one's everyday life are so obvious in this class, that there is no need to teach that chapter on 'Scientific Temper' (which usually forms a mandatory part of the syllabus) and now, doesn't that reduce the 'portion' to be 'covered'?!

Science Communicator's Forum (SCF) has innovated cost-effective ways to convey scientific concepts. For instance, since prisms are expensive, members of SCF use a glass of water and an inexpensive laser light to demonstrate the internal reflection of light. Similarly, in order to explain the concept of land and sea breeze, students are asked to take a tumbler and put some water on one side and sand on the other side. The tumbler is then left outside in the sun. An incense stick is lit and placed in between the sand and water. Once the sand and the water are warm, the movement of the smoke indicates which way the breeze is blowing. This way, students get to learn the basics of how sea and land breeze occur. [from http://timesofindia.indiatimes.com/Education/Beyond_the_chalk talk_method_of_teaching/articleshow/3935253.cms Times of India 5 January 2009, Beyond the chalk-talk method of teaching) Times of India 5 January 2009, Beyond the chalk-talk method of teaching)

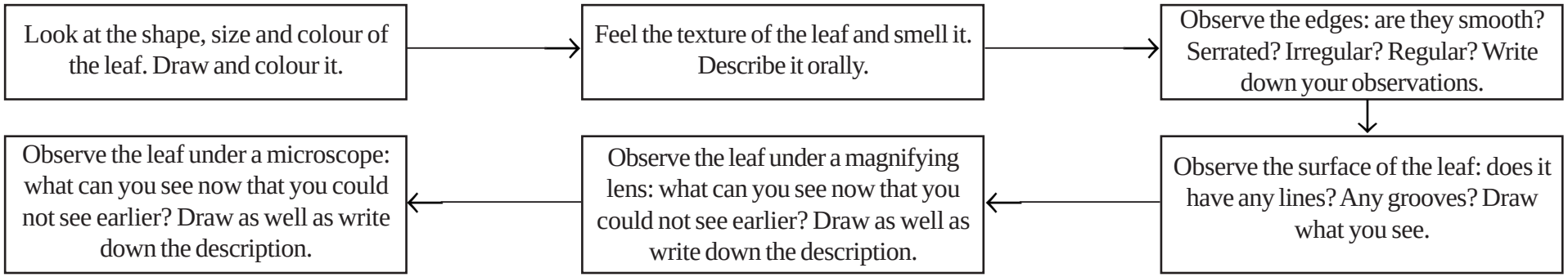
It is important to see how the shift in thinking can only occur when the teacher begins to view science more and more as a 'Verb', and less and less, as a 'Noun'. In getting children to 'own' their premises, one is empowering them to hold certain beliefs, something we never do when we are only focused on 'covering' the syllabus. Then, as we lead the children into enquiring into these strongly held beliefs, we are moving from a secure ground where the child is not threatened: instead, the child is confident enough to test his/her premise. Would it now be unreasonable to expect such a child to carry on with this practice of testing out dearly held beliefs, even outside the classroom? Surely not! It is, therefore, desirable to bring in this process of thinking into the science class, and much of this does not require a hi-fi laboratory, at least for Class IV and V.

Some suggested ways of developing Observation, Enquiry and Thinking Skills in Class IV and V are described in the following section, through the example of a Leaf.

In addition, it is important that the teacher goes to class prepared with at least a few names and biographies of scientists who have worked on the topic to be taught (in this example, leaves and plants) so as to be able to connect at least some of the questions asked (by the children) to those asked by scientists down the ages. Beginning with a set of stories about scientists, (to be culled from references, some of which are suggested elsewhere in this issue), the teacher must show how those scientists looked at certain things and then asked certain questions, just like the children are now doing in class. [For example, in connection to some of the questions posed for a leaf, here are some related scientists and discoveries, which took this writer less than ten minutes to cull from the Internet:

- While studying an orchid, botanist Robert Brown (1831) identified a structure within the cells that he termed the "nucleus."
- In the 1770s, Jan Ingenhousz discovered that plants react to sunlight differently than shade and from the underpinnings of this, the understanding of photosynthesis was born.
- From the fifteenth century onwards, early European explorers who went on sailing expeditions around the world, noticed that the tropics host a much greater variety of species. Answering why this is the case allows today's scientists to help protect life on Earth.]

Guidelines for gradually honing observation skills: (increasing intensity of colour of textbox shows increased intensity of observation) We are taking the example of a leaf:



Guidelines for gradually honing enquiry skills : In the example of a leaf, the nature of questions that can be drawn out/discussed could be of the type:

- Why is this leaf shaped thus?
- What are the uses of this leaf?
- When does it grow?
- Where does it grow?
- When does it die?
- What does it need to grow?
- Why does/doesn't it smell?
- Does it have brothers and sisters like I do?
- Does it belong to a family like I do?
- What is this leaf made up of?
- Can I eat it?
- Who can eat this leaf?
- Does its shape, size or colour change over time?
- Can its shape, size or colour be changed by planting it in different soils? By giving it different food?
- Do insects like to sleep on it? Eat it?
- How can we protect the leaf from insects? Animals? And so on.

A word of caution: In the commonly-experienced hurry to arrive at the 'right answer', too often the brilliant question is missed, the sustained enquirer is ignored, and the exercise turns into one of ticking right versus wrong answers. It is strongly recommended therefore that the flood of enquiry be sustained through active encouragement of those who kept asking, right until the end of term/year.

Thinking: Following the flood of enquiry, it may be opportune (depending upon the level of understanding and interest of the class) to stoke the fire further through discussion. This is an important part of the process of drawing the child into the fold of timeless scientific enquiry, by connecting the questions asked by the child to prior questions/discoveries or presentday unknowns. Again, it is important to bear in mind that without unduly hurrying the child to think of answers to the questions asked in the Ask stage, this Think step should be used well to roll the questions over with the tongue, as one would a piece of candy. Suck it, taste it, feel its juice pouring down your throat! The important thing here is not to worry about answers, but to allow for bold and free thinking around each question, perhaps again in the form of further questions.

Questions spring up in the mind from our own level of understanding and knowledge. Therefore, the teacher would do well to pause and take some time in looking at questions asked through the screen of the following filters, continuing with the example of the leaf:

1. A question like “Why is this leaf green?” could be connected by the teacher to why anything appears coloured, do we all see the same colour, what causes the perception of colour in each person, etc. Thus, the child can be asked to draw a chain of questions, each inside a bubble, as it were, and see how one question in the first bubble is leading to the spurting of so many more questions.
2. Questions on the shape and size of the leaf can be connected by the teacher to our own shapes and sizes, that of animals and other parts of creation, and the class can together muse on possible links between function and shape/size of any creature. Would an elephant be an elephant if it were not so huge? Would a jackfruit be as tasty if it were not so big? etc.
3. Questions like 'How does the leaf grow?' could be connected to the story of the discovery of photosynthesis (see Box 1 below), which the teacher needs to go prepared with, to class.

Box 1: Photosynthesis

Too often, this topic is taught as if the entire mystery was just revealed to scientists by the flick of a wand. This writer visited a very interesting website: http://www.juliantrubin.com/bigten/pathdiscovery.html and culled the following information in less than twenty minutes of surfing. The teacher would do well to collect four or five such stories before taking up a new topic, so as to awaken the scientist within the child.

Is Water the Source of Energy in Plants?

Experiment I

Jan Baptista van Helmont, Flemish physician, chemist, and physicist, in the 1600s carried out a famous experiment by growing a willow tree in a pot for five years. At the end of this period the tree had increased in mass by 74 kg but the mass of the soil had changed little. Van Helmont believed that water was the source of the extra mass and the plant's source of life. What could the other possibilities be? How would you test out each of those possibilities? (Sequence of experiments as they were performed historically, follows.)

Experiment II

John Woodward, a professor and physician at Cambridge University in the late 1600s, tried to design an experiment to test Van Helmont's hypothesis that water was the source of the extra mass. In a series of experiments over as many as 77 days, Woodward measured the water consumed by plants. For example, one plant showed a mass gain of about 1 gram, while Woodward had added a total of almost 76,000 grams of water during the 77 days of plant growth - this was a typical result. Woodward correctly suggested that most of this water was “drawn off and conveyed through the pores of the leaves and exhaled into the atmosphere”. So the hypothesis that water is the nutrient used by plants was rejected. (Teacher can describe the experiment and ask students to draw the inference.)

The Interaction of Plants With Air

In August of 1771, Joseph Priestley, an English Chemist, put a sprig of mint into a transparent closed space with a candle that burned out the air (oxygen was not discovered yet) until it soon went out. After 27 days, he relit the extinguished candle again and it burned perfectly well in the air that previously would not support it. And how did Priestley light the candle if it was placed in a closed space? He focused sun light beams with a mirror onto the candle wick (Priestley had no bright source of light and had to rely on the sun). Today, of course, we can use more sophisticated methods to light the candle like focusing light from a flood light through a converging lens or by an electrical spark. So Priestly proved that plants somehow change the composition of the air.

In another celebrated experiment from 1772, Priestley kept a mouse in a jar of air until it collapsed. He found that a mouse kept with a plant would survive. However, we do not recommend to repeat this experiment and hurt innocent animals. (Teacher can describe the experiment and ask students to draw the inference.)

Plants and Light

Jan Ingenhousz took Priestley's work further and demonstrated that it was light that plants needed to make oxygen (oxygen was discovered a few years earlier in 1772 by Carl Wilhelm Scheele). Ingenhousz was mistaken in believing that the oxygen made by plants came from carbon dioxide.

However, Jan Ingenhousz was the first person to show that light is essential to the plant process that “somehow purifies air fouled by candles or animals”.

In 1779, Ingenhousz put a plant and a candle into a transparent closed space. He allowed the system to stand in sunlight for two or three days. This ensured that the air inside was pure enough to support a candle flame. But he did not light the candle. Then, he covered the closed space with a black cloth and let it remain covered for several days. When he tried to light the candle it would not light.

Ingenhousz concluded that somehow the plant must have acted in darkness like an animal. It must have breathed, fouling the air. And in order to purify the air, plants need light. (The teacher can describe the experiment and ask students to draw the inference.)

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Developing Scientific Temper

Dileep Ranjekar

Among the several goals of education, the one that appeals to me the most is “Developing Scientific Temper”. There could be several reasons for this - upbringing, the education that I received, the atmosphere at home and the fact that both my brother and sister are scientists of some repute, or could be the work environment in the organisation I worked in.

Watching my ten-month old grandson, Anurag, grow, and my recently spending a day at the “Science Mela” in Shorapur block in Karnataka, are two experiences that have made me think of this subject more seriously.

For Anurag, it is a whole new world. He has just learnt to walk independently, stand up, reach out, touch, put pressure on things, and before him lies a whole new world to be explored. It is absolutely amazing how he keeps repeating things tirelessly, saves his fingers from getting crushed, does not waste time in crying even if he falls quite badly, learns how to move knobs, understands what will start music and what will stop it, interestingly keeps shifting his attention to something new, and shows immense joy on his face when he causes the light to switch on or off, or the momenthe encounters any new attraction. There are nopre-conceived notions, no one way of doing things, no resistance to absorb fresh facts that emerge out of a new experience.

The “Science Mela” in Shorapur was a different experience. It had the ingenuity of primary school children and their teachers in organizing several kinds of experiences for the 1500 children and their parents who participated in the “mela”. It broke several commonplace myths and created fresh awareness about one's own existing knowledge and understanding. I, for one, had a notion that I had a very good sense of accurately judging weights. In one of the stalls, I was required to lift three different stones and guess the weight of the stones. I was crestfallen to know that all my guesses were nowhere near the actual weight of the stones. The science mela was a powerful example of how, by simple methods, awareness, interest and knowledge could be created at a mass scale through an event that is organized by the children and the teachers themselves. What appealed to me, was the difference the mela would create to the life of those children and teachers who organized it.

Scientific temper has been defined by several educationists, philosophers and scientists. Our Indian Constitution upholds the cultivation of scientific temper as one of the fundamental duties of citizens. Scientific temper is an attitude or a way of being that involves application of the mind, application of logical analysis, willingness to meet with new facts and evidence without pre-conceived notions, and willingness to question conclusions based on newer evidence. What does this entail or lead to? Necessarily an open mind, the ability to consider facts as they exist, discuss, debate, develop rationale, argue, analyse before concluding, and the willingness to live with the co-existence of several truths.

Even to an untrained mind, science automatically means knowledge, experiment, questioning, gathering of data, reason, something that is not mystical but can be proven, touched, felt, smelt, experienced, etc. Scientific temper would mean comfort with all the above and more. Very rightly, the distinction has often been made between “science” and “scientific temper”. While science gives us knowledge, tells us the logic, provides an experience, explains why

things exist the way they do, “scientific temper” would guide us on the constructive use of the knowledge, abilities and experiences that science equips us with. There is both wisdom and morality involved in the usage of knowledge. Thus, for instance, scientific temper would lead to an attitude of “secularism” where you respect others' religious practices, rather than developing blind faith in a single religious practice and propagating that it is the only “right” way to practice religion.

There is no place for “superstition” and “blind faith in mythology” in the world of scientific temper. While mythological stories could be powerfully used to lead to virtual learning for young minds, forcing people to believe in stories that have no evidence is counterproductive to the process of forming a logical society. This can also be extended to learning history where one has to seek evidence, examine the same, connect to several other frames and conclude reliably as to what would have happened during a certain period rather than resorting to ambiguous interpretations based on one's own belief of what must have happened.

I would go the extent of saying that scientifictemper has greater implications for the broader wayin which society and human beings think, respond,and conduct themselves, than its implications for science itself. A doctor, for instance, may be agreat scientist but cannot be considered as having scientific temper if he/she does not meet patients on time and extorts disproportionate money for the treatment offered.

It beats me when I hear reputed science education institutions having politics based on caste, genderand several other illogical issues. One may recollect the two suicides not too long ago, at one of theleading institutes in the country - one for harassment, based on social backwardness and the other arisingout of stress due to the unmarried status of the lecturer, where the parents were forcing marriage. These are reflective of the need for the development of a “scientific temper” in society at large. How dowe, in the twenty-first century still discriminatebased on caste, creed, religion, gender, marital status and economic status of a person? Why don't weaccept that marriage is a personal choice and that standard norms for a 'marriageable age” should not have any place in current modern society? Scientific temper plays a major role in questioning status quo, breaking stereotypes and establishing practicesthat meet the current needs of society.

To me, scientific temper is accepting newer methodsof thinking, continuous questioning, being open to accepting that your own experiences, views, and conclusions need continuous re-calibration,and breaking stereotypes. It is about our ability tosay “I don't know”. A truly scientific attitudeshould make us tolerant, break artificial barriersof caste, religion, political and geographical boundaries, and enable us to be self-reliant tothe extent that we have the courage to change ourselves at any phase in life. Dileep Ranjekar is Chief Executive Officer, Azim Premji Foundation.