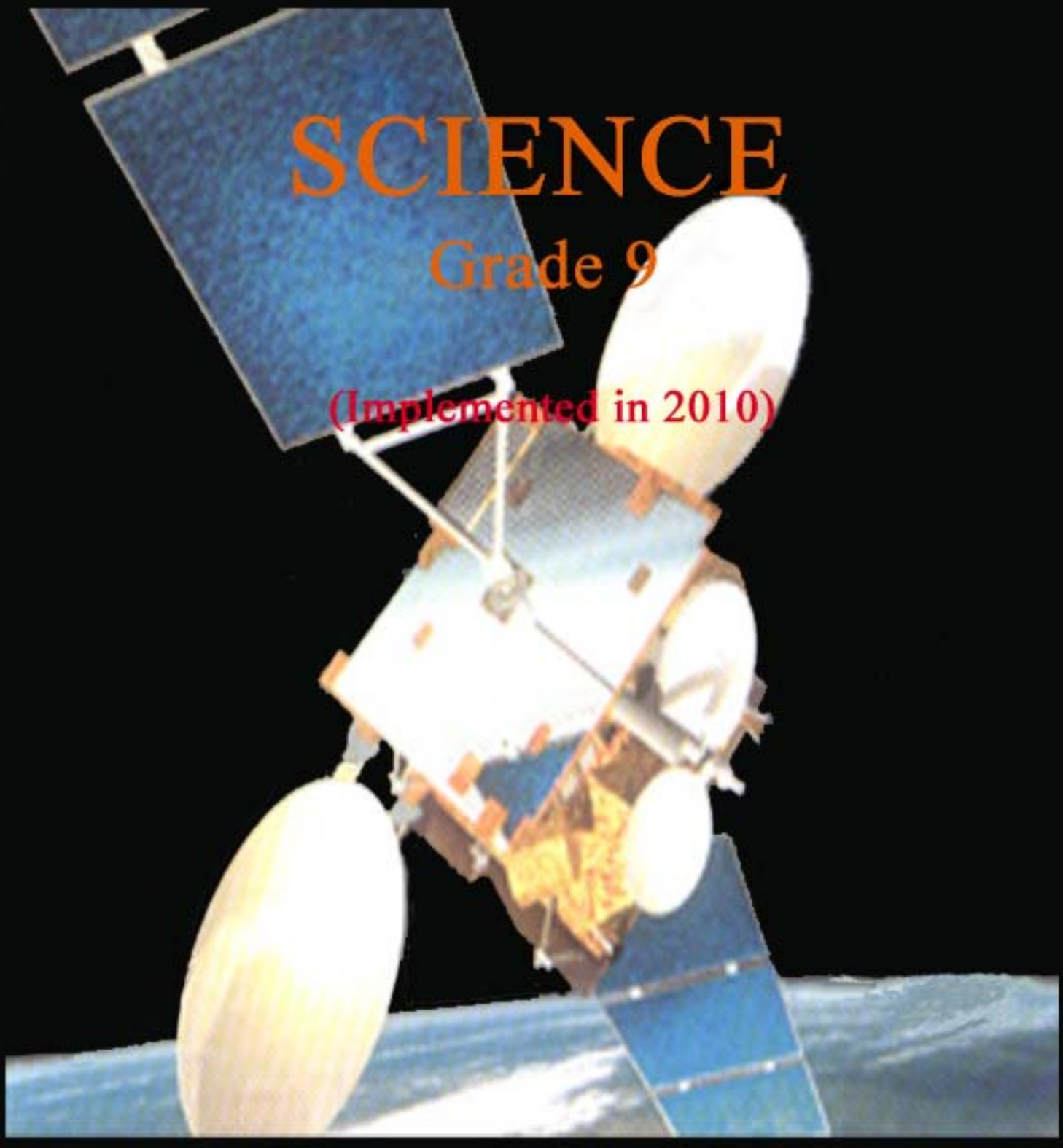
SCIENCE

Grade 9

(Implemented in 2010)



Teacher's Instructional Manual

Department of Science, Health and Physical Education
Faculty of Science and Technology
National Institute of Education

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ISBN -

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Printing:

Message of the Director General

While the new approaches to the teaching of subjects in Junior Secondary and Senior Secondary Grades have been introduced, by the National Institute of Education for Grade 8 in 2009, the present Teacher's Instructional Manual will provide excellent guidance to teachers on the teaching approaches they should adopt in teaching subjects. A significant change has been effected in the classroom Learning-Teaching activity through these teaching approaches introduced with respect to Grades 6 and 10 in 2007 and Grades 7 and 11 in 2008.

This Teacher's Instructional Manual is provided to you in order to provide you with guidance on how you should organize your classroom activities so that they are student-centered. The organization of the classroom Learning-Teaching process based on the student-centered approach is not a new experience to either the Sri Lankan classroom or to the teacher. Nevertheless, the student-centered Learning-Teaching Methodology has been provided a novel character through this new approach.

Not only does the present Teacher's Instructional Manual provide the direction necessary in planning lessons to ensure student participation but it also judiciously builds up the environment required for the purpose. The activities in this Teacher's Instructional Manual have been so organized as to provide directions to students on the setting up of new groups for each lesson, exploring new information and generating now knowledge.

The basis of the guidance inherent in the Teacher Guide is the philosophy that the teacher should be rather a Transformer of Knowledge than a mere Transmitter of Knowledge. As such, the activities here helps transform the student into a learner who seeks knowledge and thereby generates new knowledge. Therefore, teachers are expected to direct and stimulated students to discover new knowledge through exploration.

It is believed that the underlying philosophy as well as the activities described in this Teacher's Instructional Manual will stimulate the teacher to break away from the shackles of traditional teaching methodologies and think. It is necessary that our teachers focus on new approaches and teaching methods. The new millennium has seen the birth and creation of an immense range of new knowledge. Therefore, there is need to break away from traditional methods and concentrate on planning new activities of one's own.

What is expected through the information included in a Teacher's Instructional Manual of this nature is to direct the teacher to higher approaches while providing him with the basic instructions that he/she could employ in his teaching tasks. It is expected that teachers will make a study of this Teacher Guide with that objective in view and utilize the know how in the classroom. As such, what is mainly expected through an endeavour of this nature is to raise the efficiency and quality of the classroom Learning-Teaching process.

I would like to thank the subject specialists of the National Institute of Education as well as the external resource persons who contributed of their time and expertise in the preparation of this Teacher's Instructional Manual.

Professor Lal Perera
Director General
National Institute of Education

Preface

The first curriculum reform of the new millennium has now completed two years of implementation. The curricular material developed for grades 6 and 7 of the Junior Secondary Cycle (JSC) and grades10 and 11 of the Senior Secondary Cycle (SCL) are now in the system. At a time where one half of the introductory phase of the curriculum reform sees its completion, it is very important for us to reflect on our past experiences, learn from them, and pave the way for the new thinking to contribute to sustainable development of the country.

This curriculum reform allows us to break away from a reactive approach to curriculum development to take up a proactive approach. Retaining the known, learning the pre-determined and constructing what is - emphasized over the past will be replaced by revising the known, exploring the undetermined and constructing what might be. To realize this new vision we have adopted a competency-based, student-centred, and an activity-oriented approach to curriculum development under the new transformation role of the teacher.

The teacher, who directs students to construct knowledge and meaning in the new learning teaching process, attempts to produce a person with an integrated personality. For this, the teacher takes the responsibility for developing thinking, social and personnel skills of every child in the classroom. In view of bringing about a new society that can make correct decisions, solve problems and manage conflict, the teacher provides opportunity for the children to think in novel ways, derive meaning from their day-to-day experiences, engage in analytical thinking, and use both inductive and deductive logic to develop their logical thinking skills.

The new role proposed for the teacher also provides opportunity to develop social skills in students. The children exploring in groups will develop empathetic listening skills with abilities to care for others and share with others. The knowledge explosion we experience today does not allow any one of us to depend on a teacher any more to get at all the knowledge we need to be successful in life. Sharing knowledge both in small groups and with the whole class prepares the children to face challenges of the future. Getting different groups to explore different facets of the same problem and share their exploration findings with the larger group enables complex problems of tomorrow to be solved easily, and in a shorter time period. This strategy also allows the children to consider their peer group as a learning resource and begin to learn from it while they are young itself. Instead of listening to the teacher the whole time, the children in the new reform will read, discuss, observe, engage directly in relevant tasks, and reflect to find out for themselves. To activate every member of the small groups, the teacher assigns work to them and refrains from appointing a leader. Children in such a context will use their hidden abilities to achieve the common objective set out for them. All students of a class thus using their knowledge to enrich one another and making optimum use of the opportunities available in the learning environment to listen, speak, read and write will develop their communication skills as well.

It is the responsibility of the teacher to get all members of different groups to participate actively in the exploration planned for them. For the success of this exploration, the teachers have to use their personality to the maximum. As a first step here they identify a suitable way to group the students, use students with prior knowledge to support other students, direct students to share responsibility to make team presentations, discourage reading out from pre prepared answer scripts to facilitate innovative presentations, and remind students of the need to complete their work on time. In organizing for the presentations, the teacher gets the children to display their work before the class and draws the attention of everybody in the classroom to the findings presented. At the end of each presentation, the teacher requests the members of the presenting group as well as the members of the other groups to submit their constructive comments. The children take this opportunity to elaborate their findings. They clarify what is not clear and vague to them, correct what is incorrect, and fill whatever gaps they have identified in the findings. All this allows a number of student skills neglected in the past to be awakened and the schools to bring about a future generation who will not get isolated in the society.

The new methodology that comes to the fore in the new millennium helps children to develop their personnel skills that originate from within themselves. The children working in groups learn to be patient with others. Control their temper by paying due respect to the opinions of others. Manage stress by prioritisation, thriving for high quality products, and saving time for self-development by avoiding gossip and improving planning skills. In addition to initiating new things and supporting productive changes initiated by others, the children begin to develop entrepreneurial skills through improved self-awareness and ability to take planned risks. The new methodologies provide ample opportunity for the children to be responsible and accountable as well. The teacher who directs the learning-teaching process to make all of the above tasks fruitful not only contributes to the development of a new generation that is self disciplined and committed for national development, but also begins to derive high satisfaction from his/her profession.

The activities to be implemented by the teacher in the new millennium, gives an important place to assessment and evaluation. Assessment is the task in which the teachers involve themselves during the full time devoted for student explorations. Close observation of students at work, identifying where the students are, and taking necessary action to take them to the desired destination are the three main stages of the assessment process. The teacher provides feedback to those students with inabilities and weaknesses and feed forward to others with abilities and strengths to lead every child in the classroom from the darkness to the light. There is no doubt that evaluations conducted under adequate assessment give rise to excellent results. The teacher who assesses the children when they explore turns to evaluate them when they begin to explain and elaborate. The teachers completing evaluation also should not forget to announce the proficiency levels attained by their students to reinforce the learning they have accomplished.

Assessment and evaluation are conducted both within the activities and also on the basis of activity clusters. The latter considered as the second stage of school-based evaluation provides opportunity to the teacher to extend her teaching as well as the learning of her students beyond the timetable. The teacher is expected to use the learning-teaching-evaluation tools recommended in Part III of the Teachers' Instructional Manual (TIM)

together with the 5E Model to be successful in the task. To make optimum use of this opportunity made available for extended learning and teaching, all teachers should meet small groups exploring outside the timetable at least once a week to investigate the outputs they have achieved, and to support them to solve their problems.

To avoid being a burden to the teacher, action has already been taken to reduce the number of evaluations to be conducted per term. The subjects with over three periods a week will have four evaluations per term while this would be three for subjects with three periods a week, and two for others with less than three periods a week. Out of the total number of evaluations recommended per term, the last would be the term test. This is the only evaluation for which a written test is given. The teachers have to make use of the tools provided in the Teachers' Instructional Manual to complete the required number of school-based evaluations. To encourage learning outside the timetable, a compulsory question will be prepared for each term test covering the learning accomplished by the tools recommended. All this will provide opportunity for the students to involve in meaningful learning either independently or in small groups beyond the timetable.

There is no doubt that the activity continuum and the learning-teaching-evaluation tools developed thus and incorporated in Sections II and III of the Teachers' Instructional Manual will facilitate the new role of the teacher by bringing learning, teaching, assessment and evaluation to the same platform. Yet we should not forget that the teachers always have the freedom to adapt the material given to suit the size and nature of their classes or go for new material of their own to achieve the desired learning outcomes.

The examinations play a big role in realizing any developmental change proposed in the learning-teaching process. Understanding this situation, the Department of Examinations has decided to make a noticeable change in its question papers. A decision has been taken to step away from the predictable questions of what? why? when? where? who and how to introduce authentic evaluations developed on the basis of real life situations for both the term tests and the GCE (OL) examination. We hope that this action taken by the National Institute of Education to produce a new type of student who learns for life will replace the previous type of student who crammed for the examinations and forgot everything in a short while. It is our sincere belief that this new thinking will draw the attention, acceptance and active participation of everybody who is committed to national development

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Detailed Syllabus

Introduction

Basis for School Science Curriculum Reform

Previous curriculum reform, aimed at teaching Science at secondary level through the subjects, Environmental Studies for grade 6 and Science & Technology for grades 7-11, faced following drawbacks.

- Lack of adequate opportunities for the students to acquire internationally accepted Science process skills.
- Omission of some essential basic scientific concepts in the course which hindered systematic development of scientific concepts.
- Fewer opportunities provided for students to engage in a learning- teaching process which enables proper comprehension of scientific concepts.

Furthermore, the following factors that prevailed in the school Science curriculum have also contributed to the decline in the quality of Science.

- Environment related activities subject at primary level has not contributed to comprehension of basic scientific concepts as expected.
- Deviation of the learning-teaching process from practical situations towards transmission of knowledge through text books.
- Examination oriented learning-teaching process resulting in students being diverted from exploration based learning towards mechanical learning.

Basically, the prime objective of the new curriculum reform is to alleviate these shortcomings and to minimize the curriculum gap between G.C.E. (O/L) and G.C.E. (A/L) as well. In order to achieve this objective, measures should be taken to avoid the separation of theoretical aspects from practical activities in Science.

Present curriculum reform is expected to introduce a new approach to provide opportunity to amalgamate theoretical aspects and practical activities.

New methodology is unique as the science curriculum has been developed according to the following distinctive features:

- Competency based
- Activity oriented
- Student centered

Science subject is introduced as a **common Science curriculum** for grades 6-9, and as a **subject curriculum** for grades 10-13. However, in the science curriculum for grades 10-11 the three main subjects of Physics, Chemistry and Biology are presented as three modules with equal weight for the G.C.E. (O/L) examination.

Science syllabi for grades 6-9 has been developed as a spiral curriculum based on the broad themes given below.

- Observing the environment
- Organisms and life processes
- Matter, their properties and interactions
- Earth and space
- Energy, force and work

The new curriculum reform consists of a set of competencies and competency levels , a continuum of activities together with a set of activities which provide opportunities to extend the learning-teaching process beyond the classroom environment.

Course Objectives for Grade 6 - 11 Science

On completion of this course, the student will be able to;

- develop scientific concepts and principles systematically through a joyful learning environment.
- develop competencies related to problem solving by using processes in science and scientific method appropriately.
- develop competencies pertaining to managing environmental resources intelligently by understanding the potential of such resources.
- develop competencies related to the usage of scientific knowledge to lead a physically and mentally healthy life.
- develop competencies pertaining to becoming a successful individual who will contribute to the development of the nation in collaboration, engage in further studies and undertake challenging job prospects in the future.
- develop competencies related to understanding the scientific basis of the natural phenomena and the universe.
- use appropriate technology to maintain efficiency and effectiveness at an optimum level in utilizing energy and force.
- develop competencies related to evaluation of day to day life experiences and information acquired through media by employing scientific criteria with a back ground of limitations and dynamic nature of science.

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
		FIRST TERM		
1.0	Observes the environment as a scientist.	1.1 Uses scientific method to investigate phenomena in the environment.	² Steps of the scientific method ² Observations ² Identification of the problem ² Formulation of hypotheses ² Testing of hypotheses ² Making conclusions ² Scientific inventions ² Disprove the theory of Spontaneous Generation ² Discovery of Penicillin	120
		1.2 Uses microscope to observe minute objects.	² Usage of light microscope ² Parts of light microscope ² Proper usage of light microscope	120
		1.3 Investigates the importance of micro-organisms.	² Applications of microbial activities ² Production of compost ² Coir industry ² Production of diary products ² Production of vinegar ² Production of immunization vaccines and antibiotic ² Harmful effects of micro organisms ² Diseases ² Food spoilage	120
		1.4 Uses laboratory equipments appropriately.	² Volumetric instruments ² Measuring cylinder ² Beaker	120

No.	Competencies	Competency levels	Content	Time in minutes
			² Pipette and Burette ² Flask ² Instruments to measure mass/weight ² Triple beam balance ² Chemical balance ² Spring balance ² Instruments to measure electricity ² Ammeter ² Voltmeter ² Multimeter ² Other laboratory equipments ² Boiling tube/Test tube/Ignition tube ² Test tube holder ² Funnel ² Thistle funnel ² Watch glass ² Petridish ² Slide and coverslip ² Trough ² Density bottle ² Bunsen burner ² Spirit lamp ² Tri-pod ² Motar and pestle ² Wash bottle ² Cork borer	

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
			² Filter paper ² Forceps, Tongs, Pliers	
2.0	Investigates to identify the nature of earth and space.	2.1 Investigates the development of various views on solar system.	² Ancient views ² Geo-centric model ² Modern views ² Helio-centric model	120
		2.2 Investigates on constellations.	² Identification of constellations ² Zodiac ² Other constellations ² Ursa major and Ursa minor(Great bear and Little bear) ² Crux (Southern cross) ² Orion ² Pleiades (Seven sisters) ² Uses of constellations.	120
		2.3 Inquires about the information on the nature of space.	² Existence of stars and galaxies ² Birth and death of stars ² Origin and expansion of universe	120
3.0	Uses concepts, principles and theories, related to energy, work and force effectively.	3.1 Elaborates on simple linear motion by using vector and scalar quantities.	² Scalar quantities ² Distance, time and speed ² Vector quantities ² Displacement, velocity, acceleration and decelaration ² Simple calculations on uniform speed/velocity	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
			² Speed $= \frac{\text{distance}}{\text{time}}$ Velocity $= \frac{\text{displacemnt}}{\text{time}}$	
		3.2 Investigates appropriate mechanical strategies used in various work sites.	² Strategies that facilitate mechanical work in work sites. ² Construction of buildings ² Repairing of vehicles ² Agriculture	120
		3.3 Investigates on qualitative and quantitative aspects of global energy resources.	² Primary energy resources ² Crude oil ² Coal time ² Natural gas ² Nuclear energy ² Bio mass ² Wind ² Potential energy of water ² Solar energy ² Unequal distribution of primary energy resources ² Secondary energy resources ² Electricity ² Super-heated steam ² Thermal ² Conversion of primary energy resources into secondary energy resources ² Electricity from potential energy of water ² Electricity from crude oil	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
			² Super-heated steam from coal ² Heat from fire wood ² Need for the conversion ² Wastage of energy from conversion	
		3.4 Investigates the use of alternative energy resources as a solution for energy crisis.	² Alternative energy resources ² Bio-diesel ² Alcohol (Ethanol/Methanol) ² Biomass ² Bio-gas ² Solar cells ² OTEC (Ocean Thermal Energy Conversion) ² Ocean waves/tidal ² Solar energy ² Fuel cells ² Hydrogen ² Methane ² Scientific basis of the above energy resources ² Ways of using them as substitutes for existing energy resources ² Advantages and disadvantages of the use of the above energy resources	1 2 0
SECOND TERM				
4.0	Inquires on the properties, uses and interactions of matter.	4.1 Explores evidences for the occurrence of a chemical reaction.	² Differences between physical and chemical changes ² Evidences for the occurrence of a chemical reaction ² Changes of temperature (Heat exchange)	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
			² Change of colour ² Formation of precipitate ² Production of sound/light ² Formation of gases	
		4.2 Investigates on the behaviour of atoms.	² Law of conservation of mass ² Experiments to confirm the law of conservation of mass ² Dalton's atomic theory ² Modern discoveries about the atom ² Sub atomic particles (electrons, protons, neutrons) ² Nuclear model of the atom	120
		4.3 Uses chemical symbols to denote elements.	² Use of symbols in chemistry ² Symbols of elements ² Development ² International standards/conventions ² Applications	120
		4.4 Investigates on the interactions of metals and non-metals with air, water, acids & bases.	² Combustion ² Reactions with water ² Reactions with acids ² Reactions with bases (only examples of Mg, Fe, C, S)	120
		4.5 Investigates about alloys and their applications.	² Commonly used alloys ² Properties ² Applications	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
		4.6 Conducts simple experiments to identify nutrient components in food.	² Major types of nutrients ² Carbohydrates ² Proteins ² Lipids ² Tests to identify major nutrient components ² Iodine test ² Benedict test ² Bi-uret test ² Sudan III test ² Translucent oil patch test	120
		4.7 Analyses criteria on the standards and quality in selecting suitable consumer goods.	² Standards, SLS/ISO ² Date of manufacture and date of expiry ² Ingredients ² Packaging ² Total weight / net weight ² Consumer/eco – friendly nature	120
		4.8 Investigates on the properties and uses of composite materials.	² Natural and artificial composite materials ² Composite materials according to their structural arrangement. ² Reinforced with particles ² Reinforced with fibers ² Layered ² Uses of composite materials	120
		4.9 Investigates on the properties and usages of polymers.	² Monomers and polymers ² Natural and artificial polymers ² Uses of polymers ² Problems associated with the usage of artificial polymers and solutions	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
		4.10 Prepares solutions to suit the requirements.	² Mixtures ² Solutions ² Solutes, solvents and solutions ² Saturated and unsaturated solutions. ² Selection of solvents	120
		4.11 Conducts experiments to find out methods of generating of electricity.	² Structure and function of cells ² Simple cell ² Dry cell ² Lead-acid accumulator ² Electricity generators ² Bicycle dynamo ² Solar cell	120
		4.12 Investigates on the uses of nano technology.	² Concept of nano technology ² Natural nano systems ² Artificial nano systems ² Uses of nano technology ² In the medical field ² In generation of energy ² Production of consumer goods. ² Possible harmful effects of nano technology	120
	THIRD TERM			
	5.0 Investigates the diversity of plants. .	5.1 Explores the morphological diversity of flowers.	² Parts of a flower ² Pedicel, receptacle, sepals, petals, androecium and gynoecium ² Arrangements of those parts in various flowers	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
			² Symmetry of flowers ² Radial symmetry ² Bilateral symmetry ² Asymmetry	120
		5.2 Analyses the structure of flowers according to scientific conventions.	² Features used to describe a flower ² Whole flower and half flower ² Floral diagram ² Floral formula	120
		5.3 Explores the patterns of inflorescence.	² Arrangement of racemose inflorescence ² Simple raceme, spike, spadix, corymb, capitulum and umbel ² Arrangement of cymose inflorescence ² Simple cyme, dichasial cyme, helicoid cyme and scorpiod cyme	120
		5.4 Analyses the structure of fruits using scientific definitions.	² Types of fruits ² Simple fruits ² Dry fruits ² Fleshy fruits ² Aggregate fruits ² Composite fruits	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
		5.5 Investigates on the adaptations of fruits and seeds for wide dispersal of plants.	² Major methods of dispersal of fruits and seeds ² By wind ² By water ² By animals ² Explosive mechanisms ² Special adaptation for each method of dispersal of seeds and fruits	120
		5.6 Uses the diversity of life-time of plants to fulfil the day-today pursuits.	² Annual plants ² Biennial plant ² Perennial plants ² Uses of the above plants	120
6.0	Uses generation and transmission of waves and their properties to fulfill day-to-day pursuits.	6.1 Uses the behaviour of light to fulfill day-to-day pursuits.	² Reflection of light ² Laws of reflection ² Reflection of a light beam through a plane mirror ² Marvels of reflection of light ² Refraction of light ² Refraction of a light beam through a glass block ² Dense and rare media ² Uses of refraction ² Simple microscope ² Lens of the eye ² Spectacles ² Farsight - Convex lens ² Shortsight - Concavelens ² Marvels of refraction of light	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
		6.2 Uses the behaviour of sound to fulfill day-to-day pursuits.	² Phenomena related to the behaviour of sound ² Reflection ² Echo ² Reverberation ² Resonance ² Absorption ² Musical melody and noise	1 2 0
7.0	Discovers the values of marvels in the environment.	7.1 Discovers the marvels in the world of animals.	² Animals that exhibit mysterious characters ² *Planaria* ² Mekong catfish ² *Bufo kotagamii* ² Arrowhead toad ² Vampire bat ² Sea horse ² Giant panda ² Weaver bird	120
8.0	Exhibits the preparedness in management of natural disasters and associated risks.	8.1 Contributes to minimize the risks associated with drought.	² Scientific factors based on the occurrence of draught ² Short term ² Long term ² Scientific approach for the management of disaster associated with drought conditions.	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes
			² Before the disaster ² Weather forecasts, previous experiences and observations ² During the disaster ² Predicting the circumstances that can occur on available data and information ² Scientific measures that can be taken to minimize the damages to life and property ² After the disaster ² Sanitary measures ² Effective management of newly emerged environmental conditions	120
		8.2 Contributes to minimize disaster conditions associated with tsunami.	² Scientific factors based on the occurrence of tsunami ² Scientic approach for tsunami disaster management ² Before the disaster ² Announcements of tsunami warning centers ² Previous experiences and observations ² During the disaster ² Predicting the circumstances that can occur on available data and information	120

No.	Competencies	Competency levels	Content	Time in minutes
			² Scientific measures that can be taken to minimize damages to life and property ² After the disaster ² Sanitary measures ² Effective management of newly emerged environmental conditions	

Introduction

In deciding upon the learning teaching methodology relevant to the course, attention has been paid to the planning of learning-teaching activities so as to facilitate building up of student competencies based on exploration. In preparing for competency-based education, in this manner, an obvious change in the role of the teacher is expected.

The transmission role practiced in our classroom from way back and the more recently introduced transaction role is evident in the classroom even in the present day. When taking the deterioration of the thinking skills, personal skills and social skills of school leavers into consideration, it needs no effort to understand that there is a need for the development of the learning-teaching methodology and how it should be effected.

In the transmission role while the teacher is considered an individual who knows everything, his task has become that of considering the student as one who does not know anything and of transmitting knowledge to him. This learning-teaching process that takes the guise of lectures is restricted only to the flow of knowledge from the teacher to the student, does not make an adequate contribution either to the stimulation of student thinking or to the development of his personal and social skills.

The dialogue initiated by the teachers within the class is the initial stage of the transaction role apart from the ideas that flow from the teacher to the class and from the class to the teacher. These dialogues get gradually transformed into discussions as a result of the student-student interaction that takes place subsequently. The teacher is continuously involved in the task of questioning in order to take the student from the known to the unknown, from the simple to the complex and from the concrete to the abstract.

While, in competency-based education, student tasks occupy a powerful position, the teacher occupies the position of a resource person who mediates in order to provide every student in the class with at least the competency proximate to each relevant competency. For this purpose the basic functions the teacher is expected to perform include planning of a learning environment consisting of the materials and other facilities necessary for learning, close observation of how students learn, identification of student abilities and inabilities and the promotion of student learning through feed back and provision of feed forward as well as the preparation of instruments of assessment for the extension of learning beyond the classroom. The teacher's role based eventually upon the tasks above is called the transformation role.

The series of activities that can be used in the implementation of the descriptive curriculum introduced in the first part of this course guide, has been included in its second part. Each of these activities has been developed so as to contain a minimum of three steps. It is expected to get the student involved in the learning process through the first step of the activities. As such, this step is called the "Engagement" step. As an introduction to this step, the teacher assumes the Transaction role and engages in a dialogue with the students. Later, along with the transformation of this dialogue to a discussion the students engage in exploration and are provided the opportunity to recall the pre-knowledge related to the basic competency they should develop and to acquire a hint regarding the future of the activity. The teacher possesses a host of strategies that can be used in these exchanges of ideas. Some of the devices at the disposal of the teacher for the exchange of these ideas are questioning/stimulants like pictures, newspaper advertisements and flash cards/use of puzzles or case studies/dialogues, role play, poems, songs and demonstrations, video tapes or audio tapes. In summary, the first step of the activities is implemented with the objective of actualizing the three objectives below.

- Winning over of the attention of the class.
- Providing the students with the opportunity for students' recall of the necessary pre-knowledge.
- Introducing the elements of the explanation the students are expected to be directed to under the second step of the activity.

It is with the objective of providing the students with the opportunity of Exploration that the second step of the activity has been planned. Students base their exploration on a special leaflet prepared for the purpose. The teacher has to plan this explanation to enable the students to engage in cooperative learning through the exploration of various aspects of the problem, in groups. Some of the most important qualities of this step are involvement in the conscious group discussions and the use of the resource materials provided. As a result of involvement in group activities through a long period of time, student will acquire the ability to develop a number of skills like self-discipline, listening to others, working cooperatively with others, helping them, management of time, obtain creations of high quality, honesty etc. In directing students to exploration, while the teacher should avoid taking decisions regarding leadership, he should build up the background necessary to surface. Accordingly, the students will have the privilege of taking on leadership when opportune, based on hidden abilities.

During the 3rd step of the activity, every group will get the opportunity of presenting the results of its exploration for the enlightenment of the others. What the teacher has to do here is to encourage students to group presentations. It would be effective if students are directed so as to ensure that every member is given responsibility in the planning of the presentation. An important quality of

this step, related to the explanation of student findings, is the creation of the opportunity for the voice of students to be heard in the classroom where, commonly the voice of the teacher had dominated.

After the explanation of the findings in the third step of the activities, students should be directed to elaboration. Each group is given the opportunity to provide constructive suggestions on its findings first, and subsequently, members of other groups are given this opportunity. Anyway the final review is the responsibility of the teacher. The teacher is expected to touch on all the important points relevant to the students' exploration.

The main responsibility of the teacher in this learning teaching process is to monitor continuously, whether the classroom learning-teaching process is implemented successfully, as expected. While assessment and evaluation should be made use of for this purpose, the teacher is provided the opportunity, through planned activities, in the learning teaching process itself. The teacher is given the opportunity for assessment while the students are involved in exploration during the second stage of the activity and for evaluation when the students are involved in explanation and expansion during the third stage. A detailed inquiry into assessment and evaluation will be provided later on in this document.

The teacher is provided direction on the transformation role by the learning –teaching methodology described so far. While priority is given to group exploration here, the teacher is also afforded the opportunity for transaction, discussion and short lectures. While there is room for transaction and discussion, the teacher may also give a short lecture, under review, in the final stage. In the development of the learning-teaching methodology related to this curriculum, the first to be introduced under the curriculum reforms for the new millennium, the attention paid to the important features relevant to the transmission as well as the transaction roles of the teacher, apart from the transformation role, is a special feature of this methodology.

School Policies and Programmes

- According to the proposed curriculum reform five periods have been allocated to teach Science for the grade 9.
- The learning-teaching process has been designed on an activity based approach.
- The expected learning-teaching methodology will be in accordance with the trans formation role of the teacher. Activities designed on 5-E model have been provided through the Teacher Instruction Manual in order to implement the trans formation role at classroom level.
- The prescribed time to conduct one activity at class room level will be more than one period. Therefore, it is emphasized that the Sectional heads and school management to should take into account the importance of allocating two adjacent periods for the successful implementation of activities at classroom level.
- It is a crucial factor that there should be excellent planning at grade level for the successful implementation of activities. It is wise to organize the activities with the participation of all the teachers who teach science in parallel classes of a particular grade level.
- Principals / Sectional Heads are expected to provide instructional leadership to the teachers on developing plans to identify and obtain the necessary quality inputs and utilizing them before the commencement of each term.
- Some activities in particular need specific experimental setups and printed materials. It is therefore advisable to prepare and maintain a reserve of these materials with the participation of teachers in the parallel classes of a particular grade level to maintain learn ing-teaching process efficiently.
- According to the new approach, students are not engaged in separate theory and practical sessions . It is expected to establish concepts, principles and theories through hands on practical experiences by way of proposed activities.
- Laboratory equipment as well as improvised and adapted setups are needed to carryout proposed activities. School management is responsible in providing such services and assistance within the school and from outside resources.
- As a measure of recognition of the articles that students prepare during the course of proposed activities, it is recommended to organize term end or year end exhibitions. This will encourage the students on further inventions.
- With a view to extend learning beyond the activities done at classroom level and to highlight the students' special abilities, it is expected to involve students in co-curricular activities such as debates, wall newspapers, magazines, school science societies, science days, science exhibitions etc.

Learning -Teaching Methodology

Competency 1.0 : Observes the environment as a scientist

Competency 1.1 : **Uses the scientific method to investigate phenomena in the environment.**

Activity 1.1 : **Let us follow the scientific method.**

Time : 120 min

Quality Inputs :
- The article **'Unscientific decisions'** in annex 1.1.1
- Two copies of Exploration instructions in annex 1.1.2
- Teacher instructions in annex 1.1.3
- Two copies of article **'Let us be scientific - Let us follow the scientific method'** in annex 1.1.4

Teaching learning process

Step 1.1.1 :
- Present the story, **'Unscientific decisions'.**
- Lead a discussion highlighting following points.

• Tharaka's mother has caused unnecessary problems due to senseless decisions. • It is not scientific to arrive at conclusions by mere observations. • We must use the scientific method to solve our day to day problems.

(15 min)

Step 1.1.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 1.1.3 **(**
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- We can employ scientific method to solve problems.
- It has a number of steps.
- Scientists have used this method to solve various problems.
- The article **'Let us be scientific - Let us follow the scientific method'** could be used to explore about the scientific method in detail.

(45min)

Assesment and Evaluation Criteria :

- Explains the steps in scientific method.
- Engages in a scientific exploration on a given phenomenon.
- Discusses about the validity of inferences obtained by following the scientific method.
- Follows the scientific method.
- Makes accurate decisions.

Annex 1.1.1

'Unscientific decisions'

Tharaka goes to school with his father in a three wheeler. Only mother is at home during day time.

On that particular day, when Tharaka returned home, mother and Kanthi nanda from the adjoining house were discussing about the mangoes that were missing.

Tharaka questioned his mother about this when he was having lunch.

"How bad it is to do things like this! I went to the fair today. During my absence, somebody had plucked the mangoes. As there is no one in the other garden, I have seen other people plucking coconuts in that land too."

"What did Kanthi nanda say?"

"She said that it may be the fruit vendor, Themis aiya."

"How do you know for sure?"

"He asked for mangoes on Sunday. I told him they are not ripe enough. He keeps his eyes on mangoes all the time. Also, there are tyre marks in the garden. He must have brought a vehicle to transport."

Grandmother came from the 'Owita' and entered the kitchen.

"Duwa, Why are the gunny bags in the shed thrown about?"

"Are they? Then it must be somebody we know who has stolen the mangoes."

"I saw the boy in a nearby house carrying a gunny bag on his back at about ten in the morning."

"Then is it him?"

"Amma, you all must not suspect anyone without finding relevant facts. Let us inquire about it slowly. We won't be able to come to a decision till then."

When his father arrived, it was late in the night. As the three-wheeler entered the gate, mother ran towards to complain. Father spoke first.

"I plucked the mangoes in the noon and sold them at a good price."

Mother was stunned as she took the money which father gave.

Annex 1.1.2

Instructions for group exploration

Let us follow the scientific method

- One of the following events is assigned to your group.
  - **First group**
    The grass turned white in a place covered with a black polythene.
  - **Second group**
    A 'biling' ^ì,sx& fruit which fell into a salt container has become shrinked.
- Refer to the article, **'Let us be scientific - Let us follow the scientific method'**
- Explain the way you proceed to explore the event you are assigned to do, according to the scientific method, including the points given below. (Use the prior experiences gathered when this event was carried out practically on a previous day)
  - The way you arranged the steps in your experiment according to the steps in the scientific method.
  - The way you increased the validity of your inferences.
  - How you arranged the control set-up.
- Be prepared to present your findings in a creative way.

Annex 1.1.3

Instructions to the Teacher

Give general instructions to all students to findout about the following phenomena at home before the activity 1.1. (If not, do the activity in school).

1. The grass turned white in a place covered with a black polythene.
2. A 'biling' ^ì,sx& fruit which fell into a salt container has become shrinked.

Annex 1.1.4

Be scientific - follow the scientific method

Malli switched on the toy car but it did not start.
"I think the batteries are dead."
He took two new batteries from the cupboard, connected them to the toy car and switched on. The toy car started to run.
"It's correct, what I thought was correct. The toy car didn't run as the batteries were dead."
Akka who was observing all this said an important point to Malli.
"The method you adopted with your toy car is somewhat like the scientific method.

Now listen...

Steps in the scientific method.

I - Observation
II - Problem
III - Formulate hypothesis
IV - Testing the hypothesis - Planning and carrying out experiments.
V - Arriving at inferences

I - Observation - When the toy car switch was on, it did not run.
II - Problem -The car did not run.
III - Hypothesis - The batteries were dead.
IV - Testing the hypothesis -

1. Planning
   Finding new batteries
2. Implementing
   The batteries in the car were removed and new batteries inserted.

V - Arriving at inferences
The fault with the car is due to the dead batteries.

Aiya who was listening to all this put forward another suggestion.

" It is true that you have followed the scientific method. But we don't come to a conclusion at once. Sometimes the car may have not run due to some other reason. Something like this...

- Sometimes the batteries which were there, may not have been properly fixed.
- The batteries may have been inserted incorrectly.
- Switch may be faulty.
- The wheels of the car may have been stuck.
- Circuit may be loose.

Any number of hypotheses like these could have been formulated. Because of this we cannot be satisfied with testing only one hypothesis."

"But Aiya, the car started to run as soon as the new batteries were put in place."

"Yes, but that hypothesis was tested only once. If we are to reach a final conclusion we have to test that hypothesis several times.

The validity of the conclusion is more if the hypothesis is tested a number of times.

After listening to Aiya, Akka made another suggestion to Malli.

"Malli, insert the earlier batteries to the car again and try to run."

Malli connected the earlier batteries but the car didn't run.

Then he connected the new batteries and switched it on.

"How strange Akka, now it is not working even with the new batteries." Then he put the car hard on the cement floor. Car started to run. Aiya laughed.

"So it is not due to the dead batteries. This has some other problem" said Malli.

He inserted the old batteries and kept it hard on the cement floor.

"The car is running."

Aiya spoke.

"Did you see? Before we come to a conclusion, we should do the test over and over again, and see whether we get the same result".
Then Akka spoke. "Let's examine the circuit".
"I think some wires are loose inside".
Akka and Malli dismantled the toy car, and examined it well.
"Look, Malli do you see this? Here the metal strip has loosened along with the lead dot. When they touch from time to time the circuit is completed and the current flows. Then the car starts to work."
"Now let us build up a hypothesis like this."

If the toy car is to work the circuit should be completed (closed) :

"Let us test this hypothesis."
Malli fixed the batteries to the car. The circuit in the set up was made incomplete by inserting a paper plug between lead dot and the metal strip. Car did not work when the switch was on. Then the paper plug was removed and the metal strip and the lead dot were kept in touch using a piece of plaster. When switched on this time, the car started to run.
This was repeated many times. Akka too was asked to do it. In all the instances the result was the same.
After that they went to Aiya and explained to him how the experiment was carried out.
"Aiya, now we can come to a valid conclusion."

For the toy car to work the circuit should be completed (closed)

"It did not work because the circuit was incomplete."
"Very good, Malli you have correctly used the scientific method together with a control set-up too."
"What do you mean by a control set-up?"
"In scientific experiments, we arrange two set-ups. The experimental set-up and the control set-up.
I can explain this using the experiment you conducted.
What we are going to see now is whether it is necessary for the circuit to be closed for the electric toy car to run. Here the the difference is whether the circuit is closed or open. We call this the variable factor.
When the circuit is open, it is the control set-up. Here we are not providing the closed status. We are not providing the variable factor.
When the circuit is closed, it is the experimental set-up. Here we provide all the conditions, as the control set-up, and the circuit is closed. We provided the variable factor too.
In this instance we could explore the effect of the variable factor comparatively.
But there is something that we should keep in mind. Both the Control and Experimental

set-ups must be provided with all the other non variable factors equally."
"Are you saying that both Control and Experimental set-ups should be provided with similar conditions?"
"Definitely, I'll give you some examples ...

- In both these instances you ran the car on the same cement floor.
- Since you used the same car, the circuit and the motor factors are common to both instances.
- Same battery set was used in both instances.

"We can find the influence of the variable factor only when we provide similar conditions to both Control and Experimental set-ups"

"Aiya, can you explain Malli about the **Controlled Experiment**?" said Akka.
" We could consider the whole experiment you conducted as a controlled experiment. This experiment was done, providing similar conditions. In other words the both set-ups, control and experimental were controlled. Because of this, the entire experiment is called as a controlled experiment.

* * *

Competency 1.0 : Observes the environment as a Scientist.

Competency level 1.2 : Uses microscope to observe fine objects.

Activity 1.2 : Assistance to the naked eye from the microscope .
Time : 120 min

Quality inputs :
- Story on **'Micrscope of Sahas Nangi'** included in annex 1.2.1
- Microscopes, slides, cover slips, clean water, pollen obtained from a flower, fungi from a piece of stale bread, two pieces of wood about 2 cm in height (or two lids)
- Two copies of Exploration instructions in annex 1.2.2
- Three copies of the article **'Compound light microscope'** in annex 1.2.3

Teaching learning process:

Step 1.2.1 :
- Get a student to introduce the article, **'Microscope of Sahas Nangi'.**
- Arrange a set-up according to the annex 1.2.1 and ask the students to observe a line in the national identity card.
- Conduct a discussion highlighting the following points;

  - The line on which the name is written is a repeated print of the word **SRI LANKA**.
  - Water bubble with a convex surface acts as a convex lens.
  - Sahas nangi used two lenses (hand lens and the water bubble) to read the letters in the identity card.
  - It is possible to obtain a higher magnification by combining the magnifications of two lenses.
  - The image is inverted when two lenses are combined.
  - Light microscope is an instrument where lenses are used.

(15 min)

Step 1.2.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 1.2.3 **(**

- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, high-lighting the following points.

• Light microscope is used to observe fine things which are not visible to the naked eye. • It has a number of lenses in combination. • It is possible to study this in depth by referring to the article "**Compound light microscope.**"

(45 min)

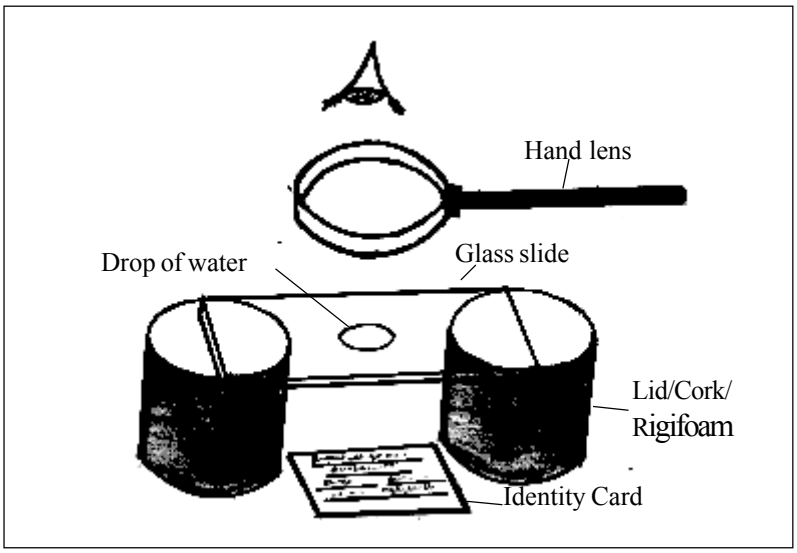
Assesment and evaluation criteria

- Uses a light microscope properly.
- Names the parts and components of a microscope and explain their functions.
- Uses the microscope to observe the structure of fine objects.
- Selects instruments for the purpose appropriately.
- Gains experience in the use of technical items.

Annex 1.2.1

Sahas Nangi's Microscope

Sahas Nangi examined the national identity card of her elder sister, with a hand lens.
"Look, Akka although the name in your identity card seems to be written on a line, but when I look with the aid of hand lens, I see it as a row of dots" said Nangi.
"No Nangi , it is not a row of dots rather. It is a string of letters that seems to look like a line."
"Is it so? how did you see it? " Akka laughed. Nangi thought for a moment.
"It is possible to enlarge it if we had two lenses." said Nangi.
" There is no need to have another lens. Think of another alternative"said Akka.
Sahas Nangi walked to and fro in the house and collected different items.
"Yes Akka! Eureka !!, now I could see the line of english letters very well which looks like a line. I made a microscope."
"Let me see", said Akka, coming into the room.
She observed the identity card with the Sahas Nangi's set-up.
"You are very clever. You are clever thousand times as your name suggests, and inventive too", said Akka patting Nangi's head.



Annex 1.2.2

Instructions for group exploration

Assistance to the naked eye from a microscope

Focus your attention to one of the the following activities you have assigned to using a microscope.

- **First group** - Observation of pollen under low power.
- **Second group** - Observation of mildew on a piece of bread under medium power.
- **Third group** - Observation of pond/stagnant water under high power.

- Study how a microscope should be handled referring the article on **'Compound light microscope'.**
- Take out, carry and place the microscope properly at your work station by employing appropriate techniques.
- Prepare the slide accordingly.
- 'You are a junior scientist...' now record the observations collectively.
- Discuss at what magnification you observed the object given to you and record.
- Store the microscope properly after use.
- Be prepared to present your findings innovatively.

Annex 1.2.4

Compound light microscope

Compound microscope is a valuable instrument with which very small objects could be clearly seen. Maximum visibility for a human being with the naked eye is about 0.1mm. But with a light microscope it is possible to get a magnification of about 2000 times. If it is necessary to obtain a much larger magnification, an electron microscope is used, instead of light microscope. It's magnifying power is about 10^5 times.

The maginification of a light microscope is obtained as a product of the magnification of the eye piece and the objective lenses.

Magnification = Magnifying power of the objective lens x Magnifying power of the eye piece.

Various types of microscopes are used in laboratories .
Although there is a difference in the parts of a microscope there is a similarity in the primary features and their functions.

Components of a microscope could be classified under three systems according to their usage.

1. Photo system

Eye piece - (It is possible to have eye pieces which could be changed)
Objective lens - Low power objective lens
Medium power objective lens
High power objective lens
Condenser - (Not found in some)
Mirror
Source of light - (Not found in some)

2. Mechanical system

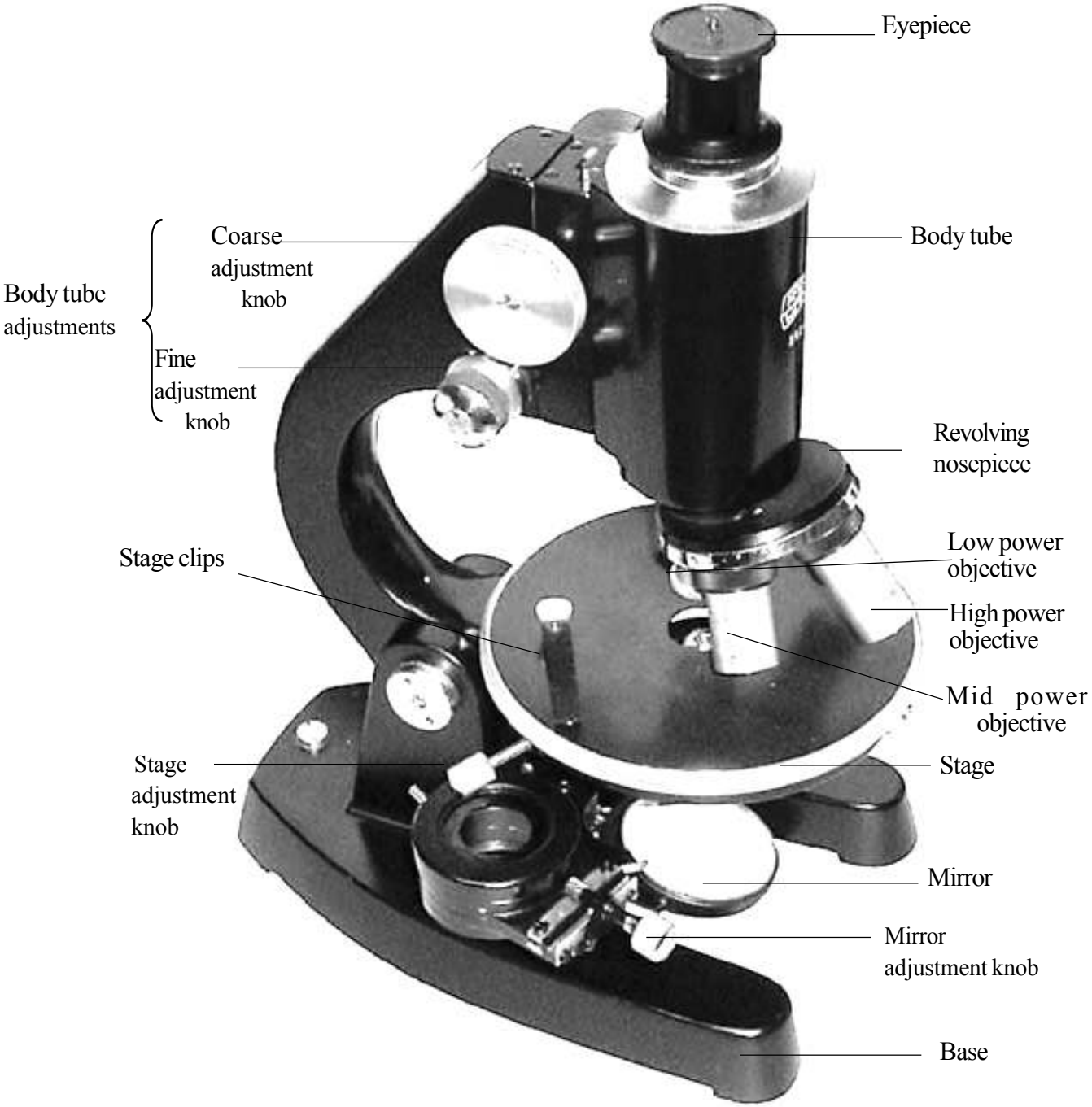
Adjustable body tube - Two parts - Coarse adjustment
- Fine adjustment

Lens adjustment
Diaphragm adjustment
Stage adjustment
Alignment adjustment
Rotating objective lenses
Stage clips

3. Body system

Handle
Stage
Body tube
Pedestal

Annotated diagram of a Light Microscope



Sequence to be followed when using a microscope

1. Keep the microscope on a stable horizontal table.
2. Turn the low power objective towards the stage.
3. Lower the low power objective lens by looking at it from a side, using the coarse adjustment.
4. Keep the both eyes opened and look through the eye piece using one eye of your choice at a distance of about 1 cm from the eyepiece.
5. Direct the light towards the stage while looking through the eye piece by adjusting the mirror and the diaphragm.
6. Keep the prepared slide on the stage and fix it by the clips.
7. Obtain a clear image by looking through the eye piece and adjusting the objectives lens upwards using the coarse adjustment.
8. Obtain a much clearer image by using the fine adjustment.
9. The objective lens rotator could be adjusted if necessary to direct the medium power objective lens first and secondly the high power objective lens to the specimen.
10. If there is a need to get a clear image, only the fine adjustment must be used.

The microsope is an expensive instrument as such special care must be taken when using and storing it.

1. When taking a microscope it's handle must be held with the hand of your choice and the base must be kept on the other palm slightly titled towards your body.
2. When using it, a suitable place must be selected where there is no dust or moisture.
3. The microscope should be in the low power when mounting or removing the slide from the stage.
4. Always use fresh slides and cover slips.
5. Microscope should not be tilted when observing specimens.
6. The microscope must be kept at low power and it is better to loosen the objective lens rotator by about half a circle after use.
7. Microscope must be stored vertically.
8. If the microscope is kept away for a long period, the lenses must be removed and kept in a desiccator.
9. If there are a number of microscopes, allocate numbers (1, 2, 3,etc) to the microscopes as well as the lenses(1-lp, 1-mp and 1-hp etc.) in order to avoid mixing the lenses when they are re-assembled.

Competency 1.0 : Observes the environment as a scientist

Competency level 1.3 : Investigates the importance of micro-organisms
Activity : Microorganisms...sometimes harmful - sometimes useful
Time : 120 min

Quality Inputs :
- Article **"Microscopic Visitor"** included in annex 1.3.1.
- Three copies of exploration instructions included in annex 1.3.2
- Three copies of the article **"Let us demonstrate the production of compost"** included in annex 1.3.3.
- Instructions for teachers included in annex 1.3.4.
- Three copies of the article **"Microorganisms... who should be associated with caution! "** included in annex 1.3.5.

Teaching learning process

Step 1.3.1. :
- Get a student to present the story about **Microscopic Visitor**.
- Lead a discussion highlighting the following facts.

• Microorganisms live in a variety of environmental conditions.
• Microorganisms may sometimes be advantageous and/or disadvantageous to other organisms.
• It is useful to explore further about this.

(15 min)

Step 1.3.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 1.3.3 **(**
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Microorganisms are useful to us in many ways.
- Given below are some examples;
  - preparing compost
  - coir industry
  - milk food industry
  - vinegar industry
  - in the preparation of antibiotics and vaccines
- There are instances where microorganisms cause harmful effects to humans and other organisms.
- Given below are some examples;
  - cause diseases
  - spoil food
- It is possible to obtain more information about these by reference to the article on **"Microorganisms... who should be associated with caution! "**

(45 min)

Assesment and evaluation criteria :

- Highlights the advantages and disadvantages of microorganisms.
- Investigates on the uses of microorganisms.
- Makes suggestions to minimise harmful effects of microorganisms.
- Familiarizes to identify various effects in the environment scientifically.
- Uses technical gadjets to observe the environment.

Annex 1.3.1

Microscopic Visitor

A special organism was invited to a Professional Council as the Chief Guest. The following description was used by the announcer to introduce him.

"Our chief guest today, is a special organism which belongs to a group which has widely distributed throughout the world. It is neither a plant, nor an animal, but is an organism. This group of organisms has the ability to provide all plants with useful substances. At the same time it is possible for them to cause unfavourable and harmful effects. We welcome this organism which represent a group of organisms that is hard to live with and also hard to live without. Let us get ready to welcome."
"But where? Where is the visitor?"
"Where?"
"No where to be seen..."
An unrest arose from the audience. Again the announcer addressed the gathering.

"Yes, I understand your problem... It is not possible to see our visitor with the naked eye. All of you, please come to the microscope ... Its' a microorganism... BACTERIA!"

Annex 1.3.2

Instructions for group exploration

Microorganisms...
sometimes harmful - sometimes useful

- Focus your attention to one of the ways of preparation of compost.
  - **Group One** - demonstrate the preparation of compost by barrel method.
  - **Group Two** - demonstrate the preparation of compost by pit method
  - **Group Three** - demonstrate preparation of compost by surface method.
- Follow the instructions kept in the workstations.
- Find out about the useful and harmful effectss of microorganisms by using the article, "**Microorganisms... who should be associated with caution!"**
- Highlight advantages and disadvantages of the activities of microorganisms.
- Get ready to present your findings in an innovative manner.

Annex 1.3.3

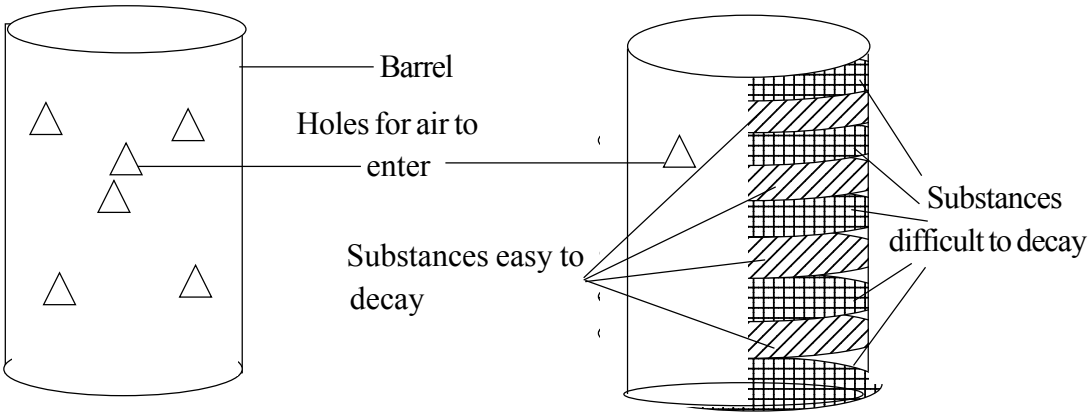
Let us demonstrate the preparation of compost

- Substances required
  - Substances which decay fast (fresh *Glirisidia*, Ipil ipil, Wild sunflower leaves etc.).
  - Substances which are difficult to decay (Paddy husk, dry leaves, hay, wood shavings etc.)
  - Small quantity of compost
  - Water
  - Black polythene sheet

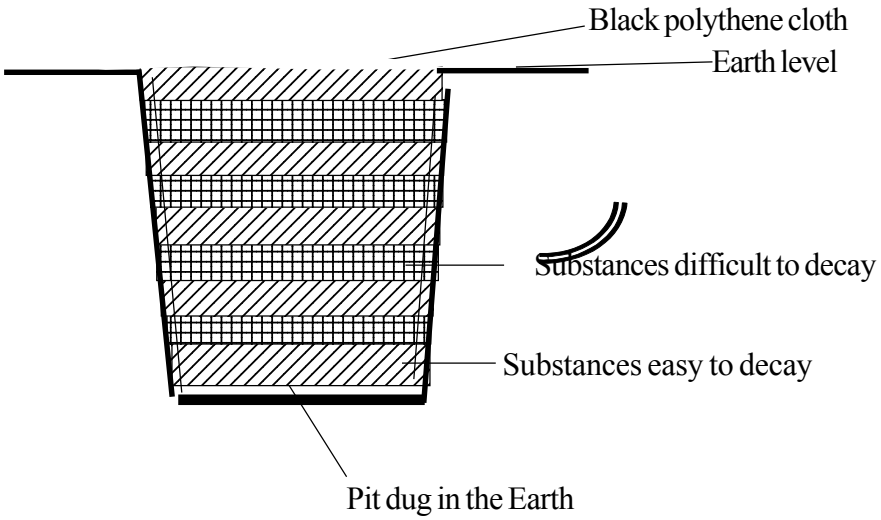
Instructions to teachers

- Get the students to collect the following items before the activity.
  - A cylindrical, plastic or a tin can about 30cm in height and 20 cm in diameter, with openings cut as in the diagram.
  - A sheet or a thick cardboard or a piece of wooden plank about 50 cm x 50 cm.
  - Raw materials, three samples from each which are easily decomposed and which are not easily decomposed.

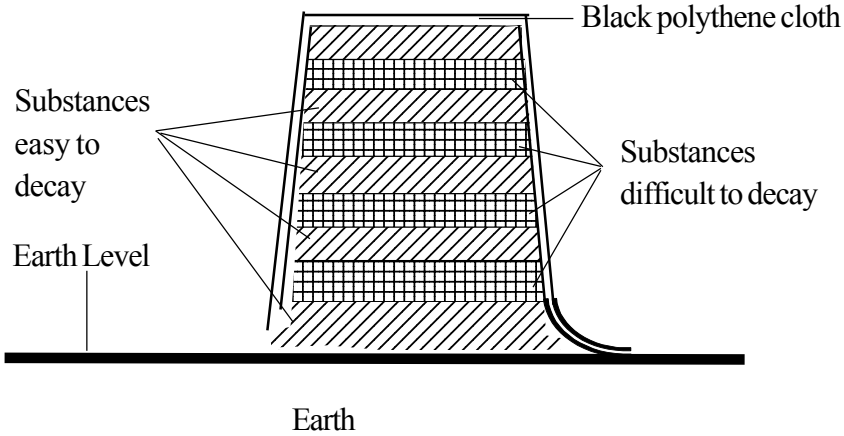
- **Barrel Method**



- **Pit Method**



- **Surface Method**



- Three black polythene sheets.
- Water

- Prepare a common table keeping the above items.
- Instruct the groups to assume that;
  - the tin can without the holes, as a pit in the garden, the
  - piece of wooden plank as the surface of the earth and
  - tin with the holes as the barrel.

Annex 1.3.5

Microorganisms... who should be associated with caution!

These are information collected by Wickrema to the school Science Magazine.

- About micro organisms...
  - Individual organisms are not visible to the naked eye.
  - Virus, Bacteria, Fungi, microscopic green Algae could be considered as microorganisms.
  - They are found in snow, boiling water, water having a high salinity, in acidic conditions, in liquids like petrol, diesel, etc.
  - Inside organisms.
  - This group exhibits a variety of nutrition patterns like auotrophic, heterotrophic, symbiotic and saprotrophic(live on dead and decaying matter).

- Using microorganisms for the advantage

1. In Medical Science
   - Production of antibiotics and vaccines

2. Production of milk foods
   - In the production of yoghurt and curd, lactic acid bacteria is used.
   - In the production cheese renin enzyme is added along with lactic acid bacteria.

3. Production of vinegar
   - At first, ethyl alcohol is produced when yeast is allowed to act on sap collected from coconut palm.
   - Afterwards *Acetobacter* is allowed to act on ethyl alcohol which converts it to acetic acid.
   - Venegar is about 4% concentration of acetic acid.

4. In the coir industry.
   - When coconut husks are allowed to decay, bacteria acts on pectin which binds the coir fibers.

- This process starts in the presence of oxygen and accelerates in the absence of oxygen.
- As a result the fibers could be separated from one another.

5. In the production of compost.
   - Compost is obtained by the decomposition of plant and animal material.
   - Three main methods of producing compost is by the barrel method, pit method and surface method.
   - The substance to be decomposed is stacked in layers accordingly and small quantities of water and pre-prepared compost are sprinkled on it.
   - Both bacteria and fungi help in the decaying process.
   - It should be kept in mind that moisture and the presence of oxygen is very important.
   - As the C:N ratio should be kept at a low level, addition of *Glirisidia* leaves, urea and ammonium sulphate is preferred.

• How microorganisms become harmful and disadvantageous

1. Causes diseases
   - Diseases caused by micro organisms are termed infectious diseases. The micro organisms are the cause of infection and the one which provides the microorganism with a place to live is named as the host.
   - Examples for viral infections are chicken pox, measels, dengue.
   - Examples for bacterial infection are diptheria, tetanus, tuberculosis.
   - Amoebiasis and Malaria are examples for protozoa infection.
   - Eczema, dandruff are examples of infections due to fungi.
   - Microorganisms like virus, bacteria and fungi cause diseases in plants.
   - Some of the diseases caused by microorganisms in plants are damping off, leaf curl, leaf mosaic, etc.

2. How microorganisms affect food spoilage
   - Microorganisms living on food derive nutrition from it. As a result, the colour, taste, smell, acidic-alkaline state, nutritional value is changed and addition of slime is observed, where as a result the physical and chemical state of the food is changed and converted to a state which cannot be consumed.
   - When microorganisms act on carbohydrates containing sucrose, fermentation takes place.
   - When microorganisms act on fatty food, it gets rancid.

Competency 01 : Observes the environment as a scientist

Competency level 1.4 : Uses laboratory equipments appropriately.

Activity 1.4 : Let us use laboratory equipments.

Time : 120 min.

Quality inputs :
- Seven copies of instructions for exploration given in annex 1.4.1
- Instruction for teachers given in annex 1.4.2
- Seven copies of the article **'Let us know about laboratory equipments'** given in annex 1.4.3
- Cards numbered from 1-7.

Teaching-learning process :

Step 1.4.1 :
- Introduce the cork borer to the class.
- Demonstrate how it is used.
- Lead a discussion highlighting the following points.

  - Cork borer is a laboratory instrument that should be used apropriately and skillfully.
  - In a laboratory there are other instruments too.
  - It is a responsibility of students who are learning science to have the ability to use various instruments productively.

(15 min)

Step 1.4.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 1.4.3 **(**
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Each and every laboratory equipments must be used according to the need properly.
- These equipments could be classified according to different criteria.
- A sound knowledge and experience related to identifying, selecting, using, proper packing and storing of equipments is essential in maintaining a laboratory.
- It is possible to find out more about this by the article **"Let us know about laboratory equipment"**

(45 min.)

Assesment and evaluation criteria :

- Classifies laboratory equipments according to given criteria.
- Explains the proper use of equipments used in the laboratory.
- Uses laboratory equipments productively.
- Selects apparatus according to the need.
- Obeys instructions.

Annex 1.4.1

Instructions for group exploration

Let us use laboratory equipments

- Your group is directed to one of the work stations which are arranged as a circle.
- Refer the article **'Let us know about laboratory equipments',** and identify the equipments that are used in laboratory activities.
- Engage in activities by setting up apparatus according to the instructions given in leaflets, and taking turns visiting from one work station to the other.
- At the end of each activity place the apparatus as before, to enable the next group to carry out the activity without difficulty.
- Get to the other similar work stations and engage in all the activities in turn.
- Select one from the numbered lots (1-7) kept on the common table and get ready to make an innovative presentation.

Annex 1.4.2.

Instructions to teachers

- **To bore soft rubber bungs**
  - Collect the following items, rubber bung/cork, set of cork borers, glass tube (or thistle funnel) and some water.
  - Select a cork borer from the set of cork borers which has the smallest diameter that is suitable for the glass tube to pass through .
  - Select the side of the rubber bung which has the small diameter and put a drop of water to make it easy to bore the rubber bung by turning and thrusting the borer.
  - After boring, keep the borer inside rubber bung, get the metal rod in the cork borer set and push it through the hole in the cork borer and remove the piece of rubber inside.
  - Isert the glass tube through the hole in the cork borer to the required length and remove the cork borer.
- **To bore hard rubber bungs and cork bungs**
  - Select the borer which has the same diameter as the glass tube and bore the bung/cork and remove the borer. After words moisten the glass tube with water mixed with soap and push the glass tube through while turning.

- **Engaging students in explorations**
  - Divide the students according to the number of work stations.
  - Give 10 minutes to each group and rotate them in successive work stations.
  - Help the students to get readings from the multimeter.
  - After the student groups finish all the activities setup at workstations select one activity to be presented bydrawing lots.

Preparation of work stations

- Number the work stations from 1-7.
- Keep the equipments in the work stations as given below.
- Keep the apprpriate instruction sheets in work stations.

(It is compulsory that all the activities(1-7) in the work sheet should be done by the students. It has seven activities. These have been planned to include all the laboratory equipments in the syllabus.)

Keep the following equipments and substances in each work station.

Work station 1 - 200 ml beaker, 200ml measuring cylinder, 25ml pipette, coloured water.
(It is possible to use measuring equipments with different volumes)

Work station 2 - Burette
Burette stand (wood or rubber/cork or jaw clamp, laboratory stand)
Beaker, Funnel, Coloured water, Conical flask (or titration flask)

Work station 3- Triple beam balance, watch glass, funnel, volumetric flask, wash bottle with water, water, salt (or some substance soluble in water)

Work station 4- 3.8v torch bulb, two 1.5v dry cells, switch, circuit board. (If there is no circuit board use an alternative)
- Volt meter
- Ammeter
- Multimeter

Work station 5 -
- Motar and pestle
- Boiling tube
- Test tube holder
- Bunsen burner / spirit lamp
- Beaker
- Funnel
- Filter papers
- Water
- Some crystals of potassium permanganate ($KMnO_4$)

Work station 6 -
- Tripod
- Wire gauze
- Flat bottom flask
- Bunsan burner/spirit lamp
- Few crystals of potasium permanganate ($KMnO_4$)
- Aluminium foil
- Water

Work station 7-
- Tripod stand
- Clay triangle
- Crucible with lid
- Crucible tongs
- Piece of cleaned magnesium ribbon
- Bunsan burner
- Pair of scissors

- **At each work station keep the following instruction sheets.**

Work station 1 -
- Add 200 ml of coloured water to the beaker.
- Take 25 ml of this to the pipette.
- Put this water into the measuring cylinder and add more coloured water and bring it to 50 ml.

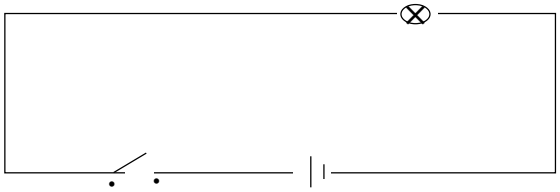
Work station 2 -
- Keep the burette so that it is parallel to the vertical axis of the stand.
- Keep the funnel on the burette and add the 50 ml of water.
- Using the hand not normally used, open the tap and take 25.5 ml from it to a conical flask. (or titration flask)

Work station 3 -

- Determine the volume of liquid that could be measured from the volumetric flask supplied to you.
- Weigh out 5g of salt onto a watch glass using a triple beam balance.
- Drain the salt into volumetric flask using a funnel and the wash bottle. Completely wash the salt in the funnel into the volumetric flask.
- Add some water to the volumetric flask and close the lid. Keep its base on the palm and holding the neck of the flask from the other hand, rotate the flask slowly in a circular horizontal plane.
- After the salt is totally dissolved, add water to bring the level closer to the mark on the neck and add the final drops from a wash bottle or a pipette and make a solution of known volume.
- Afterwards in order to mix the solution close the lid and turn the flask upside down about three times.
- Fix a label on the flask to indicate the contents and the date on which the solution was prepared.

Work station 4 -

- Set up the circuit as in the diagram given below.



- Measure the flow of current through the circuit by connecting an ammeter in series.
- Connect the voltmeter parallel to the electric bulb and measure the potential difference between the two ends.
- Get the teachers help and find the potential difference between the two ends of the bulb, by using the multimeter.
- With the help of the teacher find the resistance between the ends of the bulb when the circuit is open.
  (As only a small current could be measured by the multimeter, the flow of current in the above circuit is difficult to measure.)

Work station 5 -

- Powder a small quantity of potassium permanganate ($KMnO_4$) crystals using the motar and pestle.
- Put this powder into a boiling tube.
- Hold the boiling tube to the blue flame of the bunsen burner at an angle and directed outwards while shaking, for about five minutes.
- Put the heated substance into the breaker, add water and dissolve well.
- Get another beaker and keep a funnel on top of it and place a filter paper moistened with water in it.
- Filter the solution by pouring solution on to the filter paper using a glass rod.

Work station 6 -

- Fill more than half of the flat bottom flask with water.
- Keep the wire gauze on th tripod stand and keep the flat bottom flask on the wire gauze.
- Provide heat with the burner.
- Take a piece of aluminium foil, put some potassium permanganate crystals and a piece of stone and wrap it up so that it sinks in water.
- Put the aluminium foil containing potassium permanganate to the water when it is heated.

Work station 7 -

- Keep the clay triangle on the tripod stand.
- Remove the crucible lid and keep the crucible on the clay triangle.
- Get a piece of magnesium ribbon about 2 cm and clean well , break it up into smaller pieces and put them in the crucible.
- Hold the crucible lid with the crucible tongs and place it on the crucible.
- Ignite the bunsen burner and provide heat to the crucible.
- Allow air to flow into the crucible from time to time by lifting the crucible lid.
- Allow the crucible to cool, after the magnesium ribbon burns.

Annex 1.4.3

Let us identify laboratory equipments

We as students learning science have to engage in various activities and investigations in order to explore the environment. For this we have to use various laboratory equipments. In such activities we should have the ability to identify laboratory equipments, know what functions they perform and the skills to use those equipments is essential.

Because of this, let us identify some of the equipments we frequently use in the laboratory. (Understand about the size and capacity ratio of every equipment.)

Volumetric equipments

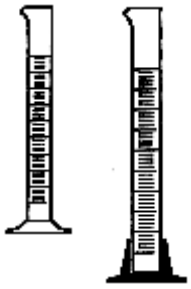
Apparatus which are used to measure liquid volumes are known as volumetric instruments. The following are some of the volumetric instruments which are often used.

- Beaker

- It is an instrument which could be used to measure a large volume of liquid.
- There are beakers with varying capacity. The capacity of the beaker to be used is decided depend-

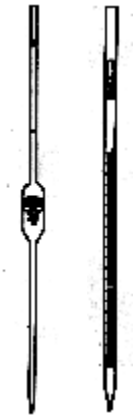
ing on the quantity of liquid to be measured or the quantity of liquid to be used.

- Measuring Cylinder



- This is a measuring instrument which is graduated in milli litres from top to bottom.
- This is suitable to measure a fairly large volume of liquid. When a liquid is filled to a certain level the volume of liquid could be read off from the scale.

- Pipette

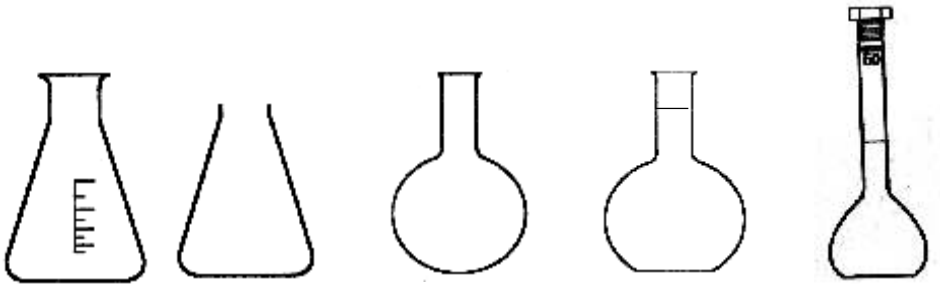


- Pipette is an instrument with which a definite and an accurate volume of liquid could be measured.
- There are two types of pipettes, bulb pipette and the graduated pipette.
- The liquid is drawn into a pipette by keeping the mouth at the open end and sucking or by using a pipette filler.
- When dangerous liquids are measured it is advisable to use the pipette filler. There is a definite way with which a pipette should be handled.

- Burette

- A burette is used to remove a difinite volume of liquid and the volume of liquid could be measured.
- The burette is calibrated from top to bottom.
- A burette is suitable to measure accurately a small volume of liquid up to about $\frac{1}{10}$ of a millilitre.

- Flasks
  - Flask is an equipment used for volumetric and other activities according to its need.
  - There are different types of flasks.



Flask - Conical Flask - Titration Round Bottom Flask Flat Bottom Flask Volumetric Flask

Equipments for Weighing Mass/Weight

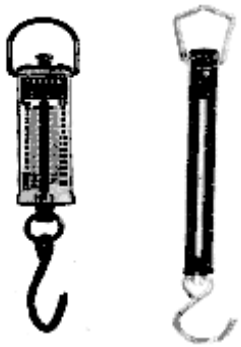
- **Triple Beam Balance**

- This a measuring instrument which is suitable to measure the mass of substances in experiments.
- It could be used to measure masses from 0.1g to 2610g.
  This could be used to measure the mass of a substance even when immersed in water (As in the case of determining the validity of the Archimedes principle)

- **Chemical Balance**

- This is a very sensitive instrument with which the mass of a chemical substances could be measured very accurately.
- A very small mass up to 0.001g could be measured by this.

- **Spring Balance**



- Spring balances which are calibrated in grams and Newtons are very often used in laboratories.
- It is possible to measure the force exerted by gravity(weight) on the object hanging in the hook at the base of the spring balance, from the newton scale.
- it is possible to measure the mass of the object using the gram scale.
- It is possible to use the spring balance to measure the magnitude of the force (in newton's) exerted on a body.

Electrical Measuring Instruments

- Ammeter

- This is an instrument used to measure the flow of current in an electrical circuit.
- The ammeter is connected to the circuit in series.
- The reading of the current flow is read from the deflection of the indicator in the ammeter.
- The reading is given in Amperes.
- In a circuit diagram ammeter is indicated by —(A)— and the Ampere as A.

- Voltmeter

- This is an instrument used to measure the potential difference (voltage) at the two ends of the circuit.
- The voltmeter is connected in parallel to the circuit.
- The respective reading is obtained by the deflection of the indicator in the scale.
- The reading is given in volts.
- The volt is denoted by V, and the voltmeter in a circuit diagram is denoted as —(V)—

- Multimeter

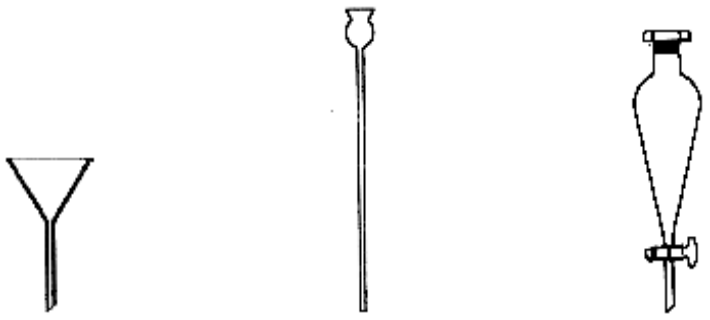
- Multimeter has the advantage of obtaining a variety of electrical measurements from one instrument.
- When obtaining measurements it is connected to the circuit by using two probes .
- It is possible to obtain the resistance, potential difference and the current flow by using the multimeter.

Other laboratory equipments

Boiling tube Test tube Ignition tube

- The boiling tube is larger than the other two, offers a high resistance to heat because it is made of boro-silicate glass.
- Because of this, boiling tubes are used in experiments where it is necessary to heat.
- For other chemical reactions where heat is not provided test tubes are used.
- In chemical reactions where it is necessary to heat up to red hot temperature, ignition tubes are used.(It is a small tube about 5cm.)
- Test tubes are made of soda glass. (Cannot withstand high temperatures).

- Funnel
  - Funnels made of glass or transparent plastics are largely used in laboratories.
  - Funnels are used when it is necessary to put liquids to other vessels, easily, safely without wastage, and methodically.
  - Funnels are used when it is necessary to collect gases into test tubes, underwater.
  - Sometimes thistle funnels are used when it is necessary to introduce acids to set ups.
  - Separating funnel is used when one liquid is to be separated from a mixture containing two immicible liquids.

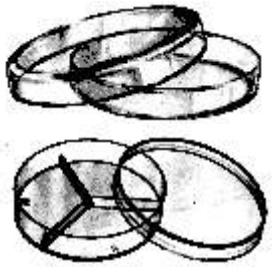


Conical Funnel Thistle Funnel Separating Funnel

- Watch glass/ Clock glass

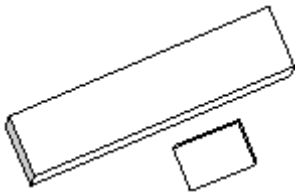
- These equipments made of glass are used when various chemicals are to be kept temporarily, when preparing microscope slides to put samples into water and other liquids.

- Petri dish



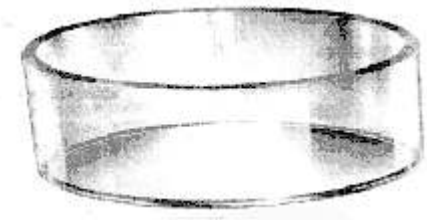
- This is a glass dish with a cover which is used when growing micro organisms, to demonstrate the effect of the metals sacrificed when rusting.

- Sildes and cover slips



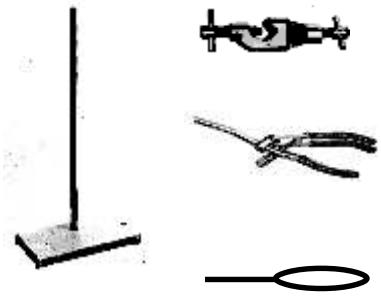
- When it is required to mount samples to observe under the microscope, thin transparent slides are used.
- Cover slips are used to cover the specimens in order to prevent from drying up and making it permanent .

- Trough



- Troughs are used to prepare various setups, in laboratory experiments and to collect water and other liquids .

- Laboratory stand



- This is an equipment which is used in the laboratory to hold equipments.
- This is made up of various parts.
- Foot, support rod, boss head and clamp.
- When all these combine together it is called the stand.

- Bunsen Burner

- This is a burner which is used in the laboratory to obtain a very hot flame by using LP gas.
- A very important advantage of this is a very hot flame could be obtained where no soot is formed.

- Sprit Lamp

- A hot flame is obtained by using wine spirit.
- Even though it is not as hot as the bunsen flame, heat could be obtained when required.
- When wine spirit is burnt less soot is formed.

- Specific gravity bottle / Density bottle

- Density bottle is the most suitable equipment by which the mass of a specific quantity of liquid could be obtained.
- It has a very thin body and a lid with a small opening.
- When the bottle is filled with liquid and the lid is replaced the excess liquid flows out through the opening.
- After wiping the density bottle with a dry cloth, it is possible to obtain the mass of the liquid.
- The body of the specific gravity bottle should not be touched after it is filled with the liquid.

- Mortar and pestle

- An equipment which could be used to powder substances in the laboratory.
- This is made out of clay/porcelain.

- Tripod stand

- This is an equipment which has three legs and used as a support in setting up equipments in the laboatory..
- Made of metal
- When heat is supplied to an object wire gauze or the clay triangle is kept on the tripod.
- There is a tripod in the laboratory with a circular support. This is the retort stand.

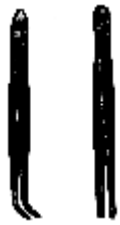
- Wash bottle

- This is a plastic bottle which could be pressed and the distilled water in it comes out through the jet.
- This could be used to prepare chemical solutions , to wash chemicals in a watch glass and add water drop by drop.

- Tongs

\In laboratory experiments different tongs are used to hold the equipment or to keep it in place. Some of those tongs are given below.

Tong-crucible



Forcep

Test tube holder

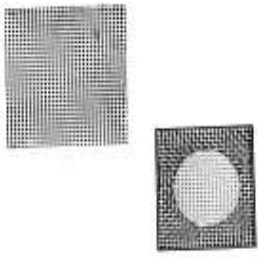
- Cork Borer

- This is an equipment to bore holes in rubber bungs and cork bungs.
- This has a set of metal borers which could be used to bore holes of different diameters and also a rod to remove the piece of cork or rubber stuck in the borer.
- Cork borer sharpner is used.to sharpen the cork borer.

- Filter paper

- This is a type of paper which could be used to filter solutions.
- It is made up as a cup and put in the funnel and is used to filter the solution.
- It has the ability to absorb liquids and is made up of special kind of paper with minute holes.

- Wire Gauze



- This is put on the tripod stand when something is heated.
- There is an asbestos paste in the wire gauze, as a result the flame is not directly exposed to the requipment.

- Clay triangle

- When something is heated in a crucible, the crucible is held in place by the clay triangle kept on the tripod.

- Crucible With Lid

- This is an equipment which is made of ceremic clay, which is used to heat the substance to a high temperature.
- Since it is provided with a ceremic clay lid, evaporation of the substance is minimized.

Competency 2.0 :Investigates to identify the nature of earth and space.

Competency Level 2.1 : Investigates the development of various views on solar system.

Activity 2.1 : "Let's have a look at solar system!

Time : 120 min

Quality inputs :
- **"Wonders of the Universe"** story in annex 2.1.1.
- Three copies of instructions for exploration in annex 2.1.2
- Three copies of article**"They were so curios about the Universe "** in annex 2.1.3.

Teaching learning process:

Step 2.1.1 :
- Get students to conduct the role play, **"Wonders of the universe"**.
- Lead a discussion to highlight the following points.

  - According to 'Suneth's story there are difference in opinion about the solar system.
  - Scientific exploration on universe is interesting.

(15 min)

Step 2.1.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 Mts)

Step 2.1.3 **(**
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups, summarize highlighting the following points.

  - Sun, moon and planets are celestial bodies which belongs to the solar system.
  - Astronomy too developed with the advancement of science.
  - Information about the universe could be gathered by;
    - making use of the appearance and disappearance of

celestial bodies from time to time
- using optical instruments and communication equipments.

- It is possible to find more about universe by reference to article, **"They were so curios about the Universe ."**

(45 min)

Assesment and evaluation criteria :

- Presents examples to explain the models of the universe.
- Explains the heliocentric model according to recent findings.
- Elaborates on methods of exploring information about the universe.
- Be sensitive about the universe.
- Updates knowledge.

Annex 2.1.1

Wonders of the Universe

"There is not even moon light today."
On that dark night, Suneth was turning pages of a book about the universe. He looked outside through the window.
"Oh, what is that?"
A small patch of green light was approaching towards Suneth from afar. It was gradually growing bigger and bigger as it appeared like a dwarf figure which stopped by the window.
"Hi Suneth! you seems to be engaged in a serious work. I'm sure that you cannot identify who I am."
Suneth stared at this strange creature who called him by his name at once. "Who are you?"
"I am a celestial body."
"Celestial bodies do not speak like that."
There was a loud laugh.
"Suneth, I too was in your solar system.
I had to leave very recently. You people removed me saying that I am not a planet."
'Really! then you must be Pluto?"
Again a loud laugh...
"Yes indeed."
"Then, if you are Pluto, how could you come here?"
"As you know, I don't have a particular orbit. So while I was wandering, I thought of dropping at your place."
Although it was a hint, Suneth laughed loudly. Again the glowing figure spoke to Suneth.
"Listen to me Suneth. I'm afraid, you know very little about the universe! We know much more than you."
"Don't under estimate us like that. Our scientists have been exploring the universe, observing the celestial bodies and making a variety of theories for last four thousand years."

Pluto laughed again cynically.

"Yes of course. I know very well. At first, it was the geocentric theory... now it is the heliocentric theory..."

Suneth thought for a while.

"How does he know these things? Must find out". He told to himself.

"Suneth, it seems that you know nothing about those. Better turn that big book to see."

Suneth turned back to the book .

"Beep...beep..."

Suneth turned towards the sound.

"Hey, are you leaving? I want more information from you..."

"Remember, that you are also a little scientist! So don't ask me. Explore and find out yourself..."

"Please, Pluto, please..."

Suneth shouted. Mother rushed into the room.

"Oh boy! Why are you shouting? Did you have a bad dream? Why do you sleep like that, with your head lying on the book? It is already passed mid night..."

Annex 2.1.2

Instructions for group exploration

Let's have a look at solar system

- Your group is expected to find out about the theories put forward by following individuals regarding the solar system.
  - **First group** - Aristarchus, Aristotle
  - **Second group** - Nicholas Copernicus, Johannas Kepler
  - **Third group** - Claudius Ptolemy, Tycho Brahe

- Find out the theories which were put forward by the individuals that you have assigned and discover whether they are heliocentric or geocentric models.
- Analyse how far do they match with the theory disclosed by Galileo Galeli.
- Get ready to present your findings innovatively.

Annex 2.1.3

"They were so curios about the Universe "

(The teacher came out of the laboratory when the school was over. Manomi, Radha and Hussain, were talking to each other, while seated on the bench under the mango tree.)

Teacher : "Have all of you found out about different theories on solar system?"

Manomi : We are still searching sir. It seems, that the names of planets are found even in the horoscopes.

Teacher : There are names of other celestial bodies too. You see...Ravi means Sun. It is a star. Moon means the Earth's sattelite. Pluto is not considered as a planet."

Hussain : I found out facts about the geocentric model. It is an old concept about the solar system.

Radha : "I also could tell about it Sir, According to the geocentric model, all other planets, Sun, Moon etc, are moving around the earth. Look at this picture. This was drawn by greek philosopher Aristotle in 384 to 322 B.C. He promoted his teacher, Plato's ideas and published to the world."

(Radha took out the picture of the geocentric model from her bag and showed it to the others.)

Manomi : Another fact...What Aristotle says is that the whole universe itself is not so big as the earth. This picture shows the movement of Sun, Moon and planets around the earth.
During that time and for a few centuries this idea was accepted.

Teacher : But astronomer Aristarchus who lived in Alexandria in 280-264 B.C. presented a different idea...didn't you find out about that?"

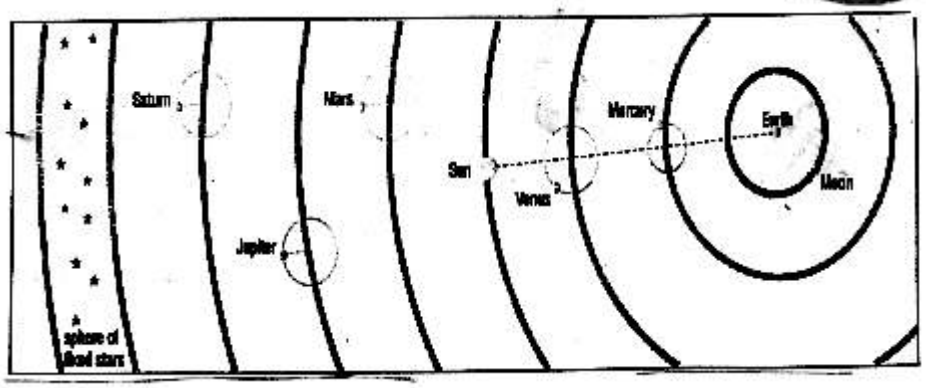
Hussain : "Yes sir, isn't it the heliocentric model? In that the Sun is at the centre and the planets are moving in circular paths around it...

But unfortunately he couldn't convince his idea, although it was correct. The great philosophers and religious leaders prevented that idea from being accepted."

Manomi : Not only that, even Claudius Ptolemy (100-178 AD) confirmed the geocentric model. He added something to it... that as planets move in circular orbits, they move in small epicycles too.

"Look at this book. This is Ptolemy's geocentric model".

(Manomi opened a book on Astronomy)



Ptolemy's geocentric model

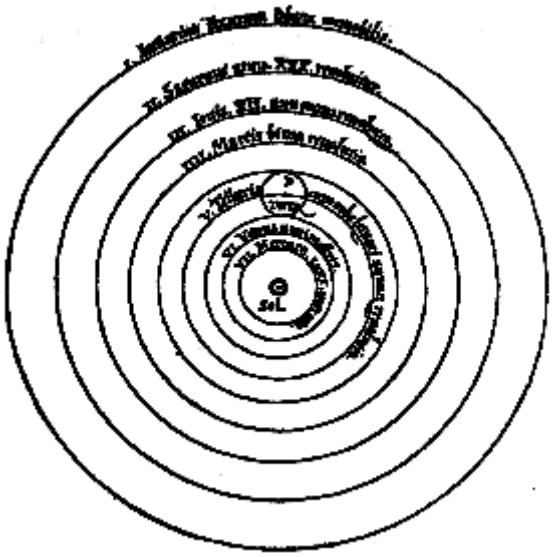
Teacher : Do you know that Sir Nicholus Copernicus is known as the greatest astronomer?

Radha : "Of course, there is a good reason for it.
About 2000 years after Aristarchus, in about 1473-1543 A.D, with the development of Science, it was Copernicus who again put forward the heliocentric model as a new theory.

There is a description about Copernicus in your astronomy book.

(Radha turned the book which was in Manomi's hands.)

Copernicus



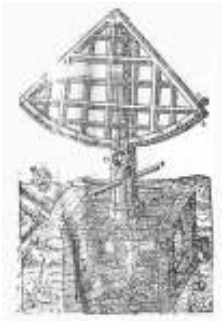
Heliocentric model of Copernicus

Hussain : However, Tyco Brahe, Johann Kepler, Galileo Galilei are considered as the individuals during the golden era of Astronomy.

But Brahe, who was a Danish national and a mathematician always tried to prove that the Copernicus's theory was wrong. For this he made a large instrument called sextant.

He wanted to prove the geocentric model. But before he could present his discoveries he died.

Tyco Brahe



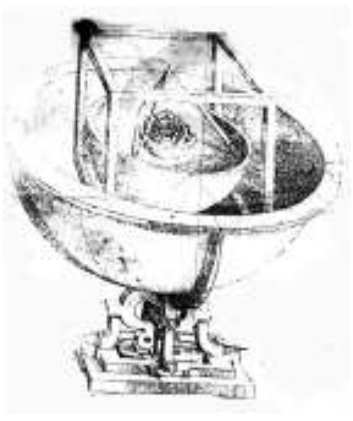
Brahe's Sextant

Manomi : There is an interesting story behind Brahe's story. The significant character in that is Johannas Kepler.

After Brahe's death Kepler studied his discoveries further within the period of 1571-1630 A.D. Though he wanted to support Brahe's idea, however Kepler proved that the heliocentric model of Nicholas Copernicus was correct, but the Brahe's geocentric model.

Radha : Kepler also explained further, that planets are not moving in circular orbits but in elliptical orbits.
He constructed a model of the universe too!
(Radha turned another page in the book)

Johannes Kepler



Kepler's model of the universe

Teacher : "Very fine. But still no one spoke about Galileo Galilei".

Hussain : Look here, I got a picture of Galileo yesterday.

Galileo Galilei

(Hussain showed a photograph which was inside a book)

Galileo's discoveries also confirmed Keplers' idea. At the same time a dutch optician made a telescope. Galileo made the maximum use of this. As you know, when we hear Galileo's name, we recall about the telescope. He was capable of explaining the phases of moon as well as other information too by observing the sky. His name gained prominence in 1609 A.D.

Teacher : "By the way, what's your ideas about the telescopes used today?"

Manomi : "Today we are living in a technologically developed world. Telescopes which are thousand times more advanced are used today. Our scientists are watching the universe endlessly to gather more information.

Tremendous services rendered by early astronomers who explored the universe at a time when there was no technology should really be admired.

Competency 2.0 : Investigates to identify the nature of earth and space.

Competency level 2.2 : Investigates on constellations.

Activity 2.2 : Stars that show us the path

Time : 120 Min

Quality inputs :
- The article **"Let's draw the ecliptic"** given in annex 2.2.1, globe , laser torch, bristol board and twine.
- Four copies of the exploration instructions in Annex 2.2.2.
- Four copies of the article, **"Stars that show us the path"** in Annex 2.2.3.
- Materials necessary for students' innovations.

Learning teaching process :

Step 2.2.1 :
- Engage the students in **"Let's draw the ecliptic"**activity.
- Lead a discussion to highlight the following.

  - Earth's axis of rotation is inclined (tilted) 23.5° relative to its plane of revolution around the Sun.
  - Patches made by laser beam could be considered as the points at which the sun reaches its zenith throughout the year.
  - The path which is demarcated on the rotating globe from these light spots are not in a straight line.
  - Different position of the earth where the sun rise occurs, on either side of the earth-to the north and to the south of the equator throughout the year is denoted as ecliptic.
  - To us on earth, we see as if that the Sun is moving along that path.
  - Because of this it is considered that the apparent motion of the sun is along the ecliptic.
  - When the apparent motion of the sun takes place along the ecliptic, the equator is intersected on 23rd September moving from north to south and south to north on March 21st.

(15 min)

Step 2.2.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore, by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 2.2.3 **(**

- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

• The sky you see is known as celestial sphere. • We cannot see the other hemisphere of the celestial sphere at the same time. • When you want to observe the night sky, we must select a night with a cloudless sky and no lights around. • Arrangement of stars across the celestial sphere could be identified as star patterns. • Out of these, the star patterns which seems to be moving in the celestial sphere are known as Zodiac. • Star patterns can be useful for various discoveries. • You can find more information about this from the article, **"Stars that show us the path."**

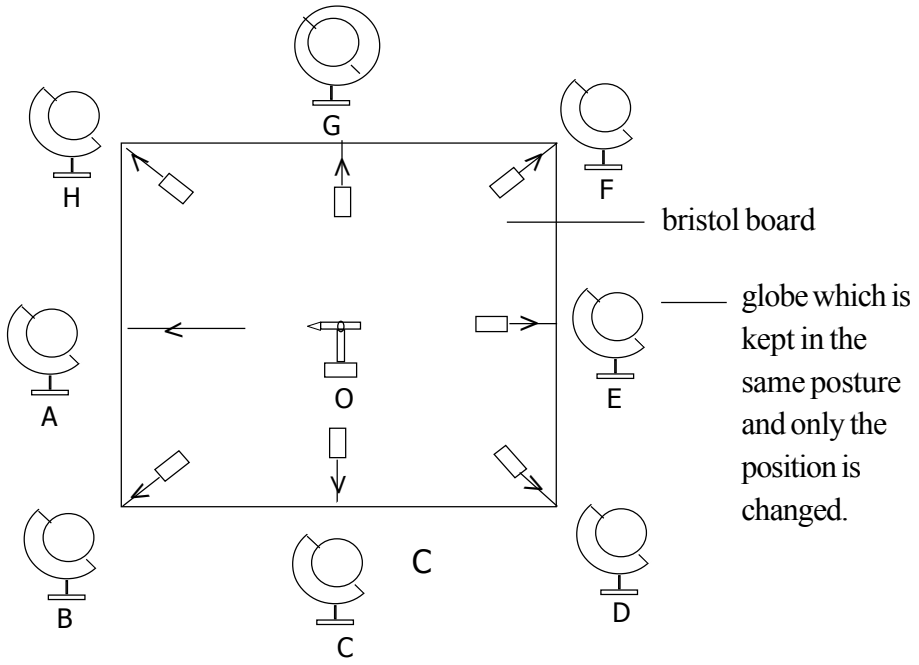
(60 min)

Assesment and evaluation criteria :

- Conducts an activity to show the ecliptic.
- Uses drawings to illustrates star patterns.
- Highlights the benefits of studying the star patterns.
- Investigates the scientific basis of folk tales.
- Explores about the infinite universe.

Annex 2.2.1

Let's draw the ecliptic



- Keep the bristol board prepared as shown, on the table.
- Keep the globe at A and arrange the laser torch at O, so that its' red light falls at a certain point on the globe.
- Mark the spot of light.
- Without turning the globe keep it in places A, B,C, D etc., light the laser torch and mark the spots.
- Lay a twine across the spots.
- Lay a twine round the equator as well.
- Mark the points at which the two twines intersect each other.
- The wave like path as indicated by twine is the apparent path of movement of the sun. On March 21st the sun moves to the north of the equator and on to the South on the 23rd of September.

Annex 2.2.2

Instructions for group exploration

Stars that show us the path

- Your group is expected to explore some star patterns given below.
  - **Group One** - Ursa major (Big dipper), Ursa minor, Aries, Leo, Sagittarius.
  - **Group Two** - Southern cross, Scorpio, Virgo, Capricon
  - **Group Three** - Orion, Gemini, Aquarius, Libra

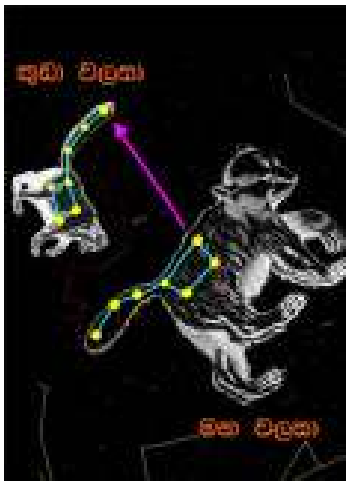
- **Group Four** - Pleade, Taurus, Pisces, Cancer
- Study about the star patterns by reference to article "Stars that show us the path."
- Highlight the following points with regard to the star patterns assigned to your group.
  - The star patterns which belong to the zodiac and do not.
  - Uses of star patterns.
  - The shape of the star pattern.
  - The durations of the year at which those star patterns are visible at 8.00 in the night.
  - The placement of those star patterns in the celestial sphere during the above mentioned time of the year .
- Get ready to present your findings innovatively.

Annex 2.2.3

Stars that show us the path

Zodiac

The apparent path of the sun is called ecliptic. Twelve star patterns (constellations) included in the zodiac are placed along the ecliptic. These are named as Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Saggitarius, Capricon, Aquarius and Pisces. As a result each constellation has 30^0 of the ecliptic ($360^0/12$). Although we consider that there is no change in reciprocal motion of stars, the astronomers show that it changes in about twenty six thousand years.



If the earth and the sun is present within the 30^0 that belongs to a constellation, we say that the sun is in that constellation. Sun goes right through the constellation cycle within one full year . As we are close to the equator we see that the star patterns rises in the east and sets in the west. Those who are above the equator and close to the north pole could see star patterns associated with the **North star**, those who are below the equator close to the South Pole could see the star patterns associated with the **Southern cross**. These are seen as non setting star patterns through out the year.

Big dipper (ursa major) and the ursa minor are two of the star patterns seen in north pole. Southern cross and Centaurus are examples in south pole .

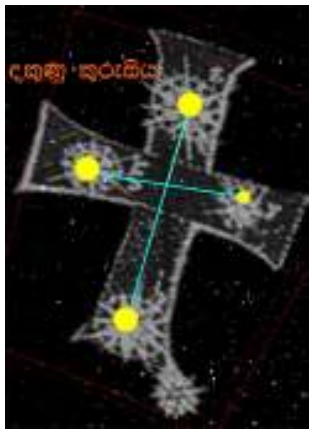
BIG DIPPER - URSA MAJOR

There are seven bright stars. Four of them take the form of a square. The line joining the first two stars of that square indicates the north. So, they are known as indicator stars.

URSA MINOR

This is seen below the ursa major close to the horizon. There is a star named polaris which is in

line with the indicator stars of Ursa major. This star is at the tip of Ursa minor's tail. It is possible to find the north pole of the earth by this star. It is also called the North star. It indicates the north. It is visible along the coastal areas, but could not be seen to the up-country.

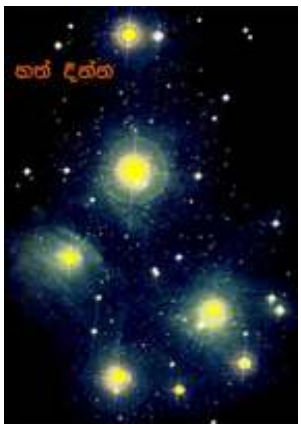


Southern Cross

The four stars in this are seen as a cross. The longer arm is directed towards the south. When we look at the stars along the short arm towards the left, we see three stars. One of these three stars is the Proxima centuary, which is closest to us. This is not seen by the naked eye. The star Alpha centuary which is far from the cross, is seen by the naked eye. They are visible in the evenings of July.

ORION

It is placed close to the 0^0 centre of the sky equator in the star map. It is the most visible star pattern in the night sky. There are four stars to the four sides. It creates a giant which has a sword in the right hand, and shield in the left, a belt with a sword case. The three stars in the belt are Mintak, Almilam and Alnimac. The brightest star is at the left shoulder of the giant is known as the Betelgeuse while the star Rigel is placed on the right heel. The violet coloured light spot seen at the end of the sword is called the orion nebula.



There are star patterns encircling the Orion which includes taurus,pleade and gemini.

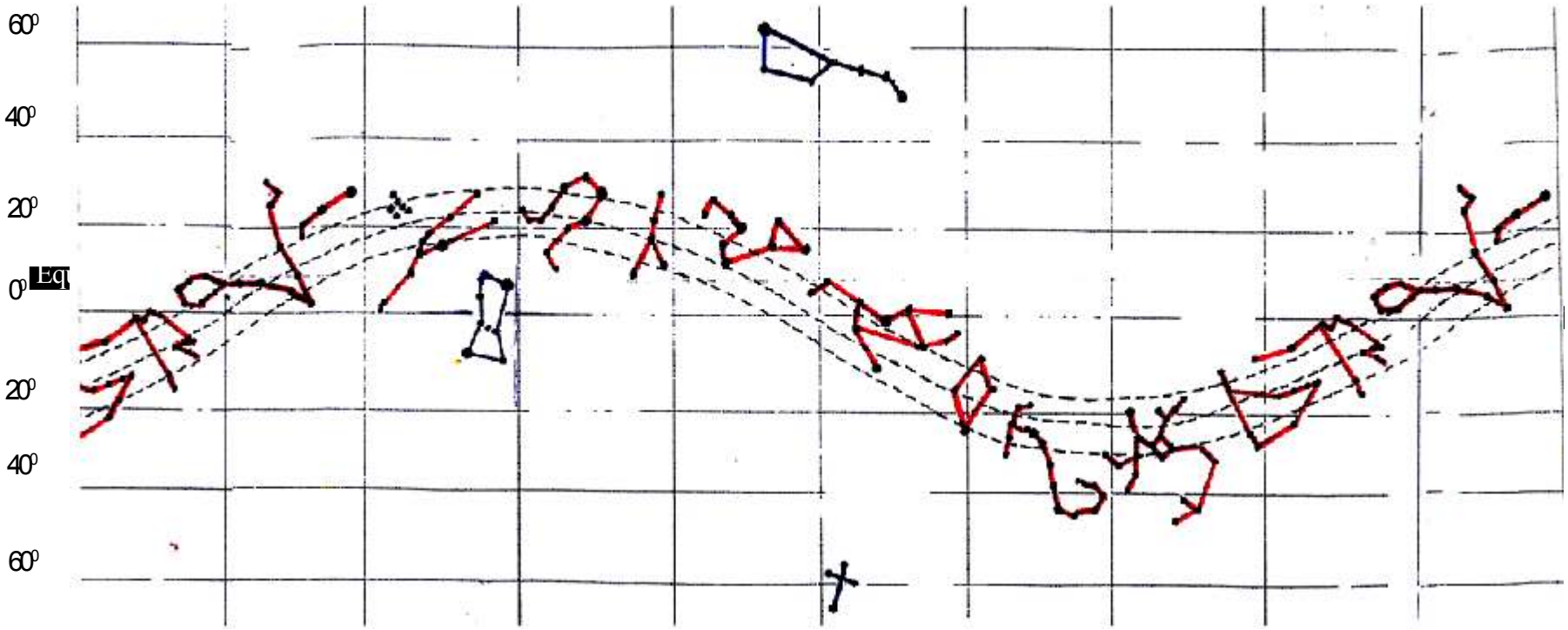
PLEADE

Six stars are seen with the naked eye but if you look with attention, you could see a seventh star. If seen through a telescope more stars are seen. This star pattern can be seen behind the Taurus.

Uses of star patterns

- To find the way (the direction) when travelling in seas and deserts and also to find out about the rainy seasons. (Eg. They come to know about the increase in water level in the river Nile when they see the star pattern Canis major.
- To find the winter and summer climates.
- To describe the motion of the planets.
- To distinguish between planets and stars.
- To determine the spherical nature of the earth.
- To measure and find the time.
- To find the latitude in which you are.

STAR MAP DEVELOPED BY OBSERVING THE SKY AT 8.00P.M. THROUGHOUT THE YEAR



CONSTELLATIONS

Competency 2.0 : Investigates to identify the nature of earth and space.

Competency level 2.3 : Inquires about the information on the nature of space.

Activity 2.3 : Keep an eye on the universe.

Time : 120 min

Quality inputs :
- Three copies of instructions for exploration in annex 2.3.1
- The article published on 'Dinamina' newspaper in annex 2.3.2
- Three copies of article **"Keep an eye on the universe"** in annex 2.3.3

Learning teaching process :

Step 2.3.1 :
- Present the article on Dinamina to the class by a student.
- Lead a discussion highlighting the following points.

  - The infinite nature of the universe.
  - There can be secrets in the universe which has not been discovered up to now and also will never be discovered.
  - Exploring about the universe is joyful.

(15 min)

Step 2.3.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 2.3.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- The galaxy named as Milky way, to which our solar system belongs is one of many galaxies in the universe.
- Out of millions of stars in the Milky way, our sun is still a young star.
- Our sun is placed in an outward arm of the milky way.
- Exploding stars, are named as Nova and Super nova stars.
- The solar system including our earth was born out of a Super nova explosion.
- The exploration of the universe is a broad subject.
- More important points are given in the article **"Keep an eye on the universe."**

(45 min)

Assesment and evaluation criteria :

- Highlights ideas of astronomers about the change in shapes of galaxies, with examples.
- Lists out the birth of a star in sequential steps.
- Attempts to explain the expansion of the universe by using scientific data and evidence.
- Obtains an awareness about the environment.
- Explores the environment by self motivation.

Annex 2.3.1

Instructions for group exploration

Keep an eye on the universe

- Draw your attention to one of the following themes of a small subject content on the infinite universe.
  - **First group** - The existence of stars and galaxies
  - **Second group** - Birth and death of a star
  - **Third group** - Beginning of the universe and its expansion
- Gather information for your theme by reference to the article "Keep an eye on the universe."
- Prepare a written resource to encourage a person who does not know much more about the theme assigned to you.
  (Examples : leaflets, short stories, articles, dialogues...)
- Get ready to present your creation.

Annex 2.3.2

Article published on Dinamina

As Abhaya mama stopped the vehicle near the gate, Saranga ran towards him.
"Abhaya mama, did you bring the Dinamina paper?"
"Yes, Saranga, there is an article which you would like most."
Abhaya mama turned to page twelve, and showed Saranga the picture and the description about space exploration.

Saranga looked amazed.
"Really! Have they discovered another planet like the earth?"

"Read and see to yourself.
There are many more things which man has not discovered yet.
You are the people to discover those things in the future."

Saranga read the article at a stretch.
A small smile broke on her face.

Dinamina
Wednesday 12th August 2009

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Annex 2.3.3

Keep an eye on the universe

Stars and Galaxies

In galaxies there are billions of stars. There are galaxies which has shapes as elliptical, spiral and lock shaped, whereas some galaxies have no definite shape.

The solar system in which the earth belongs, is a spiral shaped galaxy known as the Milky way. Our sun takes about 220 million years to complete one rotation around the Milky way. The diameter of the Milky way is about 100,000 Ly (Light years). Its' thickness is about 20,000Ly (light years). The distance to the sun from the centre of the milky way is about 30,000Ly. The milky way rotates like a cyclone. The stars at the centre of the spiral are older than those stars in the outer region.

New stars are born in the are arms of galaxies, while some stars explode. One arm of the milky way is visible in a clear sky at night. It is indicated as a white line drawn by a brush from north east to south west.

Scientists express ideas that different shapes of galaxies change from one shape to another.

Birth of a star and its end

Scientists express the birth of a star according to following steps.

i A magnanimous cloud is formed by a huge mass of gases and dust revolving at a greater speed in the space.

ii The gas molecules solidifies due to high pressure. As a result the temperature as well as the pressure inside increases.

iii The gas molecules explode and release energy. Sometimes it exceeds from 3000^0C to $30,000^0$C, resulting the atoms get fused (liquid state) and a large amount of energy is re leased. A star is born in this manner.

Explosion of stars

When stars explode they are called nebula. These nebula contains the debris and gases. These do not emit light. But they glow due to warm stars nearby.

If the exploding star has a mass exceeding more than three times of our sun, the explosion is called a **super nova** explosion, if it is less than that it is called a **nova** explosion.

If there is a super nova explosion in a star it forms elements like Uranium and Gold which has a density higher than that of Iron. Earth is also a product of a super nova explosion. Our sun which is a star, will become cold and die after about 6000million years, due to exhaustion of fuel gases.

Beginning and expansion of the Universe

Different scientists have expressed different opinions about this. Edwin Hubble put forward three laws regarding the existance of the Universe. By his big explosion law, he stated that the universe was formed by a large explosion, it is possible to compare this to the sparks formed by sky cracker, similar to these sparks getting extinguished, all these galaxies too burn out in the end.

He put forward another theory the Law of Oscillation . There is a limit to the universe, the galaxies get closer and get apart and occupy this limited space.

His Law of constant nature says that there is no beginning or an end to the universe. In other words galaxies are born and die endlessly within the universe .

According to Albert Einsteins theory there is no beginning or end or limit to the universe. The universe which is four dimensional as time and space (length, width and height) exists by its expansion and contraction.

Competency 3.0 : Uses concepts, principles and theories related to energy, work and force effectively.

Competency level 3.1 : Elaborates on simple linear motion by using vector and scalar quantities.

Activity 3.1 : What are scalar and vector quantities?

Time : 120 min

Quality inputs :
- The story of **"Rectilinear motion made by catapault"** given in annex 3.1.1
- Three copies of exploration instructions given in annex 3.1.2
- Three copies of article **"A joyful trip"** in annex 3.1.3.
- Stop watches, compass, measuring tape, trundle wheel, three from each

Teaching learning process :

Step 3.1.1 :
- Present the story **"Rectilinear motion made by catapault"** to the class.
- Lead a discussion highlighting the following points.

• The stone that was shot by the catapault travelled to the ambarella fruit in a straight line. • Displacement and velocity are two physical quantities which could describe bodies moving in a straight line. • Exploring about the movement of bodies is helpful in day to day pursuits.

(15 min)

Step 3.1.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 3.1.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.

- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Quantities which has only a magnitude and no direction are called scalar quantities.
- Distance, time, speed are some examples of scalar quantities
- Average speed $(ms^{-1}) = \frac{\text{Distance}(m)}{\text{Time}(s)}$
- Quantities which has both magnitude and direction are called vector quantities.
- Displacement, velocity, accelaration are some examples of vector of quantities.
- Average velocity $(ms^{-1}) = \frac{\text{Displacement (m)}}{\text{Time (s)}}$
- It is possible to find out more about movement of bodies in a straight line by reference to the article of **" A joyful trip."**

(45 min)

Assesment and evaluation criteria :

- Compares scalar and vector quantities.
- Investigates the patterns of motion of bodies according to accepted criteria.
- Engages in calculations associated with, distance and displacement as well as speed and velocity.
- Uses concepts of physics to improve quality of life.
- Predicts preceding steps in phenomena by calculations.

Annex 3.1.1

Rectilinear motion made by catapault

"Isn't it good to prepare an ambarella curry?"
Grandmother went towards the back yard, saying so.
Oh! we don't need a stick to pluck. I'll get you ten fruits in a minute.
Nisal took the catapault in his hand. Picked up a stone. Mother was looking from the door step. "See mother."
"Distance is the same as the displacement.
Speed is the same as the velocity."
Just as he finished his song he aimed the catapault and shot.
Everything went right. Ambarella fruit fell to the ground.
"Yes, son you could take the aim very well?"
"Here is the second fruit.
Nisal again sang the song and shot.
"Distance is the same as the displacement.
Speed is the same as the velocity."
Nisal took two minutes to pluck ten fruits.
Grandmother was looking on amazed with the stick in her hand.
What is it?
"Distance is the same as the displacement.
Speed is the same as the velocity."
"It is motion in a straight line".
That is why we say one must learn science."
Both mother and grandmother laughed.!

Annex 3.4.2

Instructions for group exploration

What are scalar and vector quantities?

- Go to the place allocated to your group.
  - **First group** - adjoining to the building where your classroom is.
  - **Second group** - School compound
  - **Third group** - Between the gate and the classroom
- Decide on two pathways to conduct a competition between members of the group. The competition could be walking or running or hopping with one leg.
  - A - Path which is not a straight line.
  - B - Path which is a straight line.

- Using the measuring tape or trundle wheel measure the lengths of the paths accurately.
- With the compass in hand start from one end of the path and go to the other end either by running, walking or hoppning on one leg or all three and measure the time taken.
- Use the compass to observe whether there is change in the direction or not.
- By reference to the article **Joyful Trip,** highlight the concepts of distance, displacement, average speed and average velocity.
- Record data on distance and displacement in an appropriate table.
- Based on the data, find the average speed and average velocity.
- By this select the winners in the group.
- Be prepared to present your findings innovatively.

Annex 3.1.3

A Joyful Trip

The monkey and the crow who were on the mango tree were talking about the ripe jak fruits on the jak tree on the other side of the lake.

"Shall we go to that tree?"

Both set off. The crow directly flew from the mango tree to the jak tree.

The monkey jumped from tree to tree along bank of the lake and reached the jak tree.

"I 've been here for so long! You got very late."

You came along the shortest route between the trees. I came around the bund of the lake."

"Even so, both are in the same place on the same tree."

Monkey laughed and asked.

"Is it possible for you to explain our trip scientifically?"

* * *

"The jak tree on which we are now is exactly in the north west to the mango tree...I flew along the shortest route from the mango tree to the jak tree. It is 340 metres. You came along a circular route. How long is the distance you travelled?"

"810 Metres."

"Although the distance we travelled is different, we are on the same tree in the end. Our change in position is the same. We call it **displacement**. Our displacement is 340 metres to the north-west of the mango tree."

"Why don't you say the displacement is from the mango tree to the jak tree?"

"There is no need to say so. It has to be a distance on a straight line from a starting point with the direction. When we state displacement, we definitely tell about only one point.

"Yes,of course. It is the point where the jak tree is."

"When we state displacement, it is obligatory to mention the direction as well."

"Exactly. Another point, when there is a direction to a certain quantity, we call it a vector quantity."
"Then displacement is a vector quantity"
"Then how about the distance I travelled along the bund of the lake?"
"It does not have a definite direction. Yes. Distance is a scalar quantity. It does not have a definite direction. If we travel a distance from a starting point, we cannot decide on the final position."
"Yes, who knows whether you travelled around the same tree again and again." laughed the monkey jumping from tree to tree."

* * *

Both of them got together and selected a good ripe jak fruit.

We took different times to get from the mango tree to the jak tree.
Then although our displacement was the same, speed was different. Wasn't it?

"This point has to be understood very clearly.

$$\text{Average speed} = \frac{\text{Distance (m)}}{\text{Time (s)}} = \frac{\text{m}}{\text{s}} = \text{ms}^{-1} \quad \text{metres per second}$$

The distance is the length of the route you travelled. It is 810 metres. When that distance is divided by the time taken, we get your average speed. It is termed as **average speed**. So, we could assume that the entire journey was travelled in a uniform speed. But if we consider your displacement, and divide it by time, we get a different value. That speed is termed as **velocity.**

$$\text{Average Velocity} = \frac{\text{Displacement (m)}}{\text{Time (s)}} = \frac{\text{m}}{\text{s}} = \text{ms}^{-1}$$

"Remember, that speed calculated by the distance is a quantity whithout a direction as such it is a **scaler quantity**. But velocity calculated by displacement has a direction as such it is a **vector quantity**. Here also we consider that the entire journey have been travelled at a uniform velocity."

"Then according to what you say, although our displacement was the same velocity was different?"
"Definitely yes. To travel the same displacement you took more time, I spent less time. My velocity is higher than your velocity."
We have to indicate the direction here as well. Am I right?"
"Definitely."
"When we consider displacement and velocity, we travel in a straight line. Don't we?"
"Yes, if any body travels in a straight line it is possible to measure the displacement and by that the velocity too could be calculated."
If the movement is not on a straight line, first the displacement and then the velocity is determined.
Both of them ate more than half of the jak fruit, while they we talking. All of a sudden the fruit fell down.
"Did you see? Even the motion of the jak fruit is in a straight line.
What can you say about its displacement and velocity?"
Before replying to the monkey's question, the crow asked.
"Do you think that when the jak fruit fell to the ground its motion was at a uniform velocity?"
Monkey thought for a moment. Took a jak seed and threw it vertically upwards. The speed of the jak seed reduced slowly. It stopped for a moment and returned in the same path increasing the speed gradually and fell to the ground.
"Now I will answer your question. Jak fruit did not fall to the ground at a uniform velocity but with a gradually increasing velocity."
"That is correct. If the velocity of a moving body increase gradually we term it as **acceleration."**
"Then that jak seed, when it was thrown upwards, it travelled up gradually reducing the velocity."
If the velocity of a moving body gradually decreases we call it **retardation.**
"But remember, that both acceleration and retardation are vector quantities. Because both have a direction."
"Sometimes I too run with acceleration and stop with retardation."
Monkey laughed loudly, saying so.
Not only you, I too fly with acceleration and stop with retardation."
Both of them laughed.

Competency 3.0 : Uses concepts, principles and theories related to energy, work and force effectively.

Competency level 3.2 : **Investigates appropriate mechanical strategies used in various work sites.**

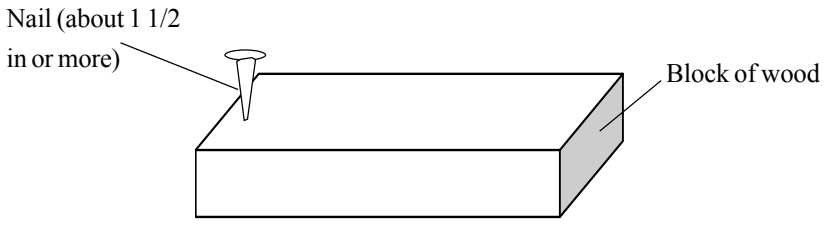
Activity 3.2 : Heroes in work sites!

Time : 120 min

Quality inputs :
- A block of wood with a nail fixed to it, claw hammer and a small piece of wood.
- Three copies of exploration instructions in annex 3.2.1
- Copy of instructions to the teacher in annex 3.2.2
- Three copies of **"Heroes in work sites"** picture handout in annex 3.2.3

Teaching learning process :

Step 3.2.1 :
- Introduce to the students, a block of wood with a tight fitting nail as in the diagram, claw hammer and a suitable small piece of wood.



- Discuss the various ways of pulling out the nail with the students.
- Give them an opportunity to remove the nail by using the claw hammer.
- Lead a discussion highlighting the following points.

  - The claw hammer is useful in making it easy to remove the nail.
  - It is made much more easy, if a piece of wood is kept in a suitable place under the hammer.
  - The place at which you hold the hammer also makes it easy to perform this task.
  - In different work sites, various strategies are used to get the work done easily.

(15 min)

Step 3.2.2 : • Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 3.2.3 : • Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

• We always come across work sites like construction of buildings, vehicle repairing and agriculture. • In the above work sites, various mechanical methods are used, according to the needs, to make the processes easy. • It is very essential to be familiar with the above mechanical methods and to use it appropriately in order to reach the world of work. • It is possible to find out about various mechanical methods that are used in various work sites with the aid of the picture hand out on **"Heroes in work sites."**

(45 min)

Assesment and evaluation criteria :

- Classifies various mechanical methods used in various work sites.
- Uses mechanical methods appropriately.
- Displays the ability to setup mechanical devices for future needs.
- Uses easy methods to fulfil requirements.
- Motivates to act innovatively.

Annex 3.2.1

Instructions for group exploration

Heroes in worksites

Your group will be assigned with one of the following work sites connected with day to day life.

- **First group** - Construction of buildings
- **Second group** - Repairing vehicles
- **Third group** - Agriculture

- Discuss about the worksite you visited (with the approval of your teacher) together with the information you collected, according to the instructions (in format) given by your teacher.
- Engage in the following tasks using the information provided by the members of your group according to the format and the picture handout provided.
  i. If your group is assigned to work in that particular work site, list out the mechanical equipments you would use to make the work easy.
  ii. Show the productivity you obtain from those equipments.
- Be prepared to present your findings innovatively.

Annex 3.2.2

Instructions to teachers

- Instruct the students to explore on the work sites proposed according to the subject content before the activity 3.2.on a holiday.
- This exploration could be carried out individually or in groups.
- It is compulsory that a teacher or a responsible adult must accompany the students in the field trip.
- The person who is responsible must see that the students refrain from engaging in dangerous activities.
- Provide the students with the following format to be completed during the field trip.

Worksite explored - Building construction/repairing vehicles/agriculture

- Date :.....
- Location of the work site :.....
- Details about mechanical devices used in it :.....

Mechanical device or equipment	How work is facilitated by it
1. 2. 3. 4.	

- The methods you employed to determine the productivity of the equipments in the work site and the co-operation you received from the operators in the work site.

  .....

- Your ideas about the experiences you obtained from this field trip.

  .....

Heroes at worksites - (i) Building construction worksite

Building construction

^1& Concrete pump car - To transport the concrete mixture to places where it is difficult for people to reach.

^2& Concrete Batching Plant- To prepare the concrete mixture.

^3& Concrete Transport Mixer- To transport concrete as it is mixed.

^4& Hammer Drill - Crushing of concrete.

^5& Mitre Saw - To cut metals

^6& Rammer (Compactor) - For pounding soil

^7& Concrete Mixer (Towable) - To prepare the concrete

^8& Excavater - To dig the soil

^9& Crane - To take building equipment to higher places.

Agriculture

^1& Water Pump - To pump water to the agricultural land.

^2& High Pressure water sprinkle - To sprinkle water to crops.

^3& Multi Purpose Tractor - Multi purpose Tractor

^4& Multi Purpose Tractor - To plough the field and for transport

^5& Mud Wheel - To go about without getting stuck in the mud.

^6& Backhoe - To dig holes and trenches, prepare the field for cultivation

^7& Rice Huller - To grind paddy

^8& Disc plough and ^9& Tine tiller - To loosen the soil

^10& Chain Saw - To cut huge trees

^11& Rotavator - For digging earth

^12& Harvesting Machine

^13& Paddy field preparation machine

Vehicle repairing worksites

^1& Toolboard - To store tools methodically

^2& MIG(Metal Inert Gas) Welding Machine - To weld without burnt patches.

^3& Oxyacetylene Welder - To weld and cut metal sheets

^4& Hydraulic Jack ^5& Screw Jack - To lift vehicles

^6& Chain Block - To lift heavy equipment like vehicle engines, gear boxes.

^7& Tyre fixing machine -To fix and remove tyres

^8& Air Compressor - To obtain compressed air

^9& Drill press ^10& Electric Drill - To punch holes in metal sheets

^11& Hoist - ^12& Inclined plane - To raise vehicles

^13& Grinder - To brush and smoothen metal parts

^14& High Pressure water pump - To wah vehicles

^15& Bench Vise - To keep the engine parts in place when repairing

^16& Wheel brace - To remove bolt nails from vehicle tyres

Competency 3.0 : Uses concepts, principles and theories related to energy, work and force effectively.

Competency level 3.3 : Invetigates on qualitative and quantitative aspects of global energy resources.

Activity 3.3 : Treasure of energy!

Time ; 120 min

Quality inputs :
- The article on **"Hearth and Rice cooker "** in annex 3.3.1.
- Three copies exploration instructions in annex 3.3.2.
- Three copies of article **"Treasure of energy"**

Teaching learning process :

Step 3.3.1 :
- Introduce the role play to the class.
- Lead a discussion highlighting the following points.

• Energy resources such as electricity for the rice cooker and fire wood (Biomass) for hearth are used. • Various other energy resources could be used in order to improve the quality of day to day life. • It is better to choose equipments depending on the availability of energy resources in our environment. • It is necessary to explore on the different energy resources in the world.

(15 min)

Step 3.3.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 3.3.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.

- After giving an opportunity to all the groups,summarize, highlighting the following points.
  - The energy resources we use could be classified as primary and secondary.
  - Naturally available energy resources are considered as **primary energy resources**.
  - There are differences in the distribution of primary energy resources throughout the world.
  - The primary energy resources could be transformed into **secondary energy resources.**
  - It is not possible to use primary energy resources as it is to fulfil some daily activities.
- For such instances secondary energy resources has to be used.
- There is loss of energy when primary energy resources are converted to secondary energy resources.
- Article **"Treasure of energy"**could be used to explore more about energy resources.

(45 min)

Assesment and evaluation criteria :

- Arranges primary and secondary energy resources in correct order.
- Shows the difference in the distribution of energy resources globally.
- Demonstrates the skills in utilizing energy resources with proper management.
- Finds solutions to problem in different ways.
- Acquires the ability of working towards progress.

Annex 3.3.1

Hearth and Rice Cooker

In the hearth of the kitchen built with three stones is a clay pot containing steaming porridge. On the other side, on a table is an electric rice cooker containing bubbling rice.

Rice Cooker : "Listen porridge pot, isn't it is very difficult for you?"

Porridge pot : Why?

Rice Cooker : "Why, covered with soot... surrounded by steam ...and smoke all over...What a suffering ah? Look how dirty you are! The entire kitchen is hot and it is difficult even for us to be here. See... a piece of firewood is burning outside. Put it in."

Porridge pot : I don't see anything what you say as a problem. I was the one who did cooking for the last thousands of years. I do my duty using pieces of wood in the garden and thrown away coconut shells. Anywhere for any emergency firewood hearth is the only help. If you want try and find out. There are also 'Anagi' (wk.s ,sm), firewood gas hearth, (Ouks ,sm). They are my relations. They know how to do work in a clean and orderly way. It is very clear that you could only cook rice."

Rice Cooker (Angrily): The job I have to perform is only cooking rice. I do it very well. I do it cleanly...orderly... and methodically. After I am entrusted the work, there is no need for anyone to waste his time. I do the cooking on my own and complete the work by switching off automatically.

There is no need to put in firewood. No need to experience flameand smoke. I use electricity. Look how beautiful I am!

There seems to be no end to their quarrel. Disgusted, Dineth came into the kitchen.

Dineth : Please be quiet and mind your business both of you! It's true that the rice cooker is an important equipment. But you need not talk too much about you. If electricity fails all your chores are over. Hearth is also an asset to us. As cost of electricity is too much I can tell mother to cook the rice too in the hearth.

Rice cooker became silent. But the porridge is still boiling.

Annex 3.3.2

Instructions for group exploration

"Treasure of energy"

- Draw your attention to one set of three phenomena given below.
  - **First group**
    - Cooking rice in an electric cooker
    - Lighting houses with glass windows
    - Running a motor vehicle using gas
  - **Second group**
    - Lighting an electric bulb at night
    - Drying paddy in sun
    - Heating water on a three stone hearth
  - **Third group**
    - Watching the television
    - Baking bread in a firewood furnace
    - Transporting goods by sail ships
- Read the article **Treasure of energy.**
- Classify the enery resources as primary or secondary in the phenomena assigned to you.
- Lead a discussion about primary energy resources under the following themes.
  - Is it available anywhere in the world sufficiently? (quantity)
  - What kind of secondary energy resources could be obtained by converting the primary energy resources assigned to you?
- Find out the primary energy resources that have been utilized to obtain the secondary energy resources required for the phenomena assigned to you.
- A dialogue between two grade nine students is given below.
  "Using secondary energy resources is a waste. When converting primary to secondary energy resources a large amount of energy is wasted. So, we better use primary energy resources directly."

  "But for some needs it is not possible to use primary energy resources as it is. On such instances, we are compelled to convert them into secondary energy resources."
- According to the above dialogue, what kind of course of action should we take in the process of convertion as well as in utilizing energy?
- State your ideas about the quality of primary and secondary energy resources we use.
- Get ready to present your findings innovatively.

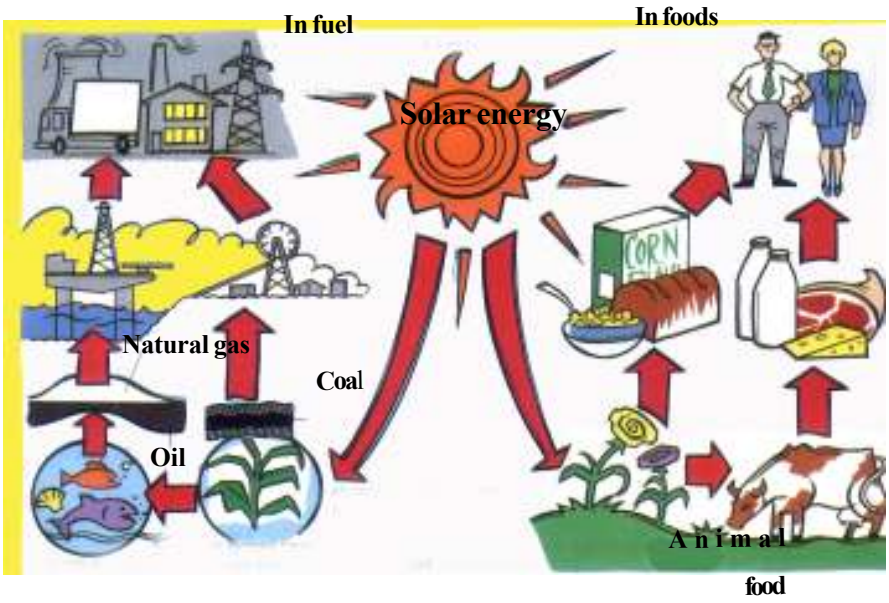
Annex 3.3.2

Treasure of energy

Primary energy resources

Primary energy resources are energy resources which we use as it is in the natural environment, without doing any sort of change.

Examples :-
- Crude Oil
- Coal
- Natural Gas
- Nuclear Energy
- Biomass
- Wind
- Potential Energy of Water
- Solar Energy



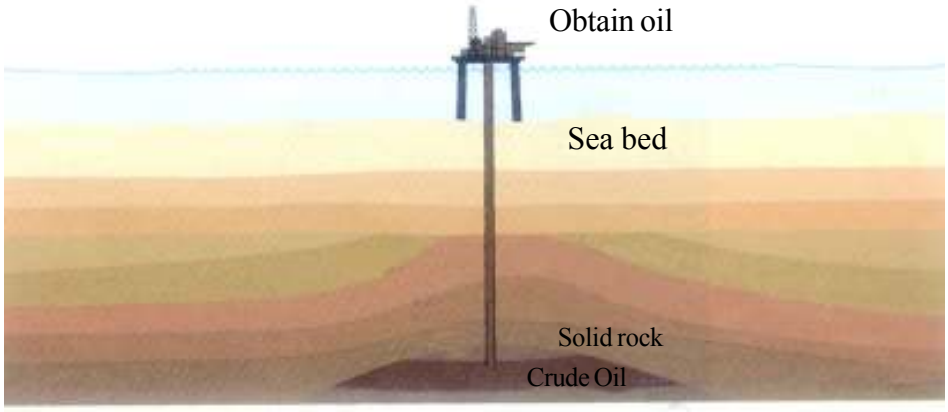
- Unequal distribution of primary energy resources.

Primary energy resources are not uniformly distributed throughout the world .

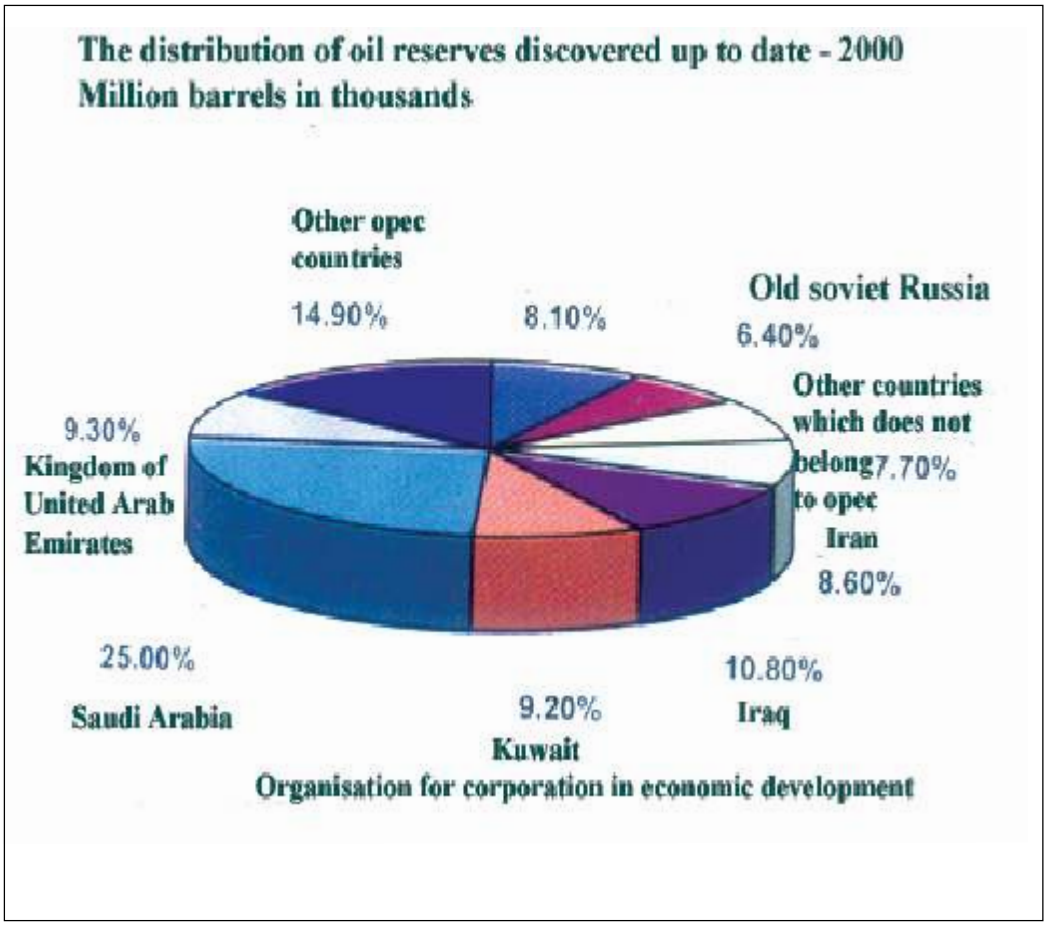
1. Crude Oil

Greenish brown viscous liquid, highly inflammable, could be obtained from permeable rocks

is a primary energy resource which cannot be regenerated. It is a fossil fuel. Mineral oil deposits are found only in some regions in the world. This is a limited resource.



An instance where crude oil is obtained from oil deposits on earth



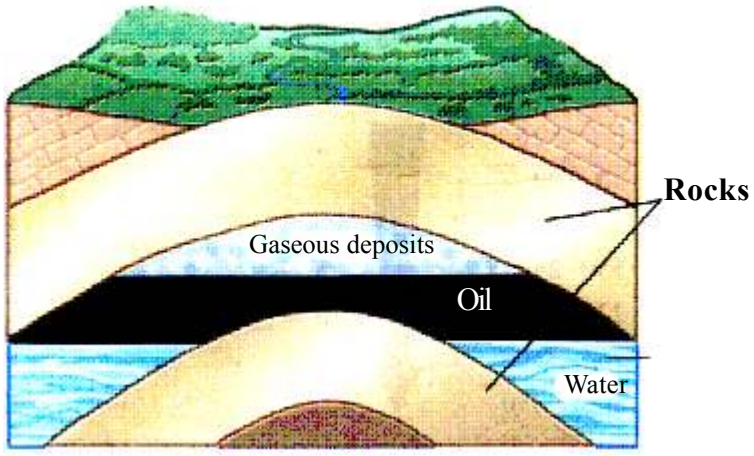
2. Coal

This is a solid primary energy resource which cannot be regenrated. Coal is an inflammable substance which could be burnt directly, and it is a fuel which has a large amount of energy. This is the cheapest and readily available fuel among other fossil fuels.

3. Natural gas

Most of the natural gas deposits are found immediately above mineral oil deposits under high pressure. Natural gas is a volatile product formed during the process of coal and mineral oil formation.

As a result natural gas deposits are commonly found with deposits of mineral oils and coal. This is also a primary energy resource which cannot be regenerated.



4. Nuclear energy

Uranium and Plutonium are the elements used to produce nuclear energy. In addition elements Radium, Thorium are also used in other nuclear activities. They are all metallic elements extracted from soil.

The energy obtained from nuclear reactions, which are conducted under controlled conditions is used to generate electricity. Extraction of nuclear fuels, building and maintaining nuclear power stations are very expensive.

5. Biomass

Bodies of animals and plants and their waste matter is termd as Biomass. This is an energy resource which could be regenerated. eg. fire wood, dung

Biomass is in use as a primary energy resource world wide. Although trees are not readily available in urban areas, it is possible to collect animal and plant waste matter to produce bio gas. As long as there are living beings, biomass could be considered as an inexhaustible primary energy resource

6. Wind

This is the least used energy resource out of all primary energy resources. Electricity could be generated by wind power. Wind farms (iq<x fldrgq) are located in the areas where high winds persist like Hambantota. As wind is not available throughout the year, and winds change directions greatly, wind mills are used only in some areas. This is an energy resource which could be regenerated.

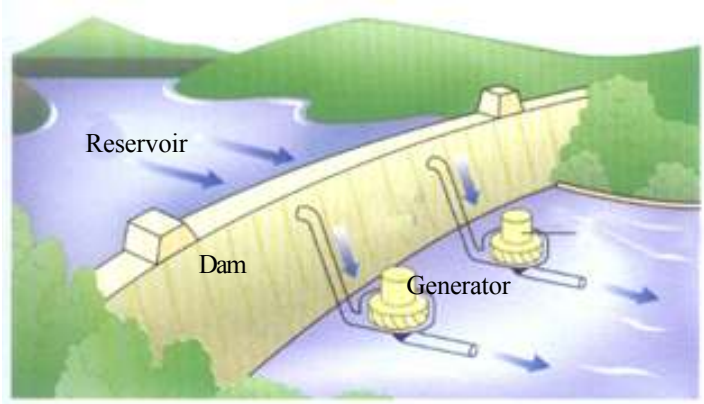
Wind Farm

7. Potential energy of water

When water falls from heights, the potential energy in it is converted to kinetic energy. Electrical energy could be generated by using this kinetic energy to work turbines.

Examples :

- Water falls and reservoirs in high elevations
- High tide and low tide
- Sea waves, ocean tides
- Convection currents (OTEC)



8. Solar energy

This is a regeneratable energy resource. Today most countries use solar driers to dry vegetables, fruits, cardamons and medicinal plants. In addition solar energy is used in heating water.

Same examples are given below where solar energy is used.

1. Black sheets which could absorb solar energy can be used to heat water as well as to keep houses warm.
2. Solar cells which could generate electricity contain photo cells which absorb solar energy. Initial cost of these methods are very high and are obsolete when sunlight is less or not available.

Solar panel complex made up of solar cells established in Mexico.

Secondary energy resources

When primary energy resources are converted into others, they are called secondary energy resources.

eg : electricity, heat energy, super heated steam

1. Electricity

The first step of the process of generating electricity is preperation of super heated steam. It has a high pressure as well as a high temperature.

Super heated steam is produced either from nuclear and coal power plants or by burning crude oil . So that even super heated steam also a secondary energy resource.

Then super heated steam is used to rotate the turbines to generate electricity.

Process of generating electricity in some power plants...

1. Coal - The power plant located in Norochcholai.

chemical energy ⟶ heat energy ⟶ mechanical energy ⟶ electrical energy
(Coal) (super heated steam) (turbines)

2. Diesel : Power plants located in Kelanitissa and Sapugaskanda.

chemical energy ⟶ heat energy ⟶ mechanical energy ⟶ electrical energy
(Diesel) (super heated steam) (turbines)

3. Fire wood(Bio mass) : Dendro power plant - located in Hanguranketa

chemical energy ⟶ heat energy ⟶ mechanical energy ⟶ electrical energy
(fire wood) (super heated steam) (turbines)

Heat energy

A secondary energy resource, mostly generated by burning fuel, L.P. gas or firewood in day to day life.

The wastage of energy due to conversion

When primary energy resources are converted to secondary energy resources, a percentage of energy is lost as heat, light andsound. But it is compelled to convert primary resources into secondary due to needs given below.

In some occasions primary energy resources cannot be used or impossible to use directly.

Inability to obtain desired efficiency.

Uneven distribution.

Attention must be focused in using methodologies to minimize loss of energy during conversion and to utilize energy resources frugally.

Competency 3.0 : Uses concepts, principles and theories related to energy, work and force effectively.

Competency level 3.4 : Investigates the use of alternative energy resourcesas a solution for energy crisis.

Activity 3.4 : Let us win the energy crisis.

Time : 120 min

Quality inputs :
- Article **" Story about Chaturanga ayya"** in annex 3.4.1
- Three copies of exploration instructions in annex 3.4.2.
- Three copies of article **"Let's popularize alternative energy resources"** in annex 3.4.3

Teaching learning process :

Step 3.4.1 :
- Present **"Story about Chaturanga ayya"**to the class .
- Lead a discussion to highlight the following points.

  - Cow urine and dung were used as raw materials for the biogas plant built by Chaturanga,
  - Biogas is used to illuminate his house as well as for cooking.
  - This is an alternative energy resource to electricity and L.P. gas.
  - We also must direct ourselves to use alternative energy resources as a solution to the power crisis like Chaturanga.

(15 min)

Step 3.4.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 3.4.3 **(**
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Although we must direct orselves to use alternative energy resources as a solution to the power crisis, most of such resources are not yet popular.
- In the case of some energy resources the following problems are present.
  - cost of production is high.
  - higher technical know how has to be used.
  - uneven distribution
  - not environmental friendly
- To find more information use the article **"Let's popularize alternative energy resources."**

(45 mts)

Assesment and Evaluation Criteria :

- Chooses alternative energy resources.
- Proposes alternative energy resources.
- Uses alternative energy resources productively avoiding disadvantages.
- Acts to overcome challenges.
- Follows strategies that suits the situation.

Annex 3.4.1

"Story about Chaturanga ayya"

"Hi, come nangi, we have been waiting for you from morning. Did you go to ***Sustainable Energy Authority?***

That is how Bandu mama welcome Shanaka, his mother and his father as they entered the house.

"No Bandu ayya, we are going there tomorrow". Shanaka putha has to do a project on alternative energy. We thought of going there in the morning to collect some data."

Chaturanga ayya served the milk coffee to Shanaka.

"It is better if Chaturanga ayya also can join with us. I am going to get instructions as to how a bio gas unit is installed."

Chaturanga laughed.

"I have already installed a bio gas unit at home. I am the one who is supplying gas to the farm, fathers boutique as well as to the kitchen.

Shanaka was looking at Chaturanga with astonishment. Bandu mama made a good suggestion.

"Chaturanga putha, you better go with Shanaka down to the garden and show him the bio gas unit".

* * *

"This is an underground tank. Biogas is made in that. What you see here is the circular opening of the big underground tank. It is closed with a concrete lid. In order to fix the lid firmly, I have applied a layer of clay between the tank and the lid.

The plastic tube here is fixed to the lid. Biogas is taken out through this tube."

"So, why have you put a layer of water above the lid."
"That fulfills three conditions.
It is perfectly air tight, when the clay layer is moist.
Next is, if there is a gas leak, we could see bubbles.
The other is, if there is too much of pressure inside the tank, the lid itself will lift a bit allowing exess gas to escape.".

A drain system is in place to flow the cow dung and urine from the cow shed into the underground tank.

"It seems this process is very cheap that you have all the raw materials available at home."

"No Shanaka malli even if you want to install a biogas unit at your place, you could get the decaying vegetables thrown away from the Sunday fair. On the other hand fair is very close to your house."

Then both of them went to see the cattle shed.

"Nanda is waiting in the boutique for you with some curd." Said Bandu mama while heading towards the owita.

When Shanaka and Chaturanga entered the boutique nanda was lighting the gas cooker. A tube was connected to the burner from the biogas unit.

"Come Shanaka putha, I'll show you the gas lamp." Nanda lighted the gas lamp .

Mother who was there also very interested about this biogas system.

"Bandu ayya, did the biogas unit cost a lot of money?"

"Yes somewhat. But by now we have covered the initial cost. Credit of this project should go to Chathuranga putha."

"Oh,Chaturanga ayya is an exemplary citizen!"

Annex 3.4.2

Instructions for group exploration

Let us win the energy crisis.

- Some instances where we could use alternative energy sources in overcoming the energy crisis are given below. Out of these draw your attention to the theme assigned to your group.
  - **First group**
    - Vehicles and factories
  - **Second group**
    - Households
  - **Third group**
    - Farms in far off places
- Use the article provided to gather information required.
- Find out the energy resources used in places assigned to you and suggest alternatives.

Energy resource necessary	Alternatives that could be used
1. 2. 3. 4.	

- Highlight and show the advantages and disadvantages in using alternatives.
- Get ready to present you findings innovatively.

Annex 3.4.3

Let's popularize alternative energy resources.

(I) Bio Diesel

Diesel manufactured from plant material. It has properties similar to normal diesel. To make biodiesel, sea algae, castor, Palm oil are used.

As crude oil is a gradually declining energy resource, diesel vehicles can be altered to use bio diesel

Advantages	Disadvantages
1. Can be manufactured locally. 2. Less environmental pollution.	1. Cannot supply to satisfy demand. 2. Initial cost is high. 3. Technical expertise essential.

(2) Alcohol (Ethanol, Methanol)

These are products of plant material. It's properties resembles that of petrol.

(i) In the preparation of ethanol plant materials like sugar cane, and manioc are used. When cane sugar is fermented ethanol is produced. By mixing ethanol with gasoline, gasonol is prepared. This gasonol is used as a fuel. This is an alternative energy resource for depleting fossil fuel.

(i) Methanol

This is prepared out of wood. Therefore, it is known as wood alcohol.
Advantages and disadvantages of its use.

Advantages	Disadvantages
1. Could be prepared locally. 2. By growing sugar cane the plant cover is increased. 3. Less environmental pollution.	1. There is less supply to fulfil the demand. 2. Large quantity of raw materials (cane) are necessary.

(3) Bio Mass

Plant and animal matter that could be used to produce energy.
(Eg.: Fire wood, Cow dung, Paddy husk, Wood shavings)

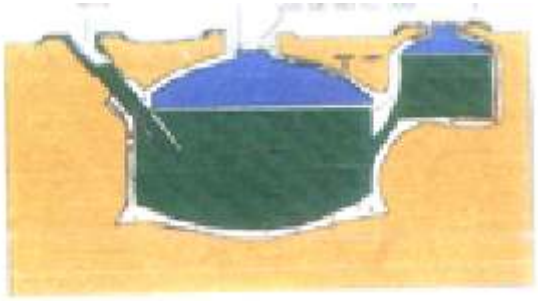
By using new methods they started to grow glirisidia like plants in large scale to produce biomass as an alternative for energy crisis.

Advantages and disadvantages of using biomass.

Advantages	Disadvantages
1. Easy to find 2. It is easy to store. 3. Less environmental pollution.	1. Difficultyof using in urban areas. 2. Lands that could be used in limited. 3. Domestic environmental pollution.

(4) Biogas

Biogas is produced when organic material is degraded by bacteria . Animal and plant products like straw deteriorating vegetables, cow dung, poultry and pig waste materials could be used.



Bio gas generator

Advantages and disadvantages of using bio gas.

Advantages	Disadvantages
1. Waste matter could be used. 2. Could be set up as small units.	1. There is an initial expenditure. 2. There is difficulty in getting space in urban areas. 3. There is difficulties in maintenance.

(5) Solar power & Solar cells

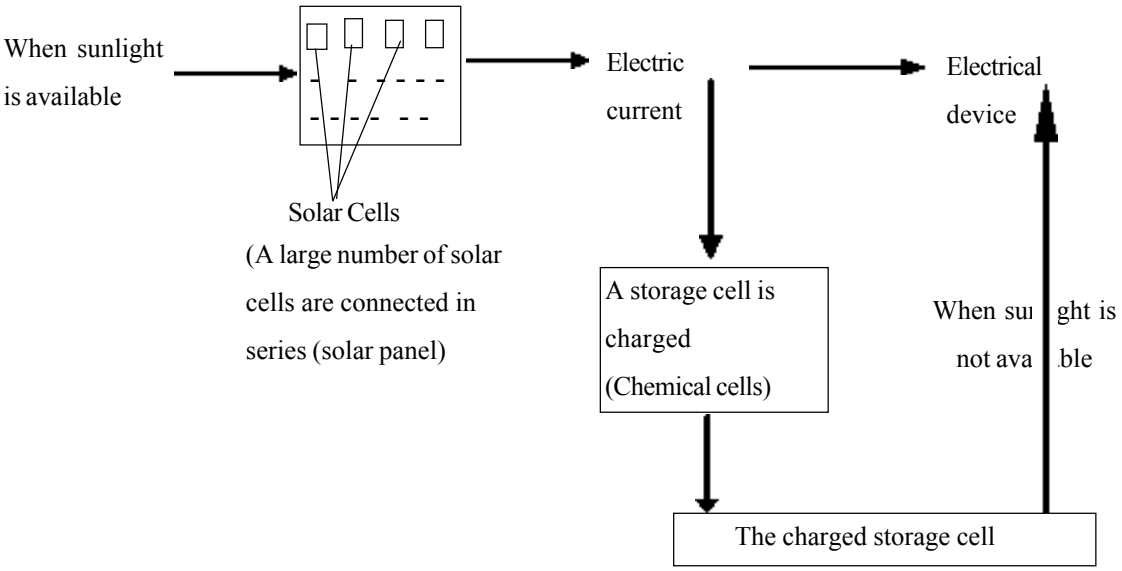
Instances where solar power could be used.

- Solar cells - To obtain electricity from solar energy.
- Solar heaters - To heat water
- Solar hot air generator - To obtain hot air to factories
- Solar oven - To cook foods
- Solar drier - To dry substances (maintaining its quality)
- Box drier - To dry house hold agricultural produce.

Man has not yet been able to device ways and means to use solar power efficiently even though it is a source of energy freely available, and to most parts of the world. But solar energy

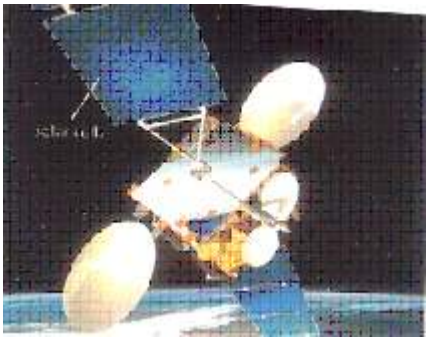
is a suitable alternative to the energy crisis.

Now a days scientists are trying out technological ways and means of using solar power. Solar cell is an example. It's process is given below.



Advantages and disadvantages of using solar energy.

Advantages	Disadvantages
1. There is no fuel expense 2. Easy maintenance 3. Could be used as a single unit.	1. Quantity of usable energy is less. 2. Initial expense is high. 3. Efficiency is less when there is more rain and cloulds.



Satellite using solar panels

(6) OTEC - Ocean Thermal Energy Conversion

Surface of the ocean gets heated during the day while sea bottom is cool. The temperature difference is about 20^0C.

Energy can be produced by using ammonia as a heat exchange substance. Exchange of heat between warm and cool water is the principle used in this.

Sea is a renewable energy resource. It is possible to adjust it to develop high electricity.

Advantages and disadvantages of OTEC.

Advantages	Disadvantages
1. There is no harm to the environment. 2. It is not a danger to ocean animals and plants.	1. It is not possible to use in all oceans. 2. Initial cost is very high.

(7) Ocean Waves /Ocean Tidal Power

It is possible to produce large amount of energy from ocean waves. That depends on height and speed of the waves. The energy in high tides and low tides is the ocean tidal power.

The advantages and disadvantages in ocean waves and tidal waves.

Advantages	Disadvantages
1. No harm to the environment. 2. There is no fuel cost.	1. Not possible to use in all oceans. 2. Initial cost is very high.

(8) Fuel Cells

In fuel cells the electricity is produced from chemical reactions.

Here hydrogen gas is used as the fuel. Fuel cells are made by using other combination reactions.

Eg.: Methane - Oxygen fuel cells.

Advantages	Disadvantages
1. By product is only water. 2. Environmental pollution is less.	1. High cost.

(9) Hydrogen

Hydrogen is not available naturally. It has to be manufactured. It is possible to obtain a large quantity of heat energy by burning Hydrogen gas. As it is possible to generate fires and explosions it is not used in the house hold as a fuel.

Hydrogen is used as a fuel in rockets.

(10) Methane Gas

Methane is obtained as a gaseous product of crudeoil. Methane gas is also the primary product in bio gas units.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.1 : Explores evidences for the occurence of a chemical reaction.

Activity 4.1 : Chemical reaction..... the change that took place.

Time : 120 min

Quality inputs :
- Burning candle and a clean piece of magnesium ribbon.
- Three copies of exploration instructions contained in annex 4.1.1
- Teacher instructions in annex 4.1.2
- Three copies of article "Chemical reaction and the change that took place" in annex 4.1.3

Teaching learning process:

Step 4.1.1 :
- Employ two students and instruct them to ignite a candle and burn the piece of cleaned piece of magnesium ribbon.
- Lead a discussion highlighting the following points.

  - When heat is supplied to the candle the parafin wax turns to liquid. Which is a physical change.
  - In a physical change there is no change in Chemical properties between the original reactants and the final substance product.
  - The burning of magnesium is a chemiacal change.
  - In a chemical change the initial substance (reactants) is converted to a new substance (product) with different properties.
  - Light is given out by burning magnesium.
  - Giving out light is evidence of a chemical reaction.
  - There are other evidences to conclude that a Chemical change has taken place.

15 Mts.

Step 4.1.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 Mts)

Step 4.1.3 **(**

- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- It is possible by using following evidence to conclude that a chemical reaction has taken place.
  - Change in temperature (heat exchange)
  - Change in colour
  - Forming a precipitate
  - Giving a sound
  - Giving out light
  - Giving out a gas

  Further details about this could be gathered by reference to the article "Chemical reaction and the change that took place".

45 Mts.

Assesment and evaluation criteria :

- Bring up the differences between physical and chemical changes.
- Explore what could happen in a chemical reaction.
- Using evidence bring up examples for chemical reactions.
- Identify substances using information.
- When using substances employ suitable precautions.

Annex 4.1.1

Instructions for group exploration

"Chemical reaction and the change that took place"

- Turn your attention to the following activities your group has to do.

- **Group One**
  - A The reaction between Calcium Oxide (CaO) or burnt lime and water (H_2O)
  - B Reaction between Urea $CO(NH_2)_2$ and water.
  - C Reaction Potassium Ferricyanide ($K_3Fe(CN)_6$) and iron wool/filings
  - D Ferric Chlorie ($FeCl_3$) solution and Sodium Hydroxide (NaOH) solution
  - E Reaction between Copper burnings (Cu) and concentrated Nitric Acid (HNO_3)

- **Group Two**
  - A Reaction between Calcium Carbonate ($CaCO_3$) chips or powder and Acetic acid

(CH_3COOH)/Vinegar

B Reaction between Potassium dichromate ($K_2Cr_2O_7$) Solution and Sodium hydroxide ($NaOH$) solution.

C Reaction between Calcium Chloride ($CaCl_2$) solution and Sodium Carbonate (Na_2CO_3) solution.

D Reaction between Glucose ($C_6H_{12}O_6$) and water.

E Reaction between Sodium hydroxide ($NaOH$) solution and water (H_2O)

- **Group Three**

A Reaction between Pottassium Chromate (K_2CrO_4) solution and dilute hydrocloric acid (HCl)

B Reaction between urea cystals ($CO(NH_2)_2$ and dilute hydrochloric acid (HCl) .

C Reaction between Sodium hydroxide ($NaOH$) solution an dilute hydrochloric acid HCl).

D Reaction between Potassium iodide (KI) solution and lead nitrate $Pb(NO_3)_2$ solution.

E Reaction between Copper sulphate ($CuSO_4.5H_2O$) Crystals and water.

- Refer to the article, "Chemical reaction and the change that took place"
- Identify the chemical substances in your work premises.
- Proceed with the practical activities, according to the instructions and make note of your observations.
- According to your observations, classify the activities you did according to the following themes.
  - Exothermic reactions.
  - Endothermic reactions.
  - Reactions which undergo colour changes.
  - Reaction which produce precipitates.
  - Reactions which liberate gases.

Annex 4.1.2

Instructions to teachers

- When keeping chemical substances in the work premises keep a label with the chemical name and the formula.
- Give the following collective instructions to the students before they start using sthe chemica substances.
  - As most chemicals are poisonous avoid tasting or smelling them. (Do not bring near the nose)
  - Do not allow the substances to touch the skin or eyes.
  - Inform the teacher immediately in case of any emergency.

- Supply each work premise a set of equipments given below.
  - 15 Test tubes

- 15 Watch glasses
- 5 beakers
  (If the above equipments are not available use any other alternative)

- Prepare three work premises, each with the following substances.

- **Work premise for group one**
  CaO (Powder/Solid), (H_2O), $CO(NH_2)_2$ Crystals
  ($K_3Fe(CN)_6$) Solution (Fe) (Wool, filings, small nails)
  ($FeCl_3$ Solution, NaOH (Solution) Cu (turning/powder/wool)
  HNO_3 (50% solution)

- **Work premise for group two**
  $CaCO_3$ (Pellets, powder, chips) CH_3COOH (Solution)
  $K_2Cr_2O_7$ (Solution) $CaCl_2$ (Solution), Na_2CO_3 (Solution)
  $C_6H_{12}O_6$ (Powder), NaOH (Solution), H_2O

- **Work premise for group three**
  K_2CrO_4 (Solution), HCl , $CO(NH_2)_2$ (Cystals) NaOH (Solution)
  KI (Solution) $Pb(NO_3)_2$ (Solution) $CuSO_4.5H_2O$ (Crystals) H_2O

Annex 4.1.3

Chemical reaction and the change that took place

We learnt in grade 7 that when paraffin wax in provided with heat it turns to liquid state and when it is cooled (Heat is removed) it turns to the former solid state, and when water is provided with heat, water turns to water vapour, and that when this vapour gets cool in the air it again forms droplets of water and that this change is called change in state.

Here although there is a change in physical state of the substance there is no change in chemical properties. These are called physical changes. They are also known as reversible reactions.

When a piece of magnesium ribbon is burnt in air it burns with a bright flame emiting a sound and leaving a white powder (residue). Here a substance is formed which is different from its original state. These reactions in which the new substance (product) obtained has chemical properties different from the initial substance (reactants) These are called chemical reactions. They are also known a irreversible reactions.

In the case of burning a piece of magenesium sound and light are emitted. Similarly in

most chemical reactions we get different observations. These observations are considered as evidence to indicate that a chemical reaction has taken place.

Here are some evidences to indicate that a chemical reaction has taken place.

- Noise / emitting light.
- Change in temperature (exchange of heat).
- Forming precipitates.
- Evolution of gases
- Change in colour.

In some cases when chemical reaction take place between chemical substances, heat is given out to the environment. during such instances the container also gets heated. Such reactions are called **Exothermic reactions**. In some cases when reactions take place between chemical substances heat is absorbed from the environment. In such instances the container gets cold. These reactions which absorb heat from the environment are called **Endothermic reactions**.

When some chemical substances react the product obtained is of a different colour to the reactants. Similarly in some chemical reactions substances are deposited at the bottom of the container. These are called precipitates. It is possible to remove the precipitate by using a funnel and a filter paper and filtering the solution.

When some chemical substances react gas bubbles are liberated. Some of these gases are colourless and some are coloured. Some have no smell others have a smell.

During this activity you will obtain the following observations.

Observation / Reaction	Heated	Cold	Change in Colour	Forming a precipitate	Evolving a gas
1' Calcium Oxide and water	✓				
2' Urea and water		✓			
3' Potassium ferricyanide and iron wool			✓		
4' Feric cloride solution and sodium hydroxide solution			✓	✓	
5' Copper turnings and concentrated nitric acid	✓		✓		✓
6' Sodium hydroxide and water	✓				
7' Glucose and water		✓			
8' Potassium dichmomate solution and sodium hydroxide			✓		
9' Calcium chloride solution and sodium carbonate solution				✓	
10' Calcium Carbonate and Acetic Acid	✓				✓
11' Sodium hydroxide solution and dilute hydroxide acid	✓				
12' Copper Sulphate crystals and water		✓			
13' Potassium chromate solution and dilute Hydrocholric acid			✓		
14' Potassium iodide solution and lead nitrate solution			✓	✓	
15' Urea and dilute Hydrocholoric acid	✓				✓

Competency 4.0 : **Inquires on the properties, uses and interactions of matter.**

Competency level 4.2 : Investigates on the behaviour of atoms.
Activity 4.2 : Seen behaviour of unseen atoms!
Time : 120 Mts.
Quality inputs :
- Activity included in annex 4.2.1 on "does the mass change?"
- Three copies of exploration instructions in annex 4.2.2.
- Work premises prepared according to the teacher instructions given in annex 4.2.3.
- Three copies of the article included in annex 4.2.5 on "Seen behaviour of unseen atoms"

Teaching learning process ;

Step 4.2.1 :
- Do the activity "does the mass change", actvity getting help from some students.
- Lead a discussion highlighting the following points.

• When a match stick burns there is a chemical reaction. • Reading in the triple beam balance was the same before and after burning the match stick. • Here the mass of the reactants and the products formed is the same. • It is better to findout whether in every chemical reaction the mass of reactants is equal to that of the products.

15

Step 4.2.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 Mts)

Step 4.2.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- When a chemical reaction occur, the mass of the reactants is equal to the mass of the products.
- This fact is expressed by the law of conservation of mass.
- When some reactions occur, some of the products are liber ated to the atmosphere.
- During some reactions some reactants are added on from the atmosphere.
- Even in such instances the mass of the system could increase or decrease, the law of conservation of mass is true even then.
- Because of this when the law of conservation of mass is to be proved it should be done in a closed system.
- In chemistry the law of conservation of mass is defined as follows.

  - Law of conservation of mass : when a chemical reaction takes place in a closed system, the mass of the products is equal to the mas of the reactants.
  - Scientist John Dalton, put forward the primary facts about the atom by his theory.
  - As a result of recent findings some of his arguments broke down but he should be praised for his findings at a time when science was in an undeveloped stage.

- According to the nuclear model of the atom, the arrange ment of electrons, protons and neutrons in the atom and also the basic features are explained.
- You could gather more facts about this by the article "Seen behaviour of unseen atoms"

45 Mts.

Assesment and evaluation criteria :

- Draw bit the nuclear model of the atom.Draw bit the nuclear model of the atom.
- Device experiments to prove the law of conservation of mass.
- Weigh $1/10^{th}$ of a gram accurately, using the triple beam balance.
- Explore findings in science.
- Use equipments in the correct way.

Annex 4.2.1

Does the mass change?

- Put four match sticks into a boiling tube; fix a balloon to its mouth to prepare a closed system as shown in the figure.

- With the help of a triple beam balance get the mass of the system.
- Keeping the above set up on the triple beam balance, hold the end of the boiling tube containing tube containing match sticks to a flame and burn the match sticks.
- Here a chemical reaction takes place in a closed system.
- After the match sticks completely burn out and the system cools, weigh the mass of the system accurately.
- Find out whether there is a change in mass of the system.
  (There is no change in mass)

Annex 4.2.2

Instructions for group exploration

Seen behaviour of unseen atoms

- Focus your attention on the reaction your group is expected to do.
  - **Group One**
    Reaction between Lead Nitrate and Sodium Chloride.
  - **Group Two**
    Reaction between Sodium bicarbonate and dilute Hydrochloric Acid.
  - **Group Three**
    Burning steel wool in air.
- Refer to the article 'seen behaviour of 'Unseen atoms'.
- Get to your work premises and attend to the activities according to the instructions kept there.
- Record results of your group.
- Explain how the activity carried out by your group confirm the law of conservation of mass.
- A certain speaker says that some of the facts in Dalton's atomic theory were rejected according to the latest discoveries about the atom. Present the ideas of your group on this.
- Present the ideas of your group on this.
- Show in a flat diagram, how the sub atomic particles, electrons, protons and neutrons are placed in the atom.
- Get ready to present your findings innovatively.

Annex 4.2.3

Instructions to teachers

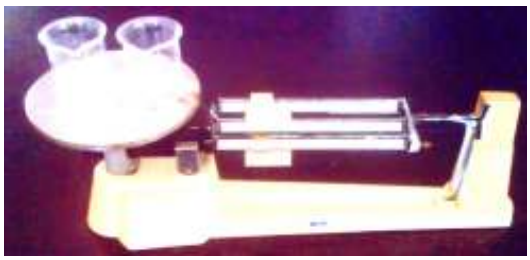
- If only one triple beam balance is available keep it on a common table.
- Prepare three work premises by keeping the materials. According to the handouts provided, keep the respective handout in it.
- If the chemical substances or instruments required to confirm the law are not available use a suitable alternative.
- As the triple beam balance is an instrument which should be used carefully, refrain from allowing chemical substances to touch the pan and also do not bring a flame near the pan.
- Do not expect from the students a definition for a closed system.
- A balanced chemical reaction is given to understand the law of conservation of mass. Emphasize that there is no need to memorize or keep them in mind.
- Give only a simple knowledge of the recent discories about the atom. This is only a pre preparation to the lesson in year ten.

Handout for the first group

Items you are provided with :

- Triple beam balance.
- Two 100ml beakers.
- About 20ml of sodium chloride solution.
- About 20ml of Lead Nitrate solution.

Activity :-Take the two100 ml beakers and to one add about 20ml of lead nitrate $Pb(NO_3)_2$ solution and to the other add about 20 ml of sodium chloride (NaCl) solution, and keep them on the pan of the triple beam balance and balance it as in the diagram



Mix the two solutions and keep the beakers with the mixture along with the empty beaker on the pan of the triple beam balance observe whether there is a change in mass.

Note : Here a precipitation reaction takes place.

$$Pb(NO_3)_2 + 2NaCl \longrightarrow PbCl_2 + 2NaNO_3$$

Lead nitrate	Sodium Chloride	Lead chloride	Sodium nitrate

Handout for the second group

Items you are provided with :

- Triple beam balance
- Two 100ml beakers
- About 20ml of sodium bicarbonate solution
- About 20ml of Hydrochloric acid

Activity :- Take the two 100ml beakers to one add about 20ml of the sodium bicarbonate ($NaHCO_3$) solution and to the other about 20ml of Hydrochloric acid (HCl), and keep them on the triple beam balance pan and balance it.

- Mix the two solutions, and keep the beaker with the mixture and the empty beaker on the balance pan and observe whether there is a change in mass,

Please note : Here there is a reaction which liberates a gas

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2 \uparrow$$

Sodium Bicarbonate	Dilute Hydrochloric acid	Sodium Chloride	Water	Carbon dioxide

Handout for the third group

Items you are provided with

- Triple beam balance
- Steel wool
- Petri dish
- Box of matches

Activity :-

Keep the petri dish with the well spread steel wool on the pan of the triple beam balance as shown in the diagram and balance it.

- Burn the steel wool after taking the petridish from the pan.
- After the burning is complete and the system is cool keep the petridish on the pan and observe whether there is a change in mass.

Note : Here a reaction is taking place where oxygen is added. (Oxidation)

Here a reaction takes place where oxygen is added. (Oxidates)

$$2Fe + O_2 \longrightarrow 2FeO$$

Iron Oxygrn gas Iron II Oxide

Annex 4.2.4

Seen behaviour of unseen atoms

Law of Conservation of mass

Antoina Lavoisier

The law of conservation of mass was put forward by the scientist Antoina Lavoisier in 1775 B.C.

Lavoisier discovered that in a chemical reaction; the total mass of the reactants taking part in the reaction is equal to the total mass of the products formed in the reaction.

In some reactions products are not given out to the environment as gases. By making use of such a reaction it is easy to confirm the law of conservation of mars. But in some cases the gaseous products are given out. In such cases the mass of the product could not easily be measured. In some instances when reaction takes place, gases or water vapour is taken from the environment. In such cases by conducting the reactions in a closed system it is possible to confirm the law.

Law of conservation of mass :-
In a chemical reaction taking place in a closed system the mass of the reactants and mass of the products is the same.

Dalton's Atomic theory

John Dalton

The atomic theory put forward by John Dalton in about 1808 B.C. Some basic facts about the atom are explained.

- Matter is made up of small particals called atoms which are not divisible further chemically.
- Breaking up or creation of atoms is impossible.
- The atoms of the same element ae similar to each other in all respects. atoms of different elements are different from each other.
- When atoms of different elements combine they do so in simple whole numbers. Here compound atoms or molecules are formed.
- The compound atom or molecule of the same compound are similar to each other in all respects.

Breakdown of Dalton's atomic theory and the features it differ from the recent finding

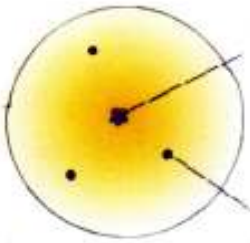
The primary ideas about the atom put forward by Dalton was of immence importance to the development of science. Some of his arguments broke down in the face of recent discoveries.

- The discovery of small sub atomic particles, electrons protons and neutrons in the atom which Dalton explained as indivisible.
- The discovery of atoms of the same element with different masses (isotopes), disproved Dalton's claim that atoms of sthe same element are similar in all respects.
- Although Dalton in his theory explained that when different atoms combine they do so in simple multiple ratios, this did not occur always. (Example in paraffin wax the ratio between carbon and hydrogen is an large as $C_{25} : H_{52}$)

The discovery of the electron by J.J. Thompson, the proton by Ernest Rutherford, Neutron by James Chadwick were the directions that lead the way to the present day discoveries about the atom.

The nuclear model of the atom put forward by using the findings of Ernest Rutherford and Neil Bohr explain the arrangement and behaviour of elctrons, protons and Neutrons inside the atom.

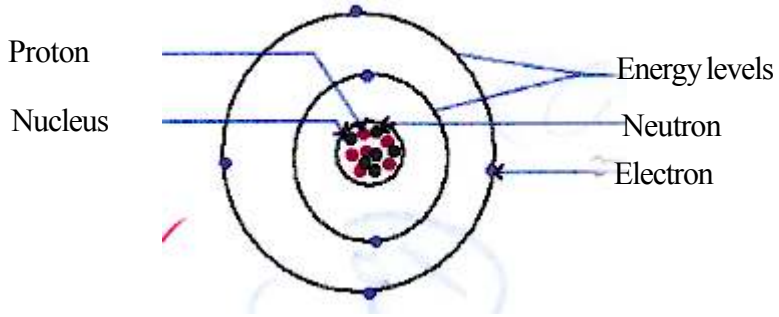
The nuclear model of the atom

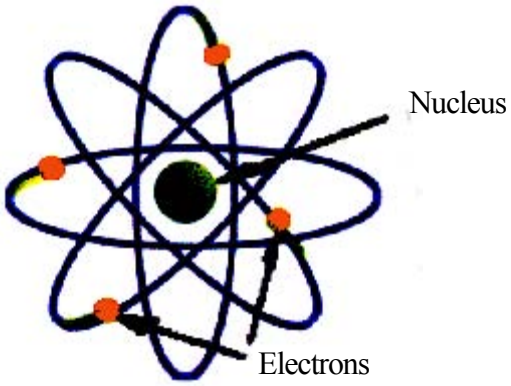


Positively charged nucleus (Made up of tightly bound protons and neutrons)

The region where negatively charged one or a few electrons move about in orbits

Explanatory nuclear modle of the atom





Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.3 : Uses chemical symbols to denote elements.

Activity 4.3 : Let us have a look at the universal language in Chemistry closely.

Time : 120 min

Quality inputs :
- A copy of the story **"Change caused by a table"** in annex 4.3.1
- Four copies of the instructions for exploration in annex 4.3.2.
- Four copies of the article **"Naming the elements"** in annex 4.3.3

Teaching learning process :

Step 4.3.1 :
- Introduce the story to the class.
- Lead a discussion highlighting the following points.

• Symbols are used to name the elements in Chemistry. • It is a universal language. • Use of symbols is an essential competency in learning Chemistry.

15 Mts.

Step 4.3.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 Mts)

Step 4.3.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- More than hundred elements have been discovered upto now.
- All matter we come across are patterns made out of various combinations of elements.
- Symbols are used to name the elements to make the study easy.
- These symbols have been given according to an international convention.
- It is possible to make use of the article **"Naming the elements"** for further information.

45 min

Assesment and evaluation criteria

- Arranges first twenty elements in order using symbols.
- D iscovers the elements included in a molecule of a compound by analyzing the chemical formula.
- Explains the necessity of using symbols to name the elements by making use of its uses in chemistry.
- Gathers data using various sources.
- Works with co-operation

Annex 4.3.1

Difference caused by a table

Kusal who was putting covers to his brother's book found a paper with an interesting picture.

"From where did you get this, malli?"

Ah! is it the time table? It was given to me by the bookshop when I was buying books.

Kusal was looking at the other side of the time table. He observed this for some time.

This must be a very valuable table related to Chemistry. It's topic is printed as Periodic Table.

Periodic table.

i	ii	iii	iv	v	v i	vii	viii / 0
H Hidrogen							He Heliun
Li Lithium	Be Beralium	B Boran	C Carbon	N Nytrogen	O Oxygen	F Fluocin	Ne Neon
Na Sodium	Mg Magnicum	Al Aluminium	Si Silicon	P phosphorus	S Sulpherr	Cl Chloride	Ar Argon
K Potasium	Ca Calciuem						

Gases
Solid

In the meantime father also came into the room.
"Why putha, have you finished putting the covers?"
"Yes thaththa, we have finished putting the covers. See this table."
"Let me see, this is the Periodic Table. This is a very important table.
You have to learn it next year. There is nothing wrong if you learn the twenty symbols of these elements, if you feel like."
Are these numbers from 1 to 20 given with a definite basis?
"Yes, of course. These are the group of elements from Hydrogen to Calcium. They are the most simple group of twenty elements according to their structure ever discovered."
"Thaththa, we studied the symbols of elements in grade eight itself.
As we see it, everywhere the symbol of the element is used rather than their name."
"That's true. The language of Chemistry is the symbols of elements.
"Yes thaththa, it is a universal language."
Kusal put the piece of paper inside the science book hoping to take it to class the following day.

Annex 4.3.2

Instructions for group exploration

Let us have a look at the universal language in Chemistry closely.

- Focus your attention to the chemical formulae assigned to your group.

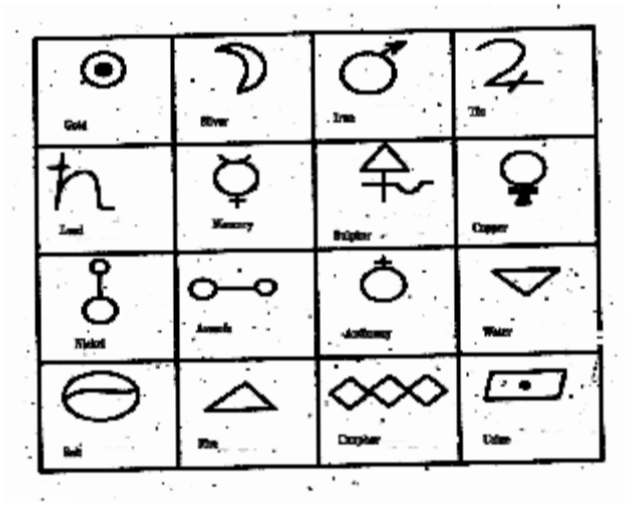
Group - i	Group - ii	Group - iii	Group - iv
O_2	H_2	N_2	Cl_2
Cu	Pb	Fe	Sn
H_2O	CO_2	SO_2	NO_2
CaO	MgO	PbO	CuO
CH_4	C_2H_4	C_2H_2	C_3H_8
$CuSO_4$	$NaNO_3$	$Mg\ SO_4$	NaOH
$KMnO_4$	HNO_3	$Pb(NO_3)_2$	$CaCO_3$
HCl	$ZnCl_2$	H_2SO_4	$C_6H_{12}O_6$
$AgNO_3$	HgO	$AlCl_3$	Na_2SiO_3

- Read the article **"Naming the elements"**.
- Identify the elements present in the chemical formulae given to you, and list out their symbols and names.
- Discuss about the international conventions about the use of symbols for elements.

- Find how the names and symbols of elements have developed up to now.
- "In chemistry the use of symbols for naming elements is a must'. Give reasons for this by using various applications.
- Be prepared to present your innovative discoveries to the class.

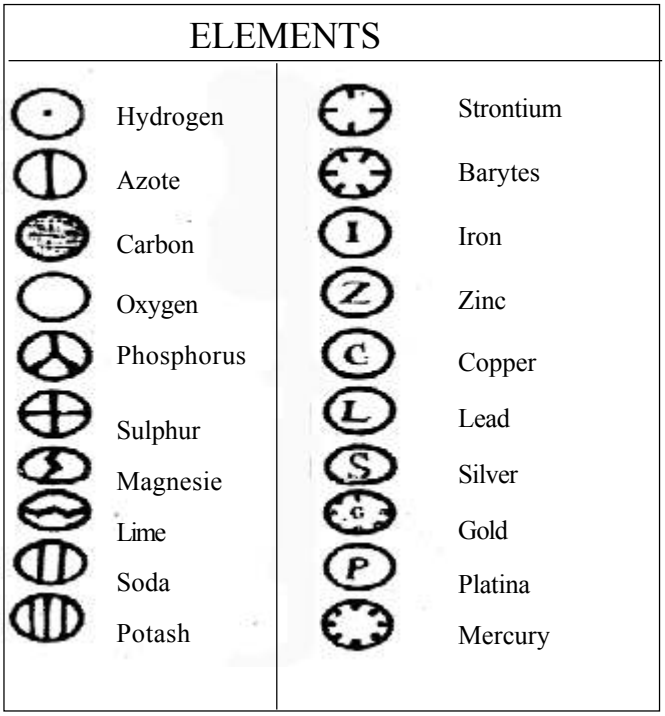
Annex 4.1.1

Naming the elements



• Allocating symbols to elements began in about the seventh century B.C. during the period of alchemy.
During that century the Egyptians tried to find out ways of converting chaep metals to gold.
As they wanted to prevent leaking information of their findings to the others, they used symbols to denote them.

Symbols of some elements used during the alchemy era.



Symbols given by Dalton

No scientific basis could be seen when symbols for elements were designed during the period of alchemy. Later John Dalton who lived in England played a leading role in using different symbols to denote elements.

According to John Dalton some compounds too have been considered as elements as indicated by the above table. The present system of symbols was designed by Johns Jacob Berzelius in 1814. At that time only 49 elements had been discovered. In 1869 Dimitri Mendelev developed the periodic table using only 66 elements.

To make it easy scientists used symbols with one or two letters instead of using the whole name to denote the elements.

Most chemicals symbols are derived from the names of the elements. Most of these names are English. In some instances they are German, French, Latin or Russian.

If the symbol has only one letter it is an English capital letter.
If it has two letters, the first is capital and the other is simple.

From ancient times symbols of some elements are given in latin names.

Element	Symbol	Latin Name
Sodium	Na	Natrium
Potassium	K	Kalium
Iron	Fe	Ferrum
Copper	Cu	Cuprum
Silver	Ag	Argentum
Tin	Sn	Stannum
Antimony	Sb	Stibnum
Tungsten	W	Wulfrum
Mercury	Hg	Hydragerum
Lead	Pb	Plumbum
Gold	Au	Aurum

As an international acceptance these symbols are written using English letters.

The symbols of the twenty simplest elements could be given in sequence as shown below.

Element	Symbol
Hydrogen	H
Helium	He
Lithium	Li
Berrylium	Be
Boron	B
Carbon	C
Nitrogen	N
Oxygen	O
Fluorine	F
Neon	Ne
Sodium	Na
Magnesium	Mg
Aluminium	Al
Silicon	Si
Phophrous	P
Sulpher	S
Chlorine	Cl
Argon	Ar
Potassium	K
Calcium	Ca

The language of Chemistry is symbols. To anyone in any part of the world could identify elements by these symbols.

Some instances where symbols of elements are used is given below.

1. To represent an atom of an element.
2. In writing molecular formulae.
3. In writing chemical reactions.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.4 : Investigates on the interaction of metals and non-metals with air, water, acids and bases.

Activity 4.4 : Some reactions of metals and non-metals.

Time : 120 min

Quality inputs :
- A test tube containing some baking soda and lime juice.
- Four copies of the article on instructions for exploration given in annex 4.4.1.
- The common table and the work stations prepared according to instructions given to teachers in annex 4.4.2.
- Table on reactions of metals and non metals given in annex 4.4.3.

Teaching learning process :

Step 4.4.1 :
- Get a student to add lime juice to baking soda.
- Lead a discussion highlighting following points
  - When lime is added to baking powder there is bubbling, evolution of gas, increase in temperature, and a sound (shoo...), could be observed.
  - It is important to find out about these reactions in day to day persuits.

(15 min)

Step 4.4.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 Mts)

Step 4.4.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Some elements react with oxygen, water, acids and bases.
- It is possible to discover some of those reactions with Mg, Fe, C and S from the table of reactions of metals and non metals.

(45 min)

Assesment and evaluation criteria:

- Conducts experiments to find out about the reactions of the elements Mg, Fe, C and S with, water, oxygen, acids, and bases.
- Compares the observations from relevant reactions with the given metals and non metals.
- Builds word equations for relevant reactions.
- Arrives at inferences basing observations.
- Conducts demonstrations according to instructions.

Annex 4.4.1

Instructions for group exploration

Some reactions of metals and non metals

- Your group is provided with one of the following elements.
  - Group One - Mg
  - Group Two - Fe
  - Group Three - C
  - Group Four - S
- Find out whether the element given to you is a metal or a non metal.
- Refer the table "reaction of metals and non metals".
- Go to each work station and perform the activities you are expected to do with the element supplied to you, and findout whether you get the expected results.
    - Reaction with cold and hot water.
    - Burning in air (reaction with oxygen)
    - Reaction with dilute hydrochloric acid.
    - Reaction with dilute sodium hydroxide.
- Write word equations for the reactions you performed.
- Get prepared to present your findings to the class.

Annex 4.4.2

Instructions to teachers

- Inform the students that it is not necessary for them to study the chemical reactions by heart in the table provided.
- Prepare four work stations with the materials given below in such a way that the student groups could change over and perform the experiments.

Station I

- Reaction with water - (Written on the board)
- Cold water and hot water
- A rack with test tubes

Station II

- Reaction with acids - (Written on the board)
- Dilute hydrochloric acid
- A rack with test tubes.

Station III

- Reaction with base - (Written on the board)
- Dilute sodium hydroxide solution
- A rack with test tubes.

Station IV

- Reaction with oxygen - (burning in air) (Written on the board)
- Burner
- Crucible tongs
- Crucibles or some tonic bottle lids.

- Provide the student groups with sufficient quantity of the material.
- Keep the following on a common table and instruct them to use when required.
  - Water - to wash the test tubes after the activity.
  - Sand paper - to clean the metals.
  - Motar and pestle - to crush the materials if necessary.

Annex 4.4.3

Reactions of metals and non metals

Metal/ Non metal	Reaction with oxygen when burning	Reaction with water	Reaction with acids (dilute Hydrochloric acid)	Reaction with Bases
Mg (Metal)	• Burn with a bright light • A white powder magnesium oxide is formed $2Mg + O_2 \rightarrow 2MgO$	• No reaction with cold water • React slowly with hot water, magnesium hydroxide and hydrogen are formed. $2Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2\uparrow$	• Magnesium chloride and hydrogen are formed $Mg + 2HCl \rightarrow MgCl_2 + H_2\uparrow$	• No reaction
Fe (Metal) (Use fine wool)	• Becomes red hot and burn • Iron oxide is formed $2Fe + O_2 \rightarrow 2FeO$	• No reaction	• Iron Chloride and hydrogen are formed. $Fe + 2HCl \rightarrow FeCl_2 + H_2\uparrow$	• No reaction
C (Non metal)	• Becomes red hot and burn • Forms carborn dioxide $C + O_2 \rightarrow CO_2$	• No reaction	• No reaction	• No reaction
S (Non metal)	• First turns to liquid. • Afterwards blue flame forming a gas with an irritating smell. The gas is sulphur dioxide $S + O_2 \rightarrow SO_2$	• No reaction	• No reaction	• No reaction

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.5 : Investigates about alloys and their applications.

Activity 4.5 : Scientific value of alloys.

Time : 120 min

Quality inputs :
- The verse **"Let's unite - Be strong as alloys"** in annex 4.5.1
- Four copies of instructions for exploration given in annex 4.5.2
- Four copies of **"Scientific value of alloys"** in annex 4.5.3

Teaching learning process :

Step 4.5.1 :
- Introduce the verse to the class.
- Lead a discussion highlighting following points

  - Nichrome alloy is prepared by mixing Nickel and Chromium.
  - Special valuable properties are found in Nichrome which are not present in Nickel and Chromium alone.
  - Like Nichrome, other alloys are made use for different needs.

(15 min)

Step 4.5.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.5.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

  - Alloys are made by mixing one metal with another.
  - Alloys have special properties than the pure metals.
  - As a result, in the technological world alloys are made use for various purposes.
  - An indepth study of alloys is possible by reference to the article on "Scientific value of alloys"

(45 min)

Assesment and evaluation criteria

- Find the alloys having the given metals.
- Scientifically show that an alloy has special properties which are not present in the metals that go to form it.
- Explains the productivity of using alloys in various daily uses.
- Classify substances and analyse them.
- Satisfy requirements depending on properties of substances.

Annex 4.5.1

Let's unite - Be strong as alloys

I am nickel
My melting point is high
And I hate decay
So I will always
Glisten and shine
Great in my own way!

* Let's unite ...

Chromium is my name
I"m always strong
And nobody can compete
With my ability to resist
The conductivity
Of electricity and heat!

*Let's unite ...

We joined together - And were able to form
A wondrous alloy - Named Nicrome!

*Let's unite ...

Come, other metals - Do take our lead
Unite and rejoice - Fulfil the world's need

(Hasika Dilhani Jayasekera)

Annex 4.5.2

Instructions for group exploration

Scientific value of alloys

- Draw your attention to one of the following metals assigned to your group.
  - **Group One -** Tin
  - **Group Two -** Iron
  - **Group Three -** Copper
  - **Group Four -** Aluminium
- By refering to the article "Scientific value of alloys", list out the alloys which contain the metal.
- Discuss about the uses of alloys and their special characters that suits specific needs.
- Get ready to present your findings to the class in an innovative way.

Annex 4.5.3

Scientific value of alloys

An alloy is formed by two metals or more or in some instances mixing a non metal like carbon. In a high standard alloy you could see that the atoms are uniformly distributed. It is a homogeneous mixture.

Since the substances mixed in an alloy are homogeneously mixed and that all the components are in the same state (solid), an alloy could be considered as a solution in solid state.

Alloys possess a large number of different properties than the pure metal. Some of these are strength required for the purpose, eye catching appearance, resistance to corrosion, light weight etc.

Alloys are prepared to increase the quality of metallic elements in different ways. With the development of technology there is a tendency to manufacture alloys to suit the needs.

Name of alloy	Components	Properties	Uses
Brass	Copper, Zinc	Hard	To manufacture ornaments, lamps, door hinges, screws nails.
Duralumin	Aluminium, Copper, Manganese, Magnesium	Strong and light in weight	Manufacture of aeroplanes, construction of window frames, vehicle parts.
Nichrome	Nickel, Chromium	High resistance to electricity	To make heat generating parts in electrical appliances (thermal elements).
Soldering lead or soft solder	Lead, Tin	Soft, low melting point (easily melt)	In soldering of metals (Eg. Circuits in electronic parts)
Bronze	Copper, Tin	Tough	Making gongs, statues, medals, engine parts, bearing, electric joints, radiators etc.
Amalgam (Used in dentistry)	Mercury, Silver	Does not react with chemicals, could easily attach to the tooth, do not ware off easily	To prepare a permanent tooth filling mixture. (To fill cavities in teeth)

Name of alloy	Components	Properties	Uses
Gold for making jewellery	Gold, Copper	Strong, Good shine	Making jewellery and coins
Silver for making jewellery	Silver, Copper	Strong, Good shine	For making jewellery
Hard steel	Iron, Carbon	Tough	To make cutting tools
Stainless steel	Iron, Chromium, Nickel	Tough, resistant to corrosion, resistant to ware and tare.	Spoons, Forks, Knives, Blades, Plates, Surgical equipments, Water taps, Wash basins etc.
Soft steel	Iron, Carbon	Easy to burn. Malleable and ducticle, but less brittle	Chassies of vehicles, boltswashers, structures of buildings.
White gold	Gold, Nickel, Palladium, (Sometimes platium and zinc)	Tough and shinning	Making Jewellery

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.6 : Conducts simple experiments to identify nutrient components in food.

Activity 4.6 : Let us clearly know whether there are nutrients.

Time : 120 min

Quality inputs :
- The verse in annex 4.6.1
- Three copies of instructions for exploration given in annex 4.6.2
- Three workstations prepared according to instructions given in annex 4.6.3
- Three copies of the article **"Let us clearly identify nutrients present in foods"** in annex 4.6.4

Teaching learning process :

Step 4.6.1 :
- Allow a student to present the verses.
- Lead a discussion highlighting following points

• We must always take a balanced diet.
• If we are to take a balanced diet we must be aware of the nutrients in the food we take.

(15 min)

Step 4.6.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.6.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- there are different nutrients in the food we eat.
- The major nutrients in food are as follows ;
  - carbohydrates
  - lipids
  - proteins
- It is possible to identify the nutrients by adding the relevant chemicals to food samples.
- Refer to the article **"Let us clearly identify nutrients present in foods"** for an in-depth study about nutrients.

(45 min)

Assesment and evaluation criteria

- Suggests experiments to identify the main nutrients present in foods separately.
- Discovers the nutrients present in different foods using relevant chemicals .
- Displays the ability to select the foods having necessary nutritional value.
- Arrives at conclusions based on observations.
- Develops the skill to conduct experiments.

Annex 4.6.1

Let us find about the nutrients ...

Food the fuel of life
When taken all along
As a balanced diet
Keeps us healthy and strong!

The nutrition and value
Of each item of food
When learnt and applied
Does a lot of good!

Glucose, sugar, starch
Lipid and protein
Are all unique
When seperately seen

Let's mix them with chemicals,
Give each substance a turn,
And study how they react,
There's so much to learn!
(*Hasika Dilhani Jayasekera*)

Annex 4.6.2

Instructions for group exploration

Let us clearly know whether there are nutrients!

- Focus your attention to the set of foods, your group is expected to use.
  - **First group** - Coconut oil, Rice, Green gram, Sprats, Glucose
  - **Second group** - Potatoes, Gram, Gingelly Oil, Fish, Sugar
  - **Third group** - Dhal, Dried fish, Margarine, Sweet potatoes, Candy

- Refer to the article **"Let us clearly identify nutrients present in foods"** and study the steps in Iodine test, Benedict test, Biurret test, Sudan III test and translucent oil patch test.
- Go to the respective work stations and conduct tests for each food separately.
- Prepare a report on the main nutrients found in the foods.
- Get ready to present your finding in an innovative manner.

Annex 4.6.3

Instructions to teachers

- Food extract could be prepared by crushing the food or pounding in a motar and mixing with a small quantity of water and filtering using a piece of muslin cloth.
- When preparing a solution of Sudan III, about 2g of sudan III could be mixed with about 10ml of ethyl alcohol.

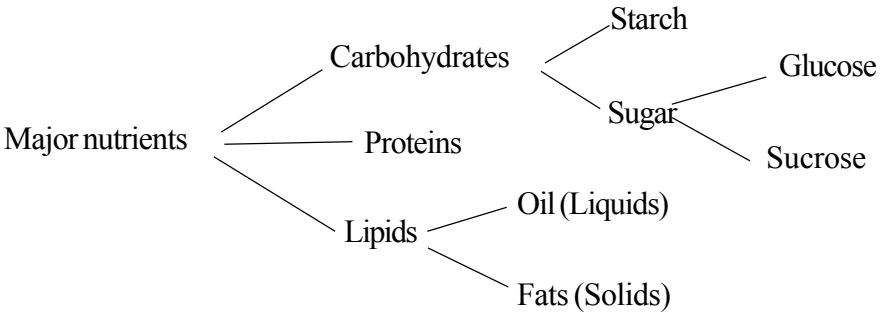
Instructions to prepare work premises

- Prepare three work stations by keeping the following substances.
- Solution of Iodine (I_2 dissolved in KI).
- Benedict solution.
- Small quantity of dilute sodium hydroxide or potassium hydroxide solution.
- Dilute $CuSO_4$ solution.
- White paper (For the translucent oil patch test)
- Boiling tubes
- Test tubes and a holder
- Bunsen burner (on a common table if required)

Annex 4.6.4

"Let us clearly identify nutrients present in foods"

- The nutrients in foods could be classified as follows.



- In foods we take various nutrients could be present in varying quantities.

  Some foods with abundant nutrients...

Carbohydrates		Lipids		Proteins	
Starch	Sugar / Glucose	Oils	Fats	Plant Protein	Animal Protein
Yams	Sugar Cane Beat Sweet Potatoes Fruits	Coconut Oil Soya Oil Gingelly Oil Sunflower oil	Butter Margarine Cheese Ground nuts Gingelly seeds	Dhal Cowpea Gram Soya Soya beans	Fish Eggs Meat

Simple tests to identify foods

Nutrients	Identify Test	Observation
Starch	Iodine Test Add a drop of iodine solution to the food sample	Dark blue or violet
Glucose	Benedict test Add benedict solution to a similar quantity of food extract solution and heat the mixture.	Change colour from green → yellow orange Brick red
Protein	Biurete test To a sample of food extract add a similar quantity of sodium hydroxide or potassium hydroxide and add two drops of copper sulphate solution.	The food extract turns mauve/ light purple.
Lipids	Sudan III test To a small quantity of food extract add a similar quantity of Sudan III, Shake and keep still for sometime.	Red coloured oil globules could be seen floating on top of the solution.
Oils	Transluscent oil patch test Rubbing the food on a piece of paper.	The paper when directed at the light a transparent oil patch is seen.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.7 : Analyses criteria on the standards and quality in selecting suitable consumer goods.

Activity 4.7 : Let us select an item from the market properly.

Time : 120 min

Quality inputs :
- The story about "The chocolate that could not be eaten" given in annex 4.7.1
- Four copies of instructions for exploration given in annex 4.7.2
- Common table arranged according to instructions given in annex 4.7.3
- Four copies of the article "Pay due attention in buying a quality item" included in annex 4.7.4

Teaching learning process :

Step 4.7.1 :
- Get two students to present the dialogue about "The chocolate that could not be eaten".
- Lead a discussion highlighting following points
  - Expiry date of the chocolate that Shashi received has passed.
  - If expiry date has passed, it is not fit for consumption.
  - When buying an item, not only the expiry date but other factors too must be considered.

(15 min)

Step 4.7.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.7.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.

- After giving an opportunity to all the groups,summarize, highlighting the following points.

  - When buying an item, its quality should be looked into primarily along with the following factors.
    - Standard SLS/ISO
    - Date of manufacture and date of expiry
    - Active ingredients
    - Packing
    - Gross weight / Net weight
    - Environment friendly / Consumer friendly
  - The consumer, in addition to the above factors, must pay his attention to the fact whether the item bought has the value for the money paid.
  - By selecting consumer items scientifically, it is possible to render a valuable service personally as well as nationally.
  - It is possible to discover more about this by reading the article "Pay due attention in buying a quality item".

(45 min)

Assesment and evaluation criteria

- Considers the standard and quality when selecting the consumer items.
- Uses scientific factors to determine standards and quality.
- Explores the data printed on the consumer items scientifically .
- Observes attentively.
- Arrives at conclusions based on the observations.

Annex 4.7.1

The Chocolate that could not be eaten

When aunty entered the house, Shashi came running.
"Here is a chocolate for you Shashi. Last time I promised to bring you a bigger one..."
"Yes, thank you Aunty, I'll share this with the others....."
Before opening the chocolate, Shashi looked at the wrapper thoughtfully.
Aunty spoke up.
"Why Shashi, don't you like this chocolate?"
"How could I decide whether I like it or not?... Didn't you look at the wrapper before buying? Its expiry date has passed!"

Annex 4.7.2

Instructions for group exploration

"Let us select an item properly from the market"

- Your attention is drawn to one of the following groups of items.
  - **Group One -** Food and beverages
  - **Group Two -** Medicine
  - **Group Three -** Sanitary items
  - **Group Four -** Building materials and others.
- Gather information relevant to the theme using the article .
- Select items suitable for your theme by going to the common table and observing the labels/ wrappers/advertisements.
- Lead a discussion about the following factors regarding their quality and value for the money spent.
  - Standard SLS / ISO
  - Date of manufacture and date of expiry
  - Ingredients
  - Type of container
  - Net weight and price
  - Hygenic nature
  - Environment friendlyness
- When buying items for daily requirements, indicate whether you prefer or not, to buy items selected from the common table. Explain your reasons.
- Present you findings innovatively to the class.

Annex 4.7.3

Instructions to prepare the common table

- Prepare the common table by keeping the labels, wrappers or advertisements of the following consumer items.
  - Foods
  - Beverages
  - Medicine
  - Sanitary items
  - Building materials and others
  - Arrange the groups of items in such a way that all groups could select at least ten items.

Annex 4.7.4

Pay due attention in buying a quality item!

There are goods of different kinds and different quality in the market . It is very important to see that goods are of the quality in keeping with the money spent by the consumer.
The quality of an item has to be decided by scientific exploration.
Given below are some of the points for consideration.

- Date of manufacture and date of expiry
- Gross weight/net weight
- Ingredients
- Standard SLS / ISO
- Packing
- Environment / Consumer friendly

1. **Date of manufacture & Date of expiry**
   It is expected that the quality of an item diminishes with expiry.
   It is also possible that chemicals could synthesise which has harmful effects to the consumer as well as to the environment.

2. **Net weight/Gross weight**
   The consumer is able to know the quantity of the item by the net weight. It is necessary to find out whether with the quantity of item it is possible to obtain the quality expected. This is very essential for foods .

3. **Ingredients**
   It is compulsary to have on the label or the wrapper, the ingredients present.
   The consumer when buying an item, should pay due attention to the ingredients in it.
   If it is a food item it could include flavours, colouring and preservatives. There is a system to include chemicals under an E number (European Standards).

Example - E_{300} (If this number is there then it Contains Vitamin C.)

E Number range	Use of the substance
E100 - E 181	Colorings
E 200 - E 290	Preservatives
E 291- E 385	Anti-Oxidants and Acids
E 400 - E 495	Emulsifiers and Stabilisers
E 500 - E 585	Mineral Salts & Anti-Caking agents
E 620- E 640	Flavour enhancers
E900 - E 1250	Other
E 300	Vitamic C (Ascorbic acid)
E 102	Tartrazine
E 954	Saccharin

If it is a food, it is important to state in the wrapper whether gene therapy has been used or not. (As it is the manufacturers are not very keen about this).

& **Standard SLS and ISO**

SLS → SRI LANAKA STANDARDS

ISO → INTERNATIONAL STANDARDS ORGANIZATION

There are different types of standards. Various numbers and symbols are used if the item is up to the required standard.

Example - SLS 35, SLS 310 .....
ISO 9001, ISO 14001
(Each item has a different number)

Let us consider some examples.

i) SLS : 205 : 2002 standard certificate is given to CFL bulbs with three stars.
This is the certificate given to the energy conversion efficiency.
(In CFL bulbs stars from 3 to 5 are indicated)

ii) For refrigerators and deepfreezers - SLS 1230:2003

iii) ISO 9001 certificate is given, if the activities carried out in an institution (standard management system) is in conformity with international standards,

iv) When the food production process is correct and also conforms to hygenic precautions **HACCP certificate is awarded. (Hazard Analysis and Critical Control Point)**
In some food containers HFAC could be seen. It indicates that it is a Halal preparation.
HFAC - (HFAC - Halal Food Awareness Committee)

- Another factor the consumer must keep in mind is, when things like foods, medicine and paint are stored or used, it has to be stored at a particular temperature. The consumer must be aware that it is kept at that temperature. If the temperature changes there is a possibility of micro organisms growing or some chemical reactions taking place and as a result there is a possibility that the item is no longer eco-friendly or individual-friendly. This is also a fact to be remembered when selecting an item.

5) Packing

The main function of a packing is to protect the item qualitatively as well as quantitatively. The packing must be able to protect the item from air, moisture, light, heat and micro organism. The packing has to be eco-friendly.

6) Consumer and eco-friendly

An item is a quality production only if it is consumer as well as eco-friendly. The product,

the substances in it, the flavours should not be a problem to the consumers' health and the environment. The substances discarded should not be a problem to the environment.

Example -

- Some preservatives, colouring and flavours are not suitable for the health.
- CFC (CHLOROFLUOROCARBON) containing refrigerators and perfumes are harmful to the environment. Non degradable wrappers too are not eco-friendly.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.8 : Investigates on the properties and uses of composite materials.

Activity 4.8 : World made of composite substances.

Time : 120 min

Quality inputs :
- The story about **"Fur coat that father brought"** given in annex 4.8.1
- Three copies of exploration instructions in annex 4.8.2
- Instructions to teachers in annex 4.8.3.
- Three copies of the article **"World made of composite substances."** included in annex 4.8.4

Teaching learning process :

Step 4.8.1 :
- Introduce the story "Fur coat that father brought" to the class
- Lead a discussion highlighting following points

• Fur coat is made of cloth prepared from a composite substance.
• We come across natural and artificial composite substances in the environment around us.
• When it is required to increase the properties like strength we use composite substances.

(15 min)

Step 4.8.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.8.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, high

lighting the following points.

- We need substances with a combination of different properties in day-to-day life.
- These are called composite substances.
- There are natural as well as artificial composite substances.
- The composite substances could be classified according to their structural arrangement.
- For further information article **"World made of composite substances"** could be used.

(45 min)

Assesment and evaluation criteria

- Explains the composite substances.
- Classifies the composite substances according to their structural arrangement.
- Highlights the advantages in using composite substances.
- Selects suitable substances for the purpose.
- Uses modern technology in daily pursuits.

Annex 4.8.1

Fur coat that father brought

Father collected a variety of items for his visit to Russia.
" Akka, isn't this a fur coat ?"
Malli took out a dress from a big bag that looked like a pile of wool.
"This looks like a sheep."
"Let me see."
Akka took the wollen coat.
Yes indeed. As you said, this coat is made by imitating the adaptation of the sheep to protect from cold.
This is not just a wollen cloth. It is made by using a number of layers of cloth.
Outermost is the wollen layer.
Malli looked at the inner layer of the coat.
"Here akka, there is a button and a piece of cloth also attached."
"Yes, most garment manufacturers provide an extra piece of cloth."
"It is possible for us to investigate the number of layers in the coat."
Both examined.
Topmost is the wollen layer, which slides down the falling snow.
In the middle there is a sponge layer. Sponge is a good insulator of heat. So body heat is not lost.
Inner most is a thick cloth which is water proof.

Malli was thoughtful for a while.
"Akka, I think that we can prepare materials as per required by combining a variety of substances with different properties.
This woolen coat is also a similar product."
"This is not new. There are a lot of such man made materials available. These are called composite materials."
"I'm afraid that the skin of sheep is also must be a composite... Isn't it so?"
Malli laughed aloud.
"Exactly. Look around. Then you can realize most of the things around you are naturally occuring composites.
Man has imitated the nature in developing a vast array of composites according to the needs of the day.
Malli was astronished.
"Akka, I would love to learn more about compsite materials".

Annex 4.8.2

Instructions for group exploration

World made of composite substances

- Your group is expected to find out about some composite substances in one of the following environments.
  - **First group -** Home
  - **Second group -** Classroom
  - **Third group -** Retail shop
- Refer to the article **"Composite substances which make the world."**
- Lead a discussion on these substances under the following headings.
  - Natural - Artificial
  - The way the substances are strengthened by its' structural arrangement.
  - When they are used.
- Get ready to present your findings to the class in an innovative manner.

Annex 4.8.3

Instructions to teacher

- Provide the article **"World made of composite substances"** to the students few days before.
- Direct them to collect a variety of composites found at home, in the classroom as well as retail shops.
  (Ask the students to select items covering all three categories given in the table of the article.)

Annex 4.8.4

World made of composite substances..!

"Duwa, are you ready to deliver the speech tomorrow?"
Thaththa asked Jayani when he came home.
"Yes, teacher told me to do a power point presentation."
"Brilliant! Can't you to do that as a rehersal now?"
Jayani was pleased for the request.

* * *

Permission from the learned gathering sisters and brothers.
My attempt is to show you during this short duration of time that this whole world in which you and I live is made up of an unlimited number of composite materials.

Presentation by Jayani Ratnayake...
World made of composite substances

Appeared on the screen.
"What are these composite materials?
A complex thing that is difficult to understand? Is it something we haven't seen or heard before?
Not at all ....."
Attention of all were directed to the screen

Composite material
It is a substance manufactured and made up of more than one raw material with relevant properties to suit a specific purpose.

You are here with a body made up of an unlimited number of natural composite materials. Your heart which protects your life is a special natural creation made up of composite materials strengthened by layers, fibres and particles.

The big rock near the school shrine room is a natural composite material with an enormous strenth.

Now you may accept that the trunk of the coconut tree seen far off is also a natural composite material.

Let us look around for a moment and find artificial composite materials. The concrete pillars of this building, the laminated covering of my identity card, asbestos used for the ceiling of this hall are all artificial composite materials.

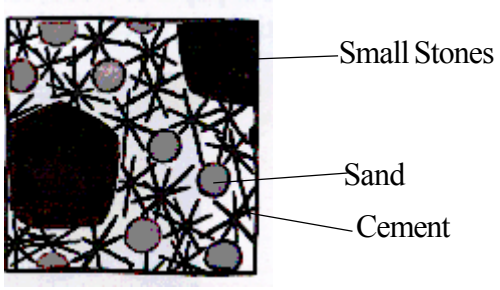
"To make it easy I divide composite materials to different types."

A table appeared on the screen.

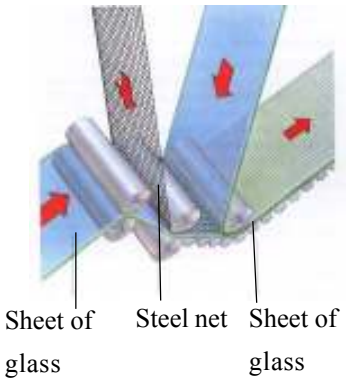
Composite Materials		
Strengthened by particles	**Strengthened by fibres**	**Strengthened by layered arrangement**
• Bones • Coconut shells • Stones • Concrete • Rubber used to make tyres • Chipboard • Cement plaster	• Skin of fruits with fibres • The bark of plants • Plant stems • Muscles and tendons. • Fibre glass • Asbestos • Paper • Fabrics	• Animal tissues • Outer layer of fruits • Rocks • Cardboard • Milk Powder wrapper • Plywood • Laminated sheets

"How do we prepare composite materials?"

Sometimes particles are arranged as methodically as strands or layers. Sometimes they are arranged irregularly. In chipboard the small pieces of wood are bonded irregularly. In plywood they are arranged in alternative layers changing the direction of the fibers. In fibre glass the fibres are in an irregular fashion. In order to increase the strength of the composite, the raw materials used and their arrangements within the composite are varied accordingly.



i. Concrete under Magnification



^ii& Steel net between glass sheets

Let me show a good example. Brick wall is strongly built by arranging the bricks regularly. But a stone wall is made strong by keeping the stones irregular...

Here I showed you only a few examples. As I said earlier one component of the composite material could be combined with different substances and get the composite material with the required properties. Now I am going to give you an example. Let us think about cement.

- To plaster the walls, cement, sand, lime and water are mixed to prepare a paste.
- When preparing concrete slabs, cement, sand, small stones, water and also iron rods or mesh are included.
- When the floor is plastered, first a cement paster is applied and to polish the surface cement is mixed with water and colouring powder.
- When manufacturing asbestos sheets, cement is mixed with asbestos fibre.
- Sometimes when bricks are made of raw clay a small percentage of cement can be mixed.

Now I think you are aware about composite materials to a certain extent. We are all scientists. So, let us be observers throughout our life time and let us explore about composite materials we come across.

Good Luck!
Thank you all for your attention.
Amma and thaththa applauded with joy.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.9 : Investigates on the properties and uses of polymers.

Activity 4.9 : "Let us learn about polymers."

Time : 120 min

Quality inputs :
- 'Paper loop chains' made as instructions given in annex 4.9.1
- Three copies of Instructions for exploraion in annex 4.9.2
- Three copies of article **"Polymers that we can't do without."**.

Teaching learning process :

Step 4.9.1 :
- Show the class the chains made of paper loops.
- Lead a discussion highlighting following points

  - Chain made with paper loops could be considered as a model of a polymer.
  - A single paper loop in the chain could be considered as a monomer
  - In a polymer the monomers are bound in a repeating sequence
  - We come across a large number of polymers which are bound together chemically in our day-to-day life.
  - It is useful to learn about them.

(15 min)

Step 4.9.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.9.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, high-

lighting the following points.

- There are a variety of polymers in our environment.
- Polythene is a good example.
- The small units in a polymer are called monomers.
- Special properties which are not present in monomers are found in polymers.
- The products of these polymers having special properties are largely used in the household as well as in the technical world.
- There are advantages as well as disadvantages in the use of polymers.
- Scientific solutions has to be put in place in order to minimize disadvantages.
- For further information article **"Polymers which we can't do without"** could be used.

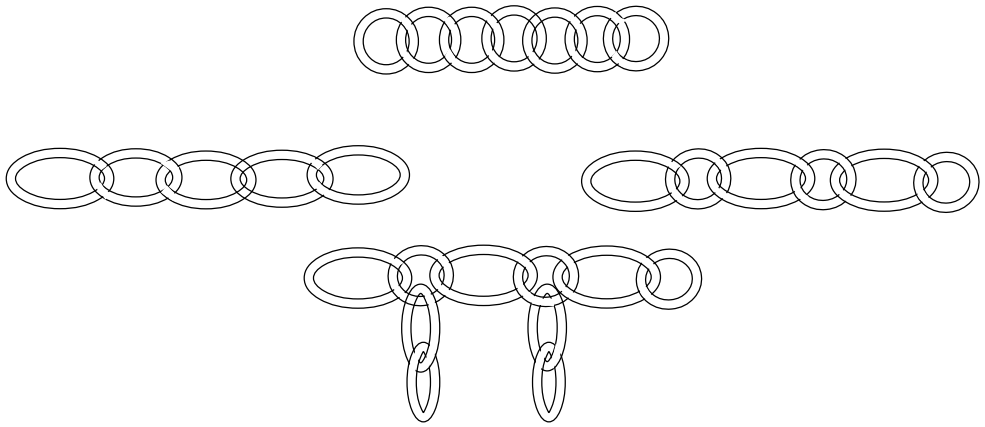
(45 min)

Assesment and evaluation criteria

- Explains the gross structure of monomers and polymers.
- Relates the properties of polymers with their appropriate uses.
- Provide solutions to the issues related to the use of polymers.
- Acts on the environment sensitively.
- Use technical products to suite the purpose.

Annex 4.9.1

Making of chains with paper circles



- Provide students with strips of colour paper of different lengths.
- Instruct them to prepare chains with the paper loops arranging them in a repeating sequence.
- Show them the above diagram as an example and direct them to prepare chains at home prior to the activity.

Annex 4.9.2

Instructions for group explorations

Let us learn about polymers!

- Attention of your group is drawn to the following properties seen in some of the polymers used daily.
  - **First group** - Stable to heat, heat insulators.
  - **Second group** - Ability to decay, durability, resistant to air, resistant to water.
  - **Third group** - Tough, soft, light weight, resistance to vibrations and tensions.

- Explain the idea of polymer with the help of the article **'Polymers which we cannot be without."**
- Prepare a list of polymers with the properties you are assigned from the polymers you use frequently.
- Highlight the following data about the polymers.
  - Its' uses and the expected properties.
  - Whether natural or artificial.
  - Problems which could arise by using the polymer and possible solutions to it.
- Get ready for an innovative presentation.

Annex 4.9.3

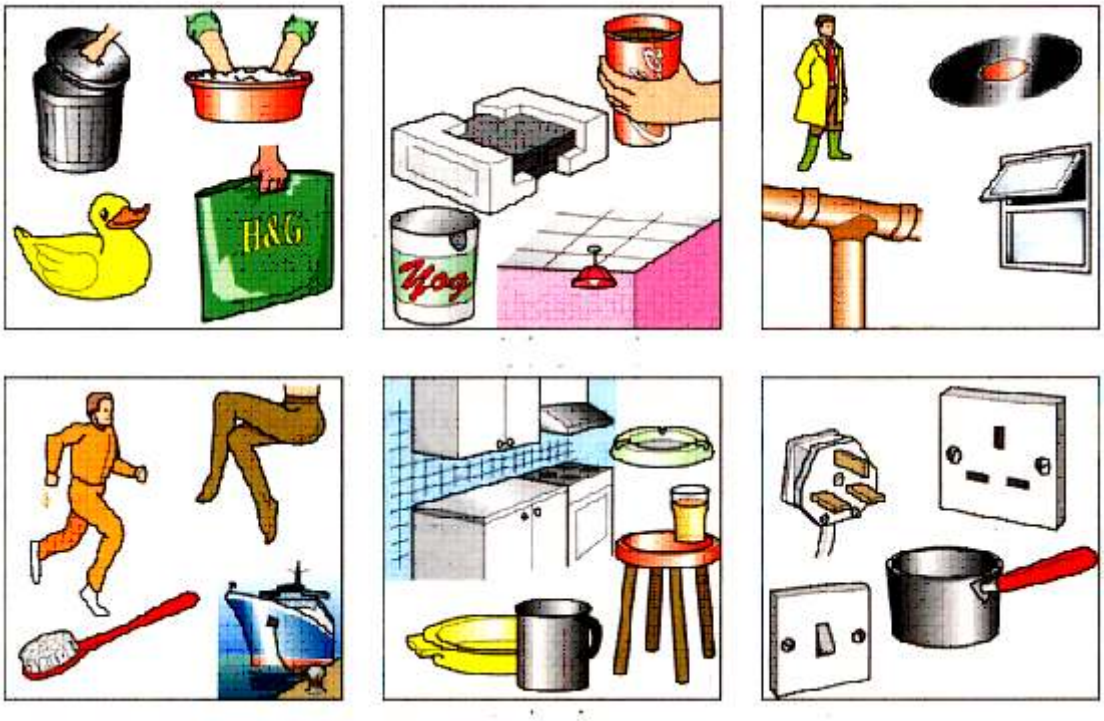
Polymers which we can't do without

By combining a large number of simple molecules to a difinite pattern it is possible to build large chemical units. When these unit molecules are taken singularly they called monomers, and the large units formed are called polymers. Although monomers exist seperately, they combine as long chains to form polymers.

Given below is a table which provides the properties of some monomers and polymers and instances they are used.

Polymers	Special properties and their use
1. Polyethene (Polythene) Artificial (Monomer - Ethene)	Water proof, gas resistant, Electrical insulators, light weight, withstand tension, long lasting does not decay (To make plastic bottles, toys travelling bags, polythene tissues)
2. Polypropene - Artificial (Monomer - Propene)	Electrical and heat insulations, withstand tension, long lasting, does not decay. (Preparation of plastic sheets, manufacture of manure bags.)
3. Polystyrene - Artificial (Monomer - Styrene)	Electrical and heat insulator, water proof , light weight, could withstand vibrations. (packing material)
4. Poly Vinyl Chloride - Artificial (PVC)	Stable to heat, heat insulator, electrical insulator, water proof, light weight (to make water pipes, conduit pipes, body parts of vehicles)
5. Poly Tetra Floro Ethene - Artificial (Teflon - PTFE)	Heat stable, electrical insulator, water proof, long lasting (To apply on non-stick pans used to cook foods)
6. Nylon fibres - Artificial	To make fibres for artificial clothes, to prepare thread and sports goods, fibres for brushes.
7. Artificial rubber - Artificial (Neoprene)	To prepare gums, the covers for golf balls.
8. Perspex - Artificial	To make optic fibres, to prepare transparent material.
9. Bakelite - Artificial	To make telephones, laminating paper, canvas cloth, buttons.

10. Silicon Rubber - Artificial	Hose pipes and water proof equipments.
11. Terelene - Artificial	Magnetic tapes, photographic films, yarn for fabrics.
12. Polyurathane - Artificial	Foam-rubber mattresses. To make artificial leather (rexin)
13. Normax - Artificial	Parachute covers to prepare heat resistant clothes during travel to outer space.
14. Starch/Cellulose/Glycogen Natural (Mononer - Glucose)	Nutrient in food.
15. Protein - Natural (Monomer - Amino acid)	Nutrient in food.
16. Natural Rubber - Natural (Monomer Isoprene)	Rubber products (tyres, shoe-soles, baloons, mattreses, gloves)



Uses of Polymers

Problems due to use of these polymers

1. Rate of decay is less.
2. Does not decay.
3. The toxic gases and pollutants on burning of these polymers mix with the atmosphere.
4. Acid rains.
5. Diseases associated with the respiratory system.
6. Harmful effects to the wild animals due to eating .

Solutions to these problems

- Production of polymers that could be reused and recycled.
- Production of polymers which decay.

Precautionary measures to overcome this issues .

- Production of plastics which is degradable by solar radiation, bacteria and water.

The following information is presented to the teacher as extra knowledge as well as to the gifted children

In plastic containers or plastic equipments the following symbols are given with a number in it.

- Arrow symbol indicates that it could be recycled.
- The number indicates the polymer in it.

Symbol	Abbreviation	Type of product
	PET (Poly Ethylene Terepthalate)	Water bottles, food containers
	HDPE (High Density Poly Ethylene)	Polythene bags, wrappers, bottle lids, cans, lunch sheets
	PVC (Poly Vinyl Chloride)	Water pipes, shoe-soles, cards
	LDPE (Low Density Poly Ethylene)	Milk packets,wrappers, gum bottles, flexible bottles
	PP (Poly Propylene)	In garments, containers, chairs, basins, ice cream containers
	PS (Poly Styrene)	Containers for electrical appliances, food containers, toys, Rigifoam, pen tubes

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.10: Prepares solutions to suit the requirements.

Activity 4.10 : "Let us prepare mixtures."

Time : 120 min

Quality inputs :
- 'The story of "**Porridge and plain tea**" given in annex 4.10.1
- Two copies of instructions for exploration in annex 4.10.2.
- Instructions for teacher in annex 4.10.3.
- Two copies of ' **Description of mixtures**' given in annex 4.10.4.

Teaching learning process :

Step 4.10.1 :
- Get a student to present the story "**Porridge and plain tea.**"
- Lead a discussion highlighting following points

  - Both herbal porridge and tea are mixtures.
  - Herbal porridge is a heterogeneous mixture.
  - Plain tea with sugar is a homogeneous mixture.
  - Exploring about mixtures is useful in life pursuits.

(15 min)

Step 4.10.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.10.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

  - Some mixtures are classified as solutions.
  - To make a solution a solvent and one or more solutes have to be mixed.
  - For further information **"Description of mixtures"** could be used.

(45 min)

Assesment and evaluation criteria

- Explains mixtures and solutions correctly.
- Prepares solutions.
- Propose suitable solvents for respective solutes.
- Arrives at inferences based on observations.
- Displays the ability to perform activities productively.

Annex 4.10.1

Porridge and plain tea

Aunty and Ruwini both sat for breakfast before the school van arrived.
"Ruwini, mix the herbal porridge well and take. If not you won't get any rice at the bottom."
Ruwini laughed.
"I'm afraid that you will say next to mix the tea too."
"There is no need to mix tea again. The problem is with the herbal porridge."
"It is true.But anyway, both herbal porridge and plain tea are mixtures."
"Herbal porridge is a heterogeneous mixture, There is no uniform distribution of particles. But in a plain tea, sugar is uniformly distributed.

Annex 4.10.2

Instructions for group exploration

Let us prepare mixtures

- Direct your group to prepare mixtures by mixing the substances given below.

  - **First group** - $CuSO_4$, flour, salt, grease, wax, water, kerozene oil, coconut oil.
  - **Second group** - $KMnO_4$, chalk powder, sugar, soap, resin, water, kerozene oil, coconut oil.

- Prepare different mixtures by referring to the article "**Description of mixtures.**"
- Find out whether there are solutions among the mixtures you prepared.
- Discuss why some mixtures cannot be considered as solutions.
- Indicate the solvent and the solute/solutes in the solutions you prepared.
- Prepare a saturated solution using salt/sugar.
- Highlight the difference between saturated and unsaturated solutions.
- Can any solute dissolve in any solvent? Explain with examples.
- Be prepared to present your findings in an innovative way to the class.

Annex 4.10.3

Instructions to teacher

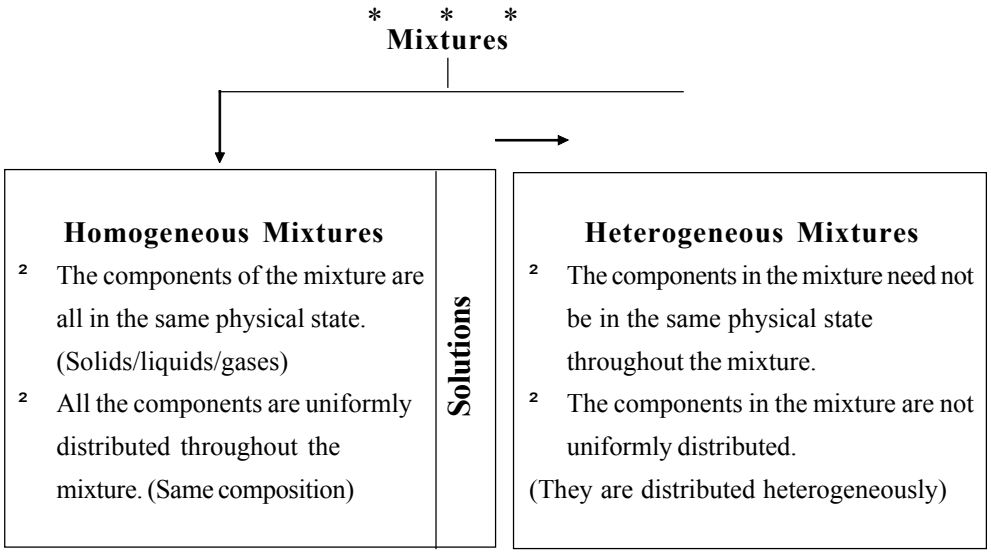
- Set up two work stations keeping the materials according to instructions given in the exploration sheet.
- Keep the following equipments in each.
- Some beakers, glass rod (for stirring)
  (If the equipment is not available use substitutes)

Annex 4.10.4

Description of mixtures

Matter which is not pure is a mixture. Last year you learnt about pure substances. You know that elements and compounds too are included in it.

A mixture is some matter which is made up of more than one component which are not chemically combined. Some examples of mixtures are air, sea water, soil, tea, milk-toffee, garbage, steel, rocks etc.



There are different solutions in our environment. These solutions could be in the solid, liquid or gaseous states.

- Sugar solution, salt solution, dilute hydrochloric acid are solutions in liquid state.
- Air in a closed system (free form dust and only consisting of gases) is a solution in gaseous state.
- Alloys of metals which are of high quality are solutions in solid state.

Air is not considered as a solution when it has dust and other suspended particles. These particles are in the solid state. In a liquid like milk, globules of fats are present without any uniform distribution.

When alloys are made, to mix the components uniformly, the components are transformed to the liquid state. At normal texperature the components of the alloy are uniformly mixed when they turn to the solid state.

In concrete, milk toffee, rocks etc., the component particles are not uniformly distributed. As a result we do not consider them as solutions.

The filtrates of sea water and fresh water could be considered as solutions after filtered using a filter paper,

To make a solution a solvent and one or more solutes which is uniformly mixed are required. The solvent is the medium in which the solute particles mix. This medium has to be a fluid (liquid or gas) in which solute particles could be uniformly distributed. When a solution is formed by two or more fluids, the solvent is the fluid that provides the highest particle percentage of components.

Selection of solvents

Water is a good solvent. Sugar, salt, alcohol and some acids dissolve in water. It is one of the reasons why most of our body weight is water. Therefore, water has become one of essential basic need for us. Because a variety of substances are dissolved in water it is considered as universal solvent.

For a solution to be formed, the components must be uniformly distributed throughout the system, for this to happen the solvent and the solute must have chemical properties which fit together.

Is it possible to dissolve grease in water? No. But in solvents like kerosene oil and thinner, grease and latex could be dissolved. It is not possible to dissove salt in kerosene oil. When we select a solvent we must remember to select solvents to suit our requirements and also the nature of the solute.

Saturated and unsaturated solution

Here your attention is drawn to solutions formed by two components which are in two physical states.

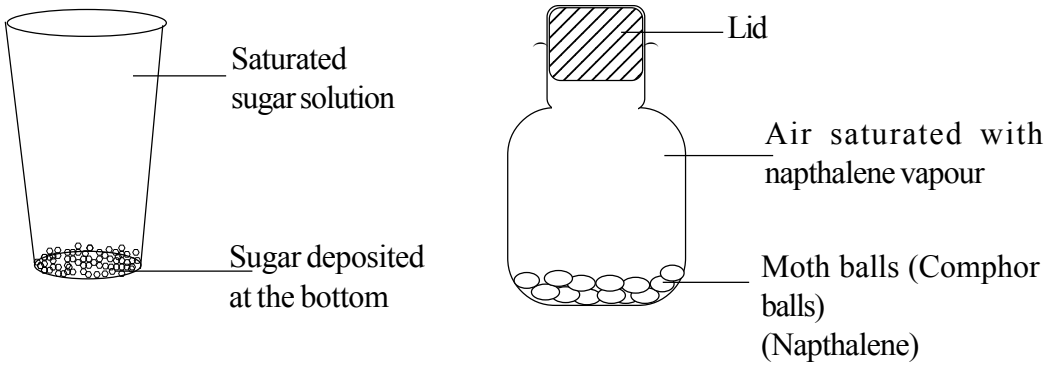
- Is it possible to dissolve any amount of sugar or salt in some volume of water? No, not possible.
- Is it possible to have in an enclosed space, any amount of water vapour or comphor ball vapour (Napthlene)? Not possible!

Why?

There is a limit to the number of solute particles which could be uniformly distributed among

solvent particles at a certain temperature. It is not possible to exceed this number of solute particles. A solution in such a state is called a **saturated solution.**

After the solution is saturated, the solute particles are deposited. Try to dissolve more sugar. The presence of undissolved sugar at the bottom in a glass of juice, the camphor balls in a closed bottle does not wear off which happens as a result of this.



Will the undissolved solute at the bottom of a saturated solution remain as it is?

When we speak of saturated solutions we have to mention about unsaturated solutions too. Unsaturated solutions are those solutions in which more solute particles could be dissolved in the solvent.

In a saturated solution, the solute particles left at the bottom go into the solution and similarly same number of solute particles in the solution is deposited at the bottom.

This condition is known as the state of **dynamic equilibrium**.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.11 : Conducts experiments to find out methods of generating of electricity.

Activity 4.11 : "Let us set up experiments and generate electricity."

Time : 120 min

Quality inputs :
- A dry cell cut longitudinally with a hack-saw blade, connecting wires and a bulb
- Two copies of exploration instructions included in annex 4.11.1.
- Two copies of article "**Electricity closer to life**" in annex 4.11.3.

Teaching learning process :

Step 4.11.1 :
- Allow a student to light a bulb with the aid of two halves of the dry cell.
- Advice the student to light a bulb with the aid of any one half of the dry cell.
- Let the students to observe the inside of the cut half of the battery.
- Conduct a discussion to highlight the folowing points.

  - The bulb ignited with the whole battery as well as with one half of the battery.
  - Dry cell is an equipment with which electricity could be generated.
  - The chemicals included in it react to produce electricity.
  - It is possible to use mechanical ways to produce electricity.
  - Such a device is the dynamo
  - Exploring the devices with which we could generate electricity is very helpful in providing life requirements.

(15 min)

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Step 4.11.2 **(**
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups

as well.

- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.11.3 **(**

- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

• Electric cells, electricity generating engines, dynamo and solar cells are used in generating electricity. • It is possible to discover more about generating electricity from the article **"electricity close to life."**

(45 min)

Assessment and evaluation criteria

- Proposes devices to generate electricity.
- Generates electricity by making various devices.
- Explores various devices used in generating electricity.
- Displays the ability in using technology according to requirements.
- Follows instructions accordingly.

Annex 4.11.1

a

Instructions for group exploration

Prepare set-ups and generate electricity

- Your group is directed to find one device to generate electricity.
  - Generating electricity by Chemical means.
  - Generating electricity by Physical means.
- Study about generating electricity by referring to the article **'Electricity close to life.'**
- Get to the four prepared work stations and carry out activities on generating electricity.
- Discuss the following points about the electricity generating method given to you.
  - Set-up used in the process.

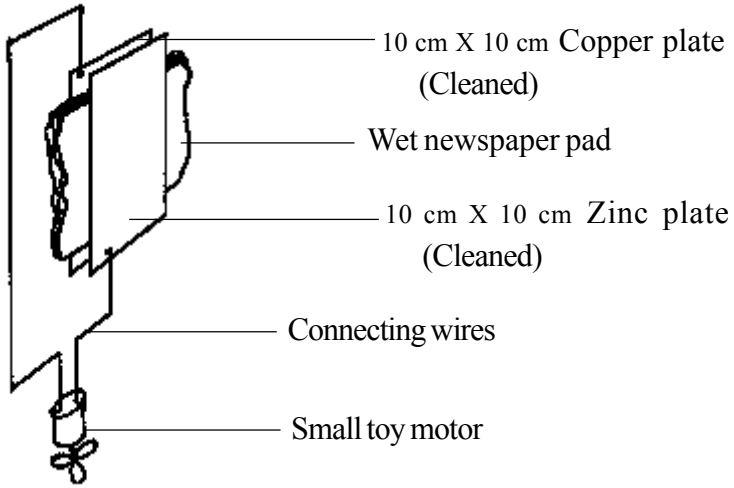
- Instances where the electricity so produced is used in day to day life.
- Advantages and disadvantages of your method from the other methods.
- Get ready to present your findings innovatively to the class.

Annex 4.11.2

Instructions to teachers

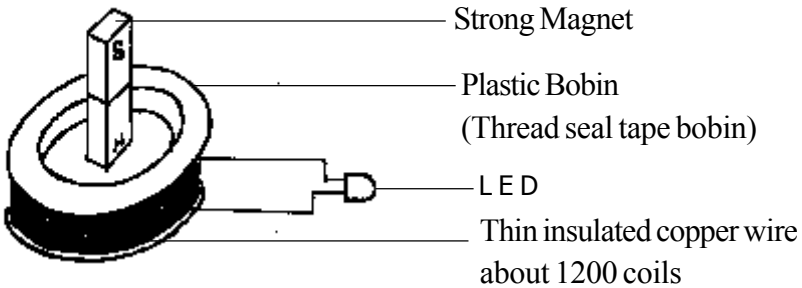
- Prepare four work stations according to the cards provided.
- Keep the cards alon g with other equipments separately in the work stations .

Card 1



- Set up the device as in the above diagram and start the motor.
- To fix the connecting wires to the plates, use crocodile clips.
- Remove the wet newspapers, wash the zinc and copper plates with water, wipe with a piece of cloth and keep it as it was.

Card I



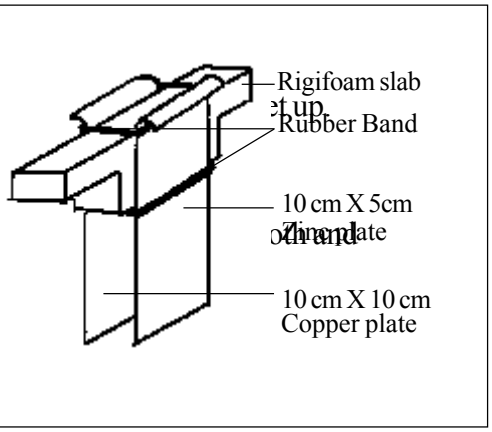
(By moving coil or the magnet fast it is possible to ignite the LED)

A
- Arrange the set up as in the figure and see whether the LED ignites.
- Keep the magnet stationary and move the coil up and down fast and see whether the LED ignites.
- Keep the coil stationary and move the magnet up and down and see whether the LED ignites.
- Stack the equipments as it was earlier.

B • See the structure and function of the bicycle dynamo supplied (with the internal parts removed) and see how it works.

C • Activate the laboratory dynamo and ignite the bulb.
• Examine the structure and function of the dynamo.

Card III



- Make a simple cell using the dilute H_2SO_4 be [illegible] set up.
- To fasten the connecting wires to the plates u[illegible]
- Note down your observations.
- Wash the copper and zinc plates with water, [illegible] and store.

Card IV

A • Discuss how the laboratory lead acid accumulator works.
- Using that see whether the bulb ignites.
- If the bulb does not ignite, use the batteries provided and charge it and afterwards see whether the bulb ignites.
- Use crocodile clips to fastern the connecting wires.
- Replace the equipments and other substances as they were before.

B • Using the photo cell panels in the laboratory try to activate the toy motor provided.
- Afterwards replace the equipment in their proper places as before.

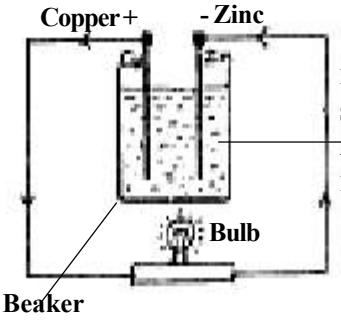
Annex 4.11.3

Electricity close to life

- Let us discuss about the history of generation of electricity and modern advances in the sources of electricity.

1. Simple Cell (1.1V)

The simple cell is a cell which could be easily set up. If the area of the zinc and copper plates are small the bulb will ignite.

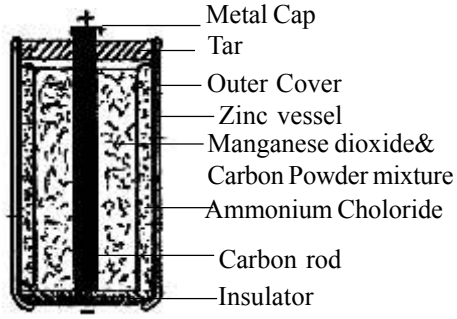


Major disadvantages of this could be considered as polarization and local action.

The gas that is liberated at the copper plate gets [illegible]late and as a result the flow of current stops. This is called [illegible]f copper sulphate $CuSO_4$ to the dilute supphuric acid, this could

The zinc gets dissolved, even if the cell is used or not is called local action.

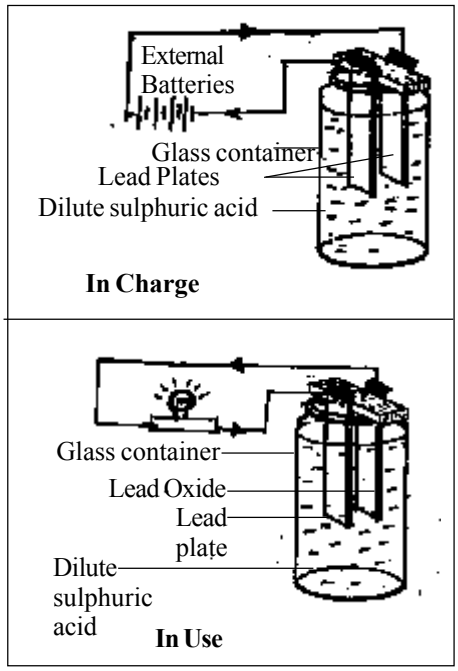
2. Dry Cell (1.5V)



It is easy to turn any side. Easy to use. If used for a long time the zinc vessel could develop pores and the liquid could come out.

As a result of the chemicals contained in it get exhausted after sometime, it cannot be used again. Because of this it is termed as a primary cell.

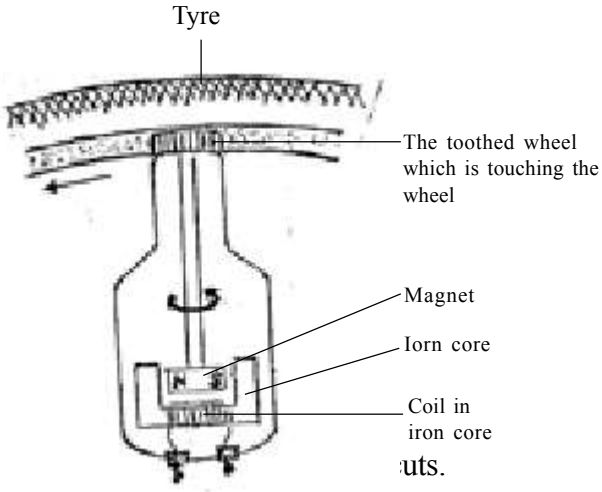
3. Lead acid accumulator (2V)



After arranging the set up given in the diagram and a current is suppled to it from an external battery, it is possible to charge this cell. During the charging process a chemical reaction takes place. Since it is possible to recharge it over and over again from an external source of electricity and used. This is known as a secondary cell or an accumulator cell. When this is charged the voltage is about 2V. It is possible for you to do this activity after setting it up as in the diagram.

4. Bicycle Dynamo(2V)

There is a toothed wheel which is touching the bicycle tyre. The toothed wheel is connected to a coil and a magnet which converts the mechanical energy to an electric current.



The current flowing depends on the speed with which the cycle is pedalled. When the bicycle stops the bulb extinguishes.

5. Electric Generator

Current is generated using fuel. It is portabl uts.

Electric Generator

6. Solar Cells

By solar cells, the light from the sun could be converted to electricity. Solar cells are made by using the element Silicon . As there is no wearing off matter, solar cells could be used longer.

Solar cells are a common solution to the energy crisis. Space centres and satellites up in the sky get their supply of electricity for transmission from the solar cells in their panels.

Competency 4.0 : Inquires on the properties, uses and interactions of matter.

Competency level 4.12: Investigates on the uses of Nano Technology.

Activity 4.12 : "Let us succeed 5th industrial revolution with NanoTechnology."

Time : 120 min

Quality inputs :
- Story about **'The last bus'** given in annex 4.12.1.
- Three copies of exploration instructions given in annex 4.12.2.
- Three copies of the article on **"Let us succeed 5th industrial revolution with Nano Technology."** given in Annex 4.12.3

Teaching learning process :

Step 4.12.1 :
- Introduce the story **'The last bus'** to the class.
- Lead a discussion to highlight the following points.

  - 'Nano Technology' is considered as the 5th industrial revolution dawning on the world.
  - The support given by education is immense, to succeed in Nano Technology.
  - All of us should learn about Nano Technology with dedication and in depth.

(15 min)

Step 4.12.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 4.12.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- The term 'Nano' is a prefix used to indicate the number $10^{-9.}$
- Nano Technology is about the substances falling within the scale from one to 100 nanometers which covers;
  - the study of the relevant substances
  - active involvement in research and development fields.
  - production processes
- The foundation of Nano technology is "bottom to top appraoch."
- What is meant by this is starting from the micro particle and producing macro products or starting from a micro particle and going to reach something very significant.
- You will be able to study more about this by reference to the article **"Let us succeed 5th industrial revolution with Nano Technology."**

(45 min)

Assessment and evaluation criteria

- Defines nanotechnology clearly.
- Surveys literature to explain the concept of Nano Technology.
- Displays the ability to find solutions to problems facing the future mankind through Nano Technology.
- Explores the natural and technological creations of Nano Technology.
- Makes predictions on the future developments.

Annex 4.12.1

The last bus

- Lankaputhra was waiting at the bus stand uneasily. There were a large number of parcels like boxes, gunny bags close to him.

Mr. Lankaputhra : At last the party is arriving, I thought that this bus too would depart."
(People reached the bus stand.)

Mr. Scientist : "Let us discuss about the trip again. Education, will you come here and read the list of names of boys in your group."

Mr. Education : " Now listen my group. Mr. Competent, Ms. Knowledgable, Ms. Potential, Mr. Wise, Ms. Brilliant, Mr. Skilful, Ms. Harmony, Mr. Brainy, Mr. Awareness and Mr.Creative."

Mr. Lankaputhra : " Where is Mr. Tech? Hasn't he turned up yet?"

Mr. Scientist : " No, no. He came with me. In his group there are Mr. Wealthy, Ms. Novelty, Mr. Energetic, Ms. Progressive and Ms. Rich..."
(Addressing the people in a loud voice.)
" Listen all of you. We are getting ready to go to 'Nano city!. The bus

scheduled for today is the 'Nano city' bus. It is not possible to say when and at what time the next bus would come. Mr. Tech, now you explain to our group their duty at Nano city."

Mr. Tech : " Here the leading role has to be the Mr. Education's group. They must carry out the duties assigned to them with knowledge and dedication. Then only my group will perform their part."

Mr. Education : " We admit that. We are organized to do that. I could take the responsibility. We are preparing the foundation required about Nanotechnology."

Mr. Lankaputhra : Please, it is good if all of you perform your duties well. I with greatest difficulty collected all these goods, equipments and money. All of you know that I'm not a millionaire. We have to use our resources wisely.

Mr. Scientist : "Mr. Education, you are the group leader. Assume that responsibility too. After we get on to the bus, till we get back look after the group.

Mr. Lankaputhra : "Another point... I have been loitering about this place enough upto now, four busses left.
One is... Steam engine city.
Second is ...Iron steel city.
Third is ...Electric engine city.
Fourth is ...Electronic city.
This fifth one is Nano city. I need a good product for the resources I am spending to send you on this trip.

Mr. Tech : "Mr. Lankaputhra don't be dissapointed. Myself and Mr. Education will get to together and provide you with thousand times more than the resources you spent."
(All of a sudden Mr. Scientist looks around with amazement.)

Mr. Scientist : "Only now I remembered, didn't Mr. Ethical turn up?"

Mr. Lankaputhra : "If Mr. Ethical is not there, it is better not to go on this trip.
If Mr. Ethical is not there, what is the use of this resources."

Mr. Educatiuon : " No, no. Mr. Ethical came along with me. I won't take part in any activity without him. Without Mr. Ethical, how could Nanotechnology move ahead?"
(A hand is raised among the gathering.)

Mr. Ethical : " I am here. I will be with my group among the others. If not, I won't be able to perform my duties properly."

Mr. Scientist : "At last now only I got relieved... any way it is better if Mr. Ethical is with the crowd... Read the list of names in your group.
"Ms. Mercy, Ms. Moral, Mr. Empathy, Mr. Pleasent and Ms. Peace."
(At this moment the Nanocity bus came rushing and stopped.)

Mr. Lankaputhra : "Wonderful! Get together. Get into the bus. Place your luggage. I'm extremely happy. Nano city folks and Mr. Victor are awaiting anxiously, to greet you. All of you should bring me an innovative product.
Happy journey and wish you luck."

All : "Good bye."

Annex 4.12.2

Instructions for group exploration

Let's win the fifth technical revolution - NANOTECH !

- The attention of your group is drawn to one of the following areas where Nano Technology is used.
  - Group One - Medical Science
  - Group Two - Power generation
  - Group Three - Production of Consumer items

- Refer to the article "**Let's win the fifth technical revolution - NANOTECH !**".
- Highlight he following points with regard to your area.
  - Natural nano systems and artificial nano systems and their usage.
  - Problems arising as a result of Nano Technology.
- Present your ideas about strange things you could do with reference to your area on this theme - "Other marvels that could be done through Nano Technology.".
- Get ready to present you findings to the class in an innovative manner.

Annex 4.12.3

Let's win the fifth technical revolution - NANOTECH !

Concept of Nanotechnology

- Man kind has set foot on Nano Technological era, which is considered as the fifth industrial revolution.

  Nano is a term used for one billionth part.

$$\frac{1}{1,000,000,000} = 10^{-9} = 0.000\ 000\ 001$$

This term is a prefix which in greek language refers to a dwarf; hence one nanometer

1 nanometer (1nm) = 10^{-9} meters = 10^{-9} m

That is $\frac{1}{1,000,000,000}$ m

Nano Technology - Introduction

Nano Technology refers to particles of substances which falls within the scale of one nanometer to 100 nanometers (nano particles).
It covers

- aquisition of knowledge about nanoparticles,
- using them actively in research and development areas,
- the production process resulting from it.

The basis of Nano Technology is bottom to top approach. What happens here is the particles of nano size are brought together and by chemical bonds reach the final product. (This is also known as molecular technology)

The father of Nano Technology is the Scientist Eric Drexler. Details of him could be traced from website 'e-drexler.com'.

In the book on Futre of Nano Technology era published by him in 1987, the concept of Nano technology became known throughout the world.

Natural Nano Systems

Living cell is a good example for a natural nano system. A cell is a functional and structural unit of life.

In a cell many biological activities take place. Isn't it amazing that in a normal cell which is of 5-10 micro metres (μm) in size, series of complex chemical reactions take place non stop?
In addition these biological activities take place in different organelle present in the cell. These are nano scale natural factories. There are no successful machines/parts artificially adapted to perform these biological activities up to date. Reason for this is that these biological activities take place in nano scales. In future these natural biological activities could be made to perform with much more efficiently with artificial systems by nano technology. If a biological activity like photo sysnthesis is successfully made to perform artificially, will there be a food shortage in the world?

Artificial Nano Systems

In all physical production processes, the particles (atoms or molecules) of raw materials that are used to form the end product are arranged in a required manner. Today, in the processes of large scale production lines related to macro level products, the atoms are not arranged in an orderly pattern. Due to this haphazard way of arranging atoms the products undergo wear and tear.

If it is possible to make the production process in the atomic scale the above disadvantages could be avoided.

By Nano Technology the atoms and molecules are correctly arranged as that a high quality product is obtained. Some models of those productions which are arranged in molecular scale (Device) are given below.

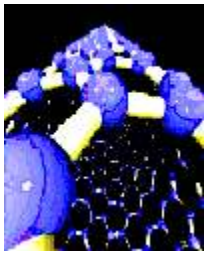
Molecular Device Model

Nano molecular device models are combined with one or more similar parts chemically in nano factories and nanotechnical laboratories.

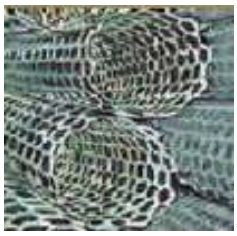
(ii) Carbon nano structures :

The following structures Carbon Bucky Ball, Carbon Nanohorns and Carbon Nanotubes are used as carbon nano structures. These belong to fullerenes which are an allotrops of carbon.

Carbon Bucky Ball



Carbon Nano Horns



Carbon NanoTubes

Uses of Nano Technology

1. Power Production

Remaining petroleum fuel that is left on earth is sufficient for a few years and also burning of fossil fuel give a gas which play a part in warming the earth. As a result more attention is focussed on alternative sources of fuel.

By Nano Technology, production of more efficient sources of electricity, methods of using power efficiently are introduced.

(a) Solar Cells :-

Solar cells are made of semi conductors. With semi conductors now in use only a small percentage of solar energy is absorbed. That is about 14%. The semi conductor manufactured by using Nano Technology could absorb a large percentage of solar energy. In addition the internal electrical conductivity of the solar cells are brought to a higher level.

(b) Hydrogen fuel cells :-

In fuel cells, electrical energy is liberated by an electro-chemical process. The most efficient of these fuel cells is the hydrogen fuel cell. But in these cells the storage of hydrogen is a practical problem. In nano substances the surface area to volume ratio is larg. Using carbon nano tubes for storage of hydrogen is therfore a solution.

(c) Rechargeable Electric Cells :-

The most efficient rechargeable electric cell is the lithium iron cell. The major defect in rechargeable cells is that the charge is lost even when it is not in use.

It is possible to increase the efficiency of the cell by using lithium nano composite. It also prevents the energy loss when the cell is not in use.

(d) Hybrid Electric Vehicles

This is done by combining the powers of the vehicles internal combustion engine and that of the electric motor.

It is possible to use super capacitors which is made by Nano Technology to store the electric energy in these vehicles.

(e) Heat insulators

Heat insultors are used to prevent the loss of heat energy. In nano insulators the following features are present.

1. It's heat insulation is many more times that of the normal heat insulators.

2. Very thin

When nano heat insulators are manufactured, air is trapped in the ceremic nano particles and carbon nano tubes.

Eg. 1. Aerogels
2. Nanofoams

To prepare jackets to escape from cold, to cover oil and gas pipes and in warships nano heat insulators are used.

(f) Transmission of electricity

Electrical energy is lost as heat energy during transmission of electricity due to resistance in the conducting wires.

To prevent this, efficient conductors and super conductors made by nano technology could be used.

(g) Nano super capacitors

In normal capacitors the electric power which is stored up as electric charges lasts only for a short period of time.

But in nano super capacitors it is possible to store up electric power for a longer period.

(h) For thermo electricity

Thermal power which is directly converted to electrical power is thermo electricity. This is done by the thermopile. In normal thermopiles the practical use is very limited as a result of its inefficiency in producing electricity.

But the efficiency of the thermopiles which is made of nano materials are at a higher level. Instances where thermopiles are used is given below.

1. Providing electricity for recharging electric cells in vehicles using fuel cells.
2. In clocks using body temperature.

(i) Nano crystals (LED)

In incandescent lamps and fluorescent lamps, electrical energy is lost as heat energy.

But with light emmiting diode (LED) crystals made by using Nano Technology the loss of energy is very small. The life time of such bulbs is about twenty times that of traditional bulbs.

2. Producing Consumer items

(a) Cloth and garment industry

Traditional cloth has small pores, dirt and dust gets entangled in these. Because of this it is difficult to remove them. There are hardly any pores in cloth manufactured according to nano scale and as a result, it is not possible for dust and dirt to settle. This is known as the lotus effect. It acts as if water falling on lotus leaves break up into small bubbles and gets dispersed.

When cloth is manufactured according to nano scale, phase change materials (PCM) are added.

Effect of PCM

- When the bodytemperature rise PCM dissolves and the body heat is absorbed in the process.
- In a cold environment the PCM solidifies and the heat that is given out make the body warm.

Gloves made to nano scale, when mixed with a mixture of nano scale silver particles could act as a disinfectant.

Bullet proof jackets made of nano fibres are very thin and light. These fibres are made out of carbon nano tubes. These jackets prevent absorption of water and germs.

(b) In beauticulture

Anti-aging chemicals and Vitamins needed for the skin.

Example - Retinal is mixed with fatty acids to form a cream which reach the market as a beauticare oinment. As these are not soluble in water they are not efficiently absorbed by the skin. This problem is avoided by storing the above vitamins and antiaging chemicals in nano scale spheres.

Suncream is an oinment which has the chemical zinc oxide which protects the skin from infra-red radiation. As this is white it is no longer popular.

By producing this by nano scale particles, the oinment turn colourless but the property of absorbing infrared rays does not change. Further nano particles are small and they could reach to a greater depth in the skin as such its activity continues for sometime.

(c) Super hard ceramic bricks

Normal ceramic brick is a brittle substance.

But a ceramic substance Silicon Carbide nano crystals which is as hard as diamond and also flexible to a certain extent has been produced by Nano Technology. These substances could withstand high temperature and high frequency radiation.

(d) Nano paint

When normal paint is applied there are small holes in it. As a result of dust and dirt getting into these holes the coating gets discoloured. As there are no holes in paint produced by nano technology, the bright colour of the paint lasts longer. As there are no holes in nano paint applied on glass, dust or dirt does not get stuck. It could be cleaned by a splash of water. This type of applications are suitable for high rise buildings and exterior glasses of vehicles.

(e) Production of sports goods

The bats and rackets used in sports, like badminton, tennis, golf, has to be very strong, should not bend and has to be lightwieght. Bats and rackets produced using carbon nano fibres have all .the above mentioned properties.

(f) Production of anti-corrosive paints

Metals get corroded as a result of its surfaces getting exposed to water and air. Corrosion could be prevented as a result of the lotus effect in nano applications which prevents by the property of water not getting collected. Corrosion in vehicle engines is prevented by application of nano Sirconia.

(g) Artificial rubber production

Rubber is a polymer. If the hydrocarbon monomers in it are added in nano scale, high quality rubber could be produced.

(h) Vehicle production

Aluminium produced by using nanotechnology has enhanced properties like very strong, stable, ability to withstand collisions and lightweight.

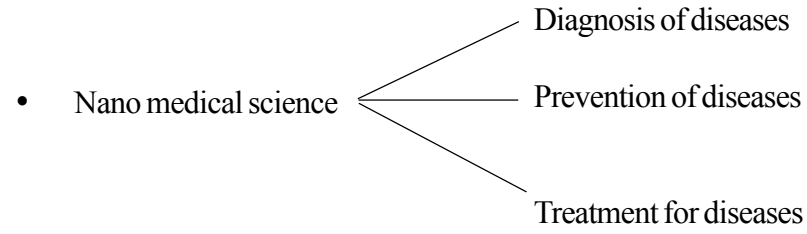
Nanotechnology is used to make vehicle parts containing metals, strong vehicle parts that could withstand vibrations and in producing vehicle paints with long lasting brightness.

Substances have been developed by using nano particles, in order to increase the efficiency of the fuel to bring about total combustion.

(i) Production of disinfectants

Nano particles like titanium oxide, zinc oxide, tin oxide and zinc sulphide act as a photocatalysts (Chemical compounds that undergo certain reactions in the presence of light) These photo-catalytic processes on nano particles could be used in purification of water.

3. In the Medical field



(a) Nano-medical science for diagnosis of disease

Achievements from basic equipment and components manufactured by nanotechnology which are in use in the medical field are as follows;

- Blood tests
- Measuring of blood pressure
- Measuring of heart beat
- Measuring of body temperature

(b) Nanotechnology for prevention of diseases

(i) Anti-biotic lotions :

These lotions are useful in preventing germs getting collected in hospitals, in protecting surgical equipment and up keeping the sanitary conditions of the surgery.
Titanium dioxide (TiO_2) and silver nano particles are used for this purpose.

(ii) Nano filters :

It is not possible to keep the virus and similar micro organisms from filtering through the filters that are in use today, as they are very small than the pores of filters. But it is possible to use nanofilters with extremely small pore size made of titanium dioxide and silver nanoparticles which prevent viruses and other very small micro organisms getting into the body.

(iii) Nano medical treatment

It is possible to use nanotechnology to make the active ingredient in the drug to dissolve easily in water and there by facilitate its absorption in to blood.

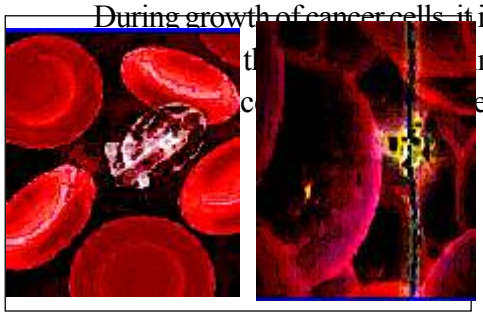
Eg.: Pain killers, treatment for asthma

(iv) Biological robots :

Biological bacterial robots having a small number of genes as low as 300 have been manufactured. It is possible to make these robots prepare things like vitamins, hormones and enzymes.

It is also possible to make them able to absorb poisonous substances and convert them to non poisonous substances.

During growth of cancer cells it is possible for the nanorobots to reach the cancer cells t ne directly to the cancer cells and make it possible to c edicines are poisonous to the other cells.)



Nano Robots

(v) Nano Technology to control diabetes

A gadget containing insulin hormone is grafted to the body, which releases the appropriate dosage when required through nanoscale pores to the system for a long time.

The technology to implant cells which secrete the hormone insulin obtained from the pancreas of pig , underneath the skin of the patients is still in the research stage.

(vi) Treatment using nanoshells

Medicines are placed inside shells which are as small as a virus. These are injected into the system and allowed to settle around the diseased cells and later these shells are made to dissolve by infra-red laser beams, and the drug in required quantity is provided to the target cells.(This is used in treating cancer cells)

(vii) Nano technology for artificial bones

Calcium phosphate is present in bones. They are made strong by the addition of required quantity of fluorine.

Apatite is a natural mineral containing the above substance. Attention is now focussed on making artificial bones and filling teeth by nano scale composites of apatite.

Possible disadvantages which would result due to nanotechnology and solutions

Environmental pollution :

There is a possibility of contaminating nanoscale chemical compounds with water and air. As a result these nano particles could reach the body through the respiratory system or the digestive system. These could cause health problems. To minimise environmental pollution the part played by nanotechnology must be looked into.

The following are some methods.

Use of Nanoporous Filters

Pollutants are allowed to absorb by passing unfavourable gases produced during combustion

through nanoscale porous filters made of cesium oxide (Cs_2O). As a result the amount of air pollutants reaching the atmosphere are minimized.

Nano scale substance which join with environmental polutants

Nanoparticles have been developed capable of combining with neutral environmental polutants like arsenic (As) and remove them from the environment. Removing arsenic, which is a neutral environmental pollutant, contaminated with water is an issue. The arsenic concentration in water is reduced by making nanoscale iron oxide particles to combine with arsenic. Later this polutant is removed by using a magnetic field.

Nano (Semi conductor) sensors

Nanosemiconductor sensor made of zinc oxide (ZnO)have been manufactured which is sensitive to unfavourable gases in the atmosphere. When the concentration of unfavourable gases like carbon monoxide (CO), nitric oxide (NO) is high, it forms bonds, whereas when the concentration is less the bonded gases are liberated. By this means it is possible to monitor the status of the atmosphere in urban areas.

Other issues

- The dangers of manufacturing weapons using nanotechnology.
- The dangers if nanoscale poisonous chemicals used in war.
- Social misconduct that could happen due to freely available electronic gadgets (eg: cameras) of minute scale.

Is Nanotechnology responsible for each and every issue?

The problems mentioned above are not due to any fault of technology or new discoveries.

These happen because of misuse of technology.
In any case there is an institution to act on unfavourable repercussions due to nanotechnology and to prevent them. (Centre for Responsible Nano Technology)
The official web site of this institution is **www.crnano.org**

Competency 5.0 : Investigates diversity of plants.

Competency level 5.1 : **Explores the morphological diversity of flowers.**

Activity 5.1 : Is every flower symmetrical?

Time : 120 min.

Quality Inputs :
- Shoe flower
- Two copies of instructions for exploration in annex 5.1.1
- Two copies of article **"Is every flower symmetrical?"** in annex 5.1.2.

Teaching learning process :

Step 5.1.1 :
- Introduce the shoe flower to the class as an example.
- Conduct a discussion highlighting the following points.

  - In a flower, stalk, receptacle, calyx, petals gynoecium and audroecium are mainly present.
  - Each of these parts perform a specific function.
  - Due to diversity in features of these parts there is a diversity in flowers.

(15 min)

Step 5.1.2 (
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.1.3 (
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

  - Flowers could be classified and identified according to the symmetry of the parts which are sepals, petals, stamens and ovary.

- Flowers could be classified according to their symmetry as follows.
  - Flowers with radial symmetry (radially symmetrical)
  - Flowers with bi lateral symmetry. (bilaterally symmetrical)
  - Asymmetrical flowers
- You will be able to gather more information from the article **"Is every flower symmetrical?"**

(45 min)

Assesment and evaluation criteria :

- Names the main parts of a flower and explain their functions.
- Highlights the diversityof flowers.
- Classifies flowers according to sysmmetry.
- Obtains the skills of observation.
- Uses classification for the convenience of study.

Annex 5.1.1

Instructions group exploration

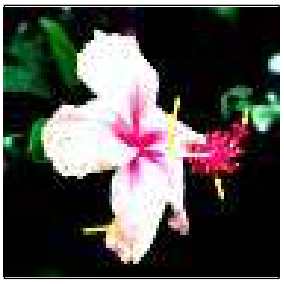
"Is every flower symmetrical?"

- Two categories of flowers that could be classified according to the arrangement of their petals are given below.
  - First group - Radially symmetrical flowers
  - Second group - Bilaterally symmetrical flowers
- Refer the article "Is every flower symmetrical?" and study the type of flower your group is assigned.
- Select the type of flowers with the symmetry your group is expected to study.
- Discuss about the parts which are clearly noticeable, the way they are arranged, special features and study their diversity in the flowers.
- Try to find more examples to the type of flowers you selected.
- Discuss about examples of flowers which has no symmetry.
- Get ready to present your findings innovatively.

Annex 5.1.2

Is every flower symmetrical?

In flowering plants the structure which perform the sexual reproduction is the flower. Flower is a part of the stem. It grows from a bud. According to the arrangement of petals in a flower they are of many types.



- Radially symmetrical flowers

If the flower could be cut into two similar parts along many axes, it is known as a radially symmetrical flower.

Some of the examples for this type are Rukattana (රුක් අත්තන), Kaneru (කණේරු), temple flower (අරලිය), Idda (ඉද්ද), Wathusudda(වතු සුද්ද), Rathmal (රත්මල්), shoe flower, Gansooriya (ගංසූරිය), Jambu (ජම්බු) Guava, Bougainvillea.

As in the flower shown in the diagram, flowers with radial symmetry could be divided into two equal parts along any radius.

- Bilaterally symmetrical flowers (යුගරූපී පුෂ්ප)

Flowers which could be cut into two equal parts only along one axis are known as bilaterlly symmetrical flowers.

Examples :Kathurumurunga (කතුරු මුරුංගා), Erabadu (එරබදු),) Ehela (අහැළ), Ranawara (රණවරා), Mai mal (මැයිමල්)

- Asymmetrical flowers :

In some flowers there is not even a single axis of symmetry.
These are asymmetrical flowers.
Example : Cannas

Competency 5.0 : Investigates the diversity of plants.

Competency level 5.2 : Explain the structure of the flower by using scientific conventions.
Activity 5.2 : "Flower, through scientific eye"...
Time : 120 min
Quality inputs :
- Collection of flowers on a common table.
- Three copies of article on instructions for exploration in annex 5.2.1.
- Three copies of article **"Beauty of a flower"** in annex 5.2.2

Teaching learning process :

Step 5.2.1 :
- Introduce to the class the collection of flowers on the common table.
- Lead a discussion highlighting the following points.

  - When you see flowers you feel happy about aesthetic beauty of the environment.
  - Why does a plant require a flower? should be scientifically investigated.
  - There should be an accepted scientific convention to explain the diversity in flowers.

(15 min)

Step 5.2.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.2.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Flowers play a special part for the existence of plants.
- The structural arrangement of flowers could be scientifically discussed.
- It is possible to obtain more information by reference to the article **"Beauty of a flower"**

(45 min)

Assesment and evaluation criteria :

- Discloses the criteria to explain the structure of a flower.
- Illustrates floral formulae and floral diagrams.
- Describes the structural arrangement of a given flower using scientific conventions.
- Appreciates bio diversity.
- Engages in scientific investigations.

Annex 5.2.1

Instructions for group exploration

Appraisal of a flower through scientific eyeගගග

- Focus your attention to the flower provided to your group.
  - Group One - Shoe Flower (වදමල)
  - Group Two - Kathurumurunga (කතුරු මුරුංගා)
  - Third group - Bimthamburu (බිම්තඹුරු)
- Refer the article 'Beauty of a flower' and find out how a scientific exploration could be carried out about the structural arrangement of a flower.
- Conduct a scientific exploration about the structural arrangement of the flower you selected according to the three approaches given and submit your findings.
- Try to explore the structural features of any of the flowers you observed in the common table.
- Get ready to submit your findings to the class innovatively.

Annex 5.2.3

Instruction to teachers

- Select one flower from the collection of flowers given to each group. Select the flower in a way that each one of the students get a flower.

First group	Second group	Third group
Shoe flower (වද) Ladies fingers Sooriya Cotton (කපු)	Kathurumurunga (කතුරු මුරුංගා) Andanahiriya (අඩනහිරියා) Ranawara (රණවරා) Ehela (අහැළ) Erabdu (එරබදු) Mai mara (මැයි මාර)	Bimthamburu (බිම්තඹුරු) Bathala (බතල) Kan kung (කංකුං) Thunbergia Girithilla (ගිරිතිල්ල)

- Keep as many flowers as possible, collected from the environment on the common table.
- These flowers should be large and the parts are clearly visible.
- From the article the students are provided experiences with three flowers from Malvacea, Papilionaceae, Convolvulaceae and Acanthaceae families only.
- Inform the students that from the flowers provided on the common table, they must indicate one or more information clearly visible like the symmetry, sexuality, number of sepals, number of petals, stamens and that they are not expected to produce a full floral formula.

For yourattention:

To show the full flower and the half flower, use the shoe flower with five petals, and use the shoe flower and Ipomea flower to give the floral formula and the floral diagram.

Do not use any other flowers in your explanations.

Annex 5.2.2

Beauty of a flower

Gamini mama got prepared to present his computer presentation on flowers.

"Mama I have some questions to ask about flowers" said Chandu.

"Isn't it possible for trees to be without flowers".

Before Gamini mama could answer Chanka laughed.

"Chandu akka, is it a question to ask? How is it possible to have fruits without flowers? How is it possible to make seeds?".

"Chanka is correct" said their aunt.

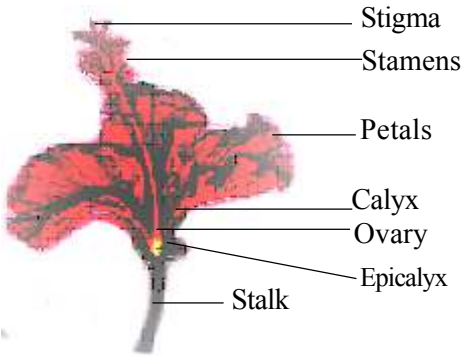
"It is true! "Gamini mama started to explain.

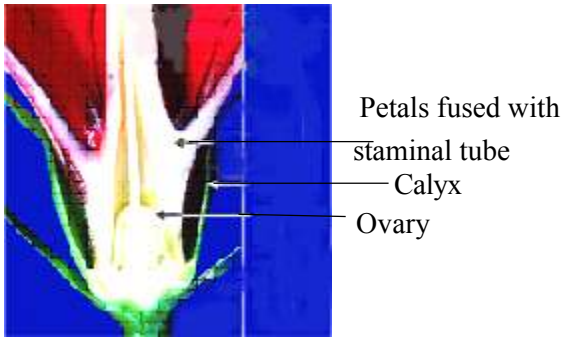
"Flower is the reproductive organ of the plant. The flower is essential for the plant to exist . Because of this study of structure of a flower according to accepted norms is a scientific exploration that is essential."

Gamini mama got Chandu and Chanka to sit on either side of him and put the computer disc in to the computer.

The whole flower and the half flower is an approach to explain the structure and arrangement of floral parts...

1. Entire flower



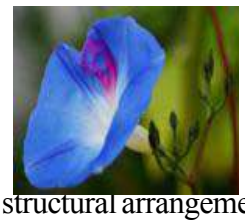


2. Half flower

3. Half flower with the ovary

(ii) Floral formulae as an approach to explain the structure and arrangement....

* ♀	$K_{(5)}$	C_5	$A\alpha$ $G_{(5)}$	Shoe flower
↓ ♀	$K_{(5)}$	C_5	$A_{(9)+1}$ G_1	Kathurumurunga කතුරු මුරුංගා
* ♀	K_5	$C_{(5)}$	A_5 $G_{(3)}$	Bimthamburu බිම්තඹුරු



Above are three floral formulae. This is the standard form in which the structural arrangement is represented scientifically.

1. Symmetry

In these floral formulae there is the * or ↓

(* radial symmetry, ↓ bilateral symmetry)

This indicates the symmetry of the flower. Sometimes there are flowers without any symmetry. In such cases no mention of it is made in the floral formula.

2. Sexuality of the flower.

Do you know that there are plants which has separate male and female flowers.

Most flowers are bisexual. Which means both androecium and gynoecium are in the same flower.

Look how they are shown.

♂ Male ♀ Female ☿ Bisexual

3. Calyx(Whorl of sepals)

K- Calyx

Letter K indicates the whorl of sepals. How many sepals form the whorl of sepals is indicated by the digit below.

$K_{(4)}$ $K_{(3)}$ K_5

If there are brackets out side the digit, that indicates the sepals are fused (united), i.e. as a cup.

4. Corolla (Whorl of petals)

Here we talk about the whorl of petals.

C - Corolla

$C_{(3)}$, C_4 , $C_{(5)}$, $C_{(6)}$

Here too the digit indicates the numbers of petals and whether the petals are separate or fused. In Kelanithissa (කැලණිතිස්ස), Bimthamburu (බිම්තඹුරු), Thunbergia flowers, the petals are fused and form a tubular structure.

5. Androecium (Stamens)

A - Androecium α

Letter 'A'indicates androecium or stamens. In some flowers the number of stamens are infinite(∞). That indicates more than twenty as a convention. There are varying number of stamens. The stamens could be fused or separate.

A A_{10} $A_{(10)}$ $A_{(9)+1}$ A_3 A_4

6. Gynoecium (Includes stigma, style and ovary)

G - Gynoecium

'G' represents the Gynoecium. How many carpels are there in the ovary (This does not indicate the number of ovules.)

The number of carpels are always written within brackets because they are closed.

For example : $\overline{G}_{(2)}$ G_1 $G_{(2)}$ $G_{(3)}$ $G_{(3)}$ $\overline{G}_{(5)}$

Why is there a line above and below the letter G ? This indicates the relative position of ov ary to all the other floral parts. If all the other floral parts are below the ovary G is written as G and if all the other floral parts are above the ovary it is denoted as $\overline{G}$.

Sometimes the stamens are fused with the petals. The stamens in Bimthamburu (බිම්තඹුරු) sweet potato flowers, are not free. See the following.

$\overset{\frown}{C_{(4)}\ A_4}$ $\overset{\frown}{C_5\ A}$ $\overset{\frown}{C_{(5)}\ A_5}$

The fusion between C and A is indicated by an arc drawn above C and A.
(Sometimes you may think that in the shoe flower, stamens are not fused to the petals but the stamens are fused to a tube which is derived from petals called staminal tube.)

Now let us draw your attention to the floral formulae given earlier. Now it is possible for you to understand the floral formulae much better.

Floral diagram as an approach to explain the structural arrangement of flowers.

Floral diagram of shoe flower

α

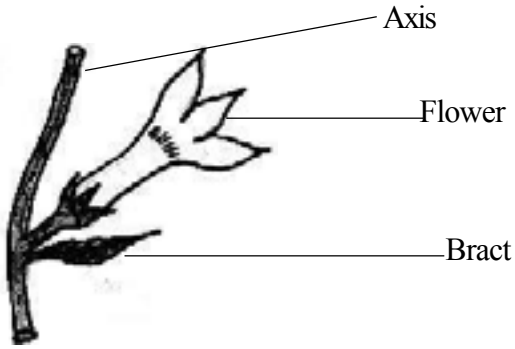
Floral diagram of Kathurumurunga (කතුරු මුරුංගා) flower

Floral diagram of Bimthamburu (බිම්තඹුරු) flower

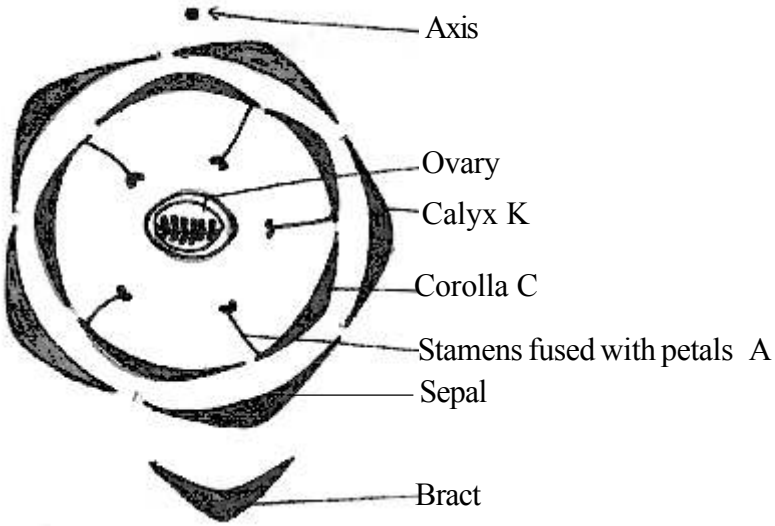
In drawing the floral diagram the arrangement of sepals, petals, androecium and the gynoecium in a horizontal plane as seen from above is indicated in a single diagram. This could be considered as a ground map of a flower.

When drawing a floral diagram, the flower should be kept facing and the tip of the bract is directing towards us. Then the stalk of the flower or the axis is placed in the opposite direction to us.

After the flower is kept as above we draw the parts. In the floral diagram the upper most point indicates the axis of the flower. It is an accepted convention that in a floral diagram outer most at the bottom is the bract and on the other side directly opposite is the axis.



Let us look at a floral diagram in details.



According to the above floral diagram let us write the floral formula

$$* \quad \varphi \quad K_5 \quad C_5 \quad A_5 \quad G_{(5)}$$

Competency 5.0 : Investigates the diversity of plants.

Competency level 5.3 : Explores the patterns of inflorescences.
Activity 5.3 : "A single flower or a cluster?"
Time : 120 min
Quality inputs :
- "**A single flower or a cluster**?" given in annex 5.3.1
- Two copies of instructions for exploration in annex 5.3.2
- Two copies of instructions for teachers in annex 5.3.3
- Two copies of article, " Flowers dancing in the breeze" given in annex 5.3.4

Teaching learning process :

Step 5.3.1 :
- Get two students to present to the class the story of **"A single flower or a cluster?"**
- Lead a discussion highlighting the following points.

  - We can see single flowers in some plants. (Shoeflower, Catharanthes, Muntingia)
  - In some plants they occur as clusters.
  - They are known as inflorescences.
  - The sun flower or anthurium flower are not single flowers, they are inflorescences.
  - Learning about flowers which make the world beautiful is an intersting experience.

(15 min)

Step 5.3.2 :
- Group the class according to the exploration instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.3.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Inflorescences could be classified as racemose or cymose
- In addition there are other inflorescences.
- Further details of inflorescences could be obtained from the article **"Flowers dancing in the breeze"**

(45 min)

Assessment and evaluation criteria :

- Categorizes inflorescences according to the arrangement of flowers in the axis.
- Quotes suitable examples to show the diversity of inflorescences.
- Selects appropriate criteria to classify inflorescences in the environment.
- Enjoys the beautyof nature a as scientist.
- Engages actively in group work.

Annex 5.3.1

A single flower or a cluster?

Piumi ran towards her as Sapumali entered from the gate.
"Sapumali akka how good of you to come?
Tomorrow I have to make a presentation in the school, about the floral parts.
Can you please help me?"
"Yes, bring a flower along with a blade.".
Sapumali sat in the verandah. Piumi kept the blade on the T-poy and went to the garden to bring a flower.
"Here Sapumali Akka, I brought a very big flower, it's a sunflower".
Piumi held the flower with the long stalk and showed it.
Sapumali laughed.
"It is not a flower. It is a cluster of flowers."
Pumi couldn't help laughing.
"Do you see a bunch of flowers on this stalk? "
Piumi started to laugh again.
"Piumi Nangi as you look at it you see as if there is only a single flower on the stalk. But if you examine it scientifically, you will realize that its an inflorescence."
Sapumali took the flower.
These bigger petals in the outer ring are called **ray** florets and the small ones in the mioddle are called **disc** florets.

Piumi slowly pulled out a ray floret and a disc floret.
"Yes, indeed. This is a cluster of flowers."said to her self.
"Then Sapumali Akka, flowers like Zinnias, Barbaton daisies, Lantana which are borne on a single stalk are not single flowers after all?"
"Exactly. Flowers of Anthurium, Coconut, Banana are also borne as clusters as well."

"Is it so, Sapumali Akka? Is Anthurium also a kind of cluster?"
Sapumali smiled.
"Piumi nangi, let us do a scientific investigation on inflorescences. It would really be a fantastic experience for you..."
Sapumali picked up a shoe flower, to teach Piumi about parts of a flower.
But Piumi picked up a bright yellow Kelanithissa(කැලණිතිස්ස) cluster dancing gracefully in the wind.

Annex 5.3.2

Instructions for group exploration

A single flower or a cluster?

- Your group is provided with a set of single flowers / clusters of flowers.
  - First group - 1st set - Single flowers and clusters of flowers (infloresences)
  - Second group - 2nd set - Single flowers and clusters of flowers (infloresences)
- Refer the article "Flowers dancing in the breeze" and gather information about infloresences.
- Sort out the flowers provided into single flowers and infloresences.
- Find out whether there are more of single flowers or inflorescenses in your set of flowers . Discuss whether it is the same in the environment.
- Classify the set of flowers given to you by studying the article "Flowers dancing in the breeze" which provides you with examples of racemose and cymose inflorescences and line diagrams.
- Be ready to present your findings innovatively.

Annex 5.3.3

Instructions for teachers

- Pay your attention when making specimen sets that both groups get single flowers and inflorescences and both groups won't get the same flowers.
- Only the following points are expected through student explorations .
  - Differentiate between single flowers and inflorescences.
  - Study types of inflorescences included in the subject content.

Balsam (කුඩාළු)

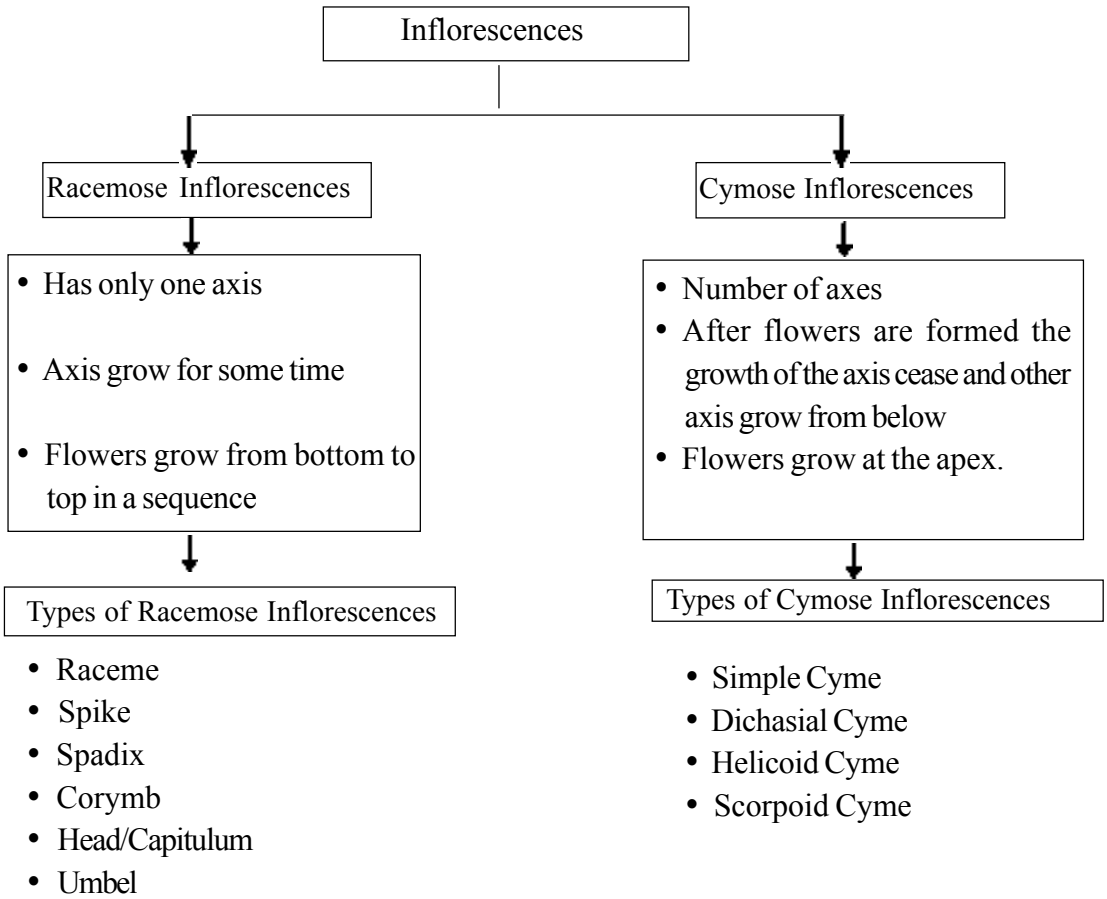
Kothala (කොතල)

Bola idda (බෝල ඉද්ද)

Rose

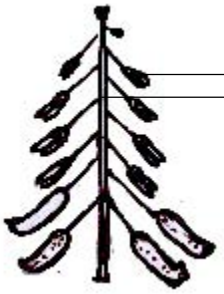
Muntingia - Jam

Katarolu කටරොළු



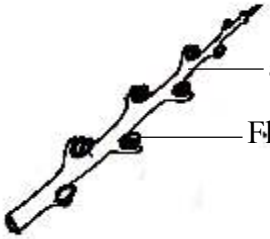
Racemose inflorescences

(i) Raceme



Examples - Moneramal (මොනර මල), Raddish, Andanahiriya (අඬනහිරියා), Orchid

(ii) Spike

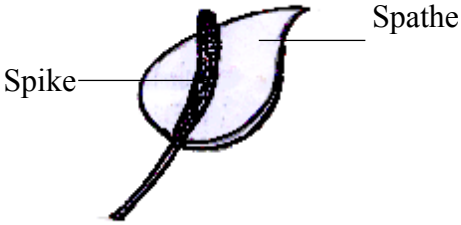


Rila walga
රිලා වල්ග

Balunaguta
බලු නඟුට

Examples - Thampala (තම්පලා), Karal heba (කරල් හැබ), Kuppamenia (කුප්පමේනියා), Balunaguta (බලු නඟුට), Rila walga (රිලා වල්ග)

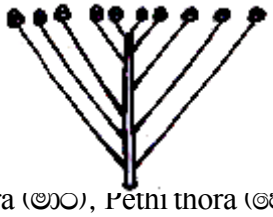
(iii) Spadix

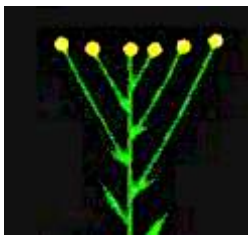


Examples - Habarala (හබරල), Gahala (ගහල), Anthurium

Anthurium

(iv) Corymb

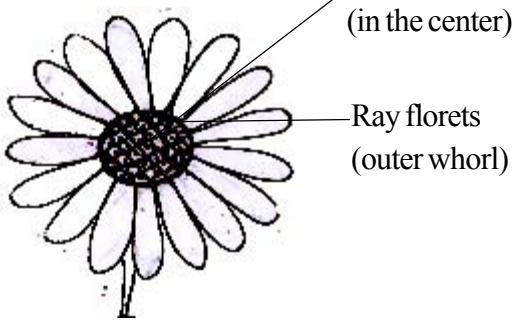




Examples - Mara (මාර), Pethi thora (පෙති තෝර)

Mei mara (මැයි මාර)

(v) Head/Capitulum (sessile)

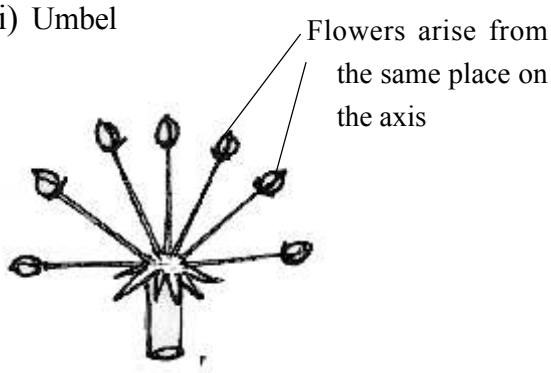



Atapethiya
අටපෙතියා


Sunflower

Examples - Sunflower, Zinnia, Tridax, Monarakudumbiya(මොනරකුඩුම්බිය), Daspethiya (දාස්පෙතියා) , Atapethiya (අටපෙතියා)

(vi) Umbel




Onion flowers

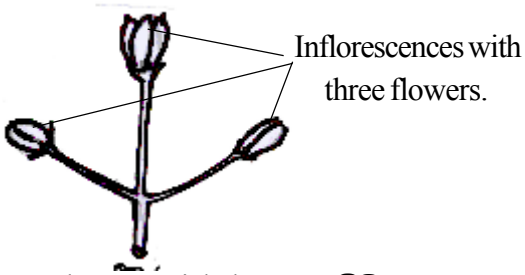
Examples - Wal loonu - වල්ලූනු, Onions, Corriander, Centella(ගොටුකොළ), Tholabo තොලබෝ, Wara (වරා)

Mature flowers are at the periphery and young flowers are at the centre.


Getapichcha (ගැට පිච්ච)

Dichasial inflorescences

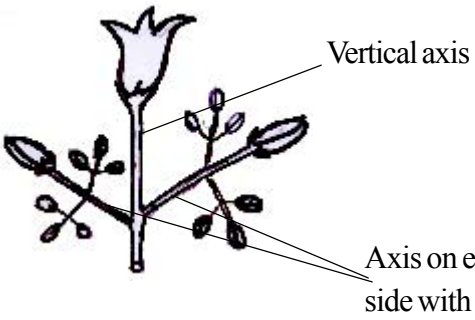
(i) Simple cyme



Example - Getapichcha (ගැට පිච්ච)


Jasmine

(ii) Dichasial cyme

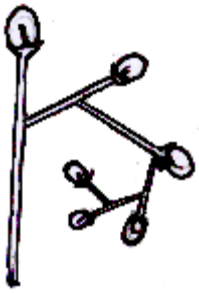



Bougainvillea


Kaneru (කනේරු)

Example - Girithilla (ගිරිතිල්ලා), Bimthamburu (බිම් තඹුරු) Kaneru (කනේරු), Bougainvillea

(iii) Helicoid cyme

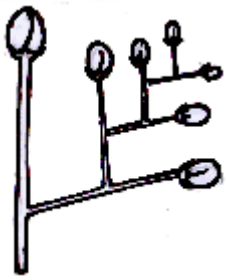


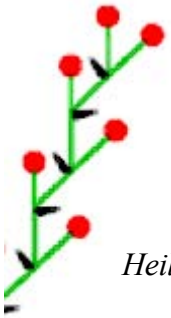

Hamelia (හැමිලියා)


Heiliotropium amplexicaule

Example - Bladderwort, Thibbotu (තිබ්බටු), Hamelia (හැමිලියා)

(iv) Scorpoid cyme




Heiliotropium

Example - *Heiliotropium*

Competency 5.0 : Investigates the diversity of plants.

Competency level 5.4 : **Analyses the structure of fruits using scientific definitions.**
Activity 5.4 : Fruits growing on the tree - not a burden to the tree.
Time : 120 min.
Quality inputs :
- The verse given in annex 5.4.1
- Four copies of exploration instructions in annex 5.4.2
- The common table arranged according to instructions in annex 5.4.3
- Four copies of the article 'Fruits growing on the tree - not a burden to the tree.' given in annex 5.4.4

Teaching learning process :

Step 5.4.1 :
- Introduce the verse to the class.
- Lead a discussion highlighting the following points.

  - There is a diversity of fruits in plants which develop from flowers.
  - Studying the diversity of fruits is an interseting experience.

(15 min)

Step 5.4.2 :
- Group the class according to the exploration instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.4.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- The fruits could be classified as simple, aggregate and composite.
- More information could be explored by referring to the article "Fruits of the tree- not a burden to the tree."

(45 min)

Assesment and evaluation criteria :

- Classifies fruits as simple, aggregate and composite fruits.
- Illustrates the characters of types of fruits, highlighting their identity.
- Makes predictions on a fruit formed from an inflorescence.
- Be aware about the environment.
- Conducts an in depth exploration on nature.

Annex 5.4.1

Do you know a single flower
That creates a single fruit?
Do you know a lot of flowers
That together create one fruit?

Do you know a single flower
That creates a lot of fruits?
Wouldn't you like to find out about
All these amazing truths?

(Hasika Dilhani Jayasekera)

Annex 5.4.2

Instructions for group exploration

Fruits growing on the tree - not a burden to the tree

- Focus your attention to the type of fruit your group is given.
  - First group - Simple dry fruits
  - Second group - Simple fleshy fruits
  - Third group - Aggregate fruits
  - Fourth group - Composite fruits
- Study the article 'Fruits growing on the tree - not a burden to the tree.'
- Find out what criteria could be used to distinguish the fruits assigned to your group.
- Sort out the pictures and descriptions relevant to the type of fruits assigned to you.
- Discuss whether there is a relationship between the flower/inflorescence and the fruit/bunch
- Observe the twenty fruits placed on the common table and prepare a report indicating whether each of those fruits could be or could not be included in the type assigned to you.
- Be ready to present your findings innovatively.

Annex 5.4.3

Instructions to teachers

- Prepare a common table with a set of flower/inflorescence to include at least one from each type of fruit as given in Annex 5.4.4.
- In addition direct the students before hand to bring other types of fruits.
- (It is expected only to distinguish fruits externally as simple/aggregate/composite types.)

Annex 5.4.4

Fruits growing on the tree - not a burden to the tree

Manju nanda started to explain about fruits.
"My dear children there are many types of fruits. It is a bit difficult to classify them. But we classify them using several criteria. Let us see what the criteria are".

(i) Simple fruits - If a single flower gives rise to a single fruit it is called a simple fruit. There are two types of simple fruits.

(a) Simple dry fruits - If a simple fruit at the time of dispersal of seeds is in a dry state it is called a dry fruit.
(b) Simple fleshy fruits - If a simple fruit is fiberous or fleshy, we call it a fleshy fruit.

Now let us talk about aggregate fruits and composite fruits.
(ii) Aggregate fruits - If more than one fruit is formed from a single flower we call it an aggregate fruit.
(iii) Composite fruits - If a large number of flowers, an entire inflorescence forms a single fruit we call it as a composite fruit.

Then Manju nanda showed an apple.
Which part of the flower is this apple fruit?

In apple and pears, we eat the fleshy receptacle. It is the receptacle that has become fleshy, big and turned in to a fruit.

In coconut we eat the endosperm. What we eat in a growing seedling is the cotyledon.

In Jak fruit what we eat as seeds are cotyledons. The part that we eat is a structure formed out of perianth (un-adapted petals and sepals). Likewise, the part of fruit that we consume as food differs accordingly.

Types of fruits			
Simple fruits		Aggregate fruits	Composite fruits
Dry fruits	Fleshy fruits		
Rubber	Coconut	Plumeria (අරලිය)	Pineapple
Beans	Mango	Idda (ඉද්ද)	Jak
Balsam	Tomato	Godakaduru (ගොඩ කඳුරු)	Bread fruit
Green Gram	Brinjals	Nava (නාවා)	Mulberry
Gingelly	Pears	Strawberry	Bo (බෝ ඇහැටු)
Paddy	Apple	Mustard	Banyan
Kurakkan	Kitul		අත්තික්කා
Coriander			
Castor			
Mimosa			

Competency 5.0 : Investigates the diversity of plants.

Competency level 5.5 : Investigates on the adaptations of fruits and seeds for wide dispersal of plants.

Activity 5.5 : "Trees sessile - Seeds all around".

Time : 120 min

Quality inputs :
- The speech by **"Association of Green Producers of the World"** in annex 5.5.1
- Three copies of instructions for exploration in annex 5.5.2.
- Three work stations prepared according to instructions for teachers given in annex 5.5.3.
- Three copies of the article **"Trees sessile - Seeds all around"** in annex 5.5.4.

Teaching learning process :

Step 5.5.1 :
- Introduce the speech by the **"Association of Green Producers of the World"**
- Lead a discussion highlighting the following.
  - Plants lead a stationary life, but they are spread by dispersal of fruits and seeds.
  - Plants adapt various methods for dispersal.

(15 min)

Step 5.5.2 :
- Group the class according to the exploration instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.5.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Most plants spread by means of seeds or fruits with seeds.
- The spread of these fruits or seeds is by means of wind, water, animals or explosions.
- By referring to article "Tree is in here - Seeds are every where" it is possible to gain more information about this.

(45 min)

Assesment and evaluation criteria :

- Explains methods by which fruits and seeds are dispersed.
- Highlights adaptations of seeds and fruits according to the method of their dispersal.
- Sorts out fruits and seeds according to the method of their dispersal.
- Discovers the wonders of nature.
- Engages in conservation of the environment.

Annex 5.5.1

Association of Green Producers of the World

The Veera tree rose up piercing the forest canopy.
Listen all of you. It is necessary to prepare a report on the problems faced by the producers of Sri Lanka, before going to the International Conference of Association of Green Producers of the World.

That is why I called this session. The theme of this session is the issues related to the dispersal of our seeds.
Before we begin you could present any common issues about soil, air, water, space and manure etc.

There was a pin-drop silence in the audience. Ultimately the Jak tree spoke up.
"There is no problem for us regarding above factors at all. When water is scarce, trees adopt suitable steps to continue its existence. Eventhough, in the event of a severe drought, plants that are incapable of withstanding may die off. But their population will not get extinct. Therefore, I am very much proud to say that our plant community , that means, the Sri Lankan Producers Association is capable of solving our own problems independently."

The gathering gave a thunderous applause. The mild breeze carried the music and rustle all over the country. The Veera tree wore a proud smile.
"Good, lets get to the topic. Any problems regarding the dispersal of seeds."
There was a deep silence. The Veera tree spoke up again.
"Jak tree, can you explain the reasons for this silence?"
"Yes. My seeds are dispersed throughout the country. People and animals have taken over that job, because the services I render to satisfy their hunger is immense."
Plants like Mango, Rambuttan, Passion fruit too get their seeds dispersed by providing food for animals. You too are doing the same. Isn't it?
There are others like cotton, *Calatropis* and *Vernonia* who disperse with the aid of the

wind.

We have to praise them too. They use a natural resource which is available freely to fulfil their need. There is another group like *Cerbera*, lotus, coconut which disperse their seeds with the help of water. That is their tactic.

There are some other plants likeNagadarana, Karalheba (නාගදරණ, කරල් හැඹ) which employ other means of dispersing their seeds, by clinging on to the animals who roam about. Isn't it really a harmless method?

There are some others who like to disperse their seeds by explosive methods like rubber. Such ones also should be there. Shouldn't they?

Similarly, plants like paddy disperse their seeds very well. But I cannot think of the method by which they disperse themselves. Anyhow they get it done effectively."

Jack smiled proudly.

Veera tree nodded patiently with approval.

"What the Jak tree says is correct. Like all the plants in the world, our plants too have adapted to various methods of dispersal as well.

We have not been second to anyone. We have shown that practically. I would announce this message proudly to the Association of Green Producers of the World.

And as you all know, how can the others bother about our offspring in my mother-land, than myself?"

The cheers from the audience echoed in everybody's heart.

Annex 5.5.2

Instructions for group exploration

'Trees sessile - Seeds all around'.

- Examine the packet of fruits and seeds supplied to you
  - First group : Packet I
  - Second group : Packet II
  - Third group : Packet III
- Classify the seeds and fruits supplied, according to the information gathered by referring the article, 'Trees sessile - Seeds all around'
  - Fruits and seeds dispersed by wind
  - Fruits and seeds dispersed by water
  - Fruits and seeds dispersed by animals
  - Fruits and seeds dispersed by explosive mechanisms
- Record the adaptations shown by the respective fruits and seeds to the method of dispersal.
- Are there any fruits and seeds in your packet which do not show any special adaptation to be dispersed by wind, water, animals or explosive mechanisms ?
- Express your opinions.
- Get ready to present your findings to the class innovatively.

Annex 5.5.3

Instructions to teacher

- Collect the relevant fruits and seeds with the help of children prior to the activity.
- Prepare three packs which include different fruits and seeds that disperse by wind, water, animals, explosive mechanisms and by other indeterminate methods.
- Number the packets and place them in work stations.

Annex 5.5.4

Trees sessile - Seeds all around

If the seeds produced by the mother plant falls in the same place and germinate there is a competition among them for water, space, nutrients and sun light. As a result, a large number of young seedlings may die off. Unlike animals, plants lead a sedentary life. They have to adapt accordingly to disperse their fruits and seeds. For this reason plants produce a large number of seeds during their lifetime.

Main methods of disperal :

- By animals
- By water
- By wind
- By explosive mechanisms

- Dispersal by means of animals
  Plants get the help of animals to disperse their fruits and seeds in various ways.

  - Fruits for food
    Mango, Jambu , Passion fruit, Guava, Palmyrah

Mango

Guava

Cashew

  - By clinging on to the bodies of animals
    Burr, Tigerclaw (නාගදරණ), ඇපල, කරල්හැඹ, නෙරිංචි.

නාගදරණ

In these fruits and seeds there are hooks, spines, hair in order to cling on to the animals.

  - To mislead the animals

Burr

Castor, ඔලිඳ, Madder

Madder

- Dispersal by wind

  These have no value as foods. They are light, dry and have appendages to float in air.
  - Seeds are light without any appendages - Eg. Orchids
  - Sepals are modified as wings - Eg. Hora, Beraliya
  - The seedcoat is drawn as a thin film around the seed. Eg.: Gammalu, Drumstick, Mahogany
    - Tuft of hair attached to the seed - Eg. Calatropis, Tridax
    - Seed is within a tuft of cotton. Eg. Cotton (පුළුන් ගස්)

Hora

Calatropis

Drumstick

ගම්මලු

- Dispersal by water

  Fruits and seeds on the ground are carried away by the water flow and there by gets dispersed. The fruits and seeds of plants which grow close to rivers, canals and sea fall on to the waer and gets carried away by the current and get dispersed. Here we are dealing with fruits and seeds which are specially modified to disperse by water. These have modifications to float in water.
  - In lotus the peduncle has air cavities which help it to float.
  - In lotus and water lillyl the porous seed cover helps it to float.
  - The fibrous covering of fruit in *Cerbera* and coconut, helps to float on water.

Fruit of Lotus

Coconut

Diyamidella (දිය මිදෙල්ල)

Kaduru (කදුරු)

- Dispersal by explosiive mechanisms
  Here the fruit splits up or explodes in a definite pattern and cause the seeds to disperse.
  - By splitting up - Ex.: කොඹෝලිල, ඔලිඳ, මදටිය
  - By explosion - Ex. Rubber, Balsam, Beling

R

- Some special features about fruits and seeds dispersal.
  - The dispersal of fruits and seeds of crop plants have gained the influence of man which is dominant over the natural factors.
    Eg. paddy, rubber, tea
  - Some fruits and seeds are dispersed by more than one method of natural dispersal.
    Eg.: Arecanut, Terminalia (කොට්ටම්බා)
  - Some plants do not bear fruits and seeds, they are dispersed by vegetative methods.
    Eg.: shoe flower, *Manihot*
  - Eventhough in some plants bear fruits and seeds, they do not germinate.
    Eg.: pineapple, plantain
  - In case of some fruits and seeds it is not possible to definitely state the method of dispersal by their adaptations.

Competency 5.0 : Investigates the diversity of plants.

Competency level 5.6 : Uses the diversity of life-time of plants to fulfill day-to-day pursuits.
Activity 5.6 : Diverse plants - diverse lifespan.
Time : 120 min
Quality inputs :
- Verse **"Lifespan of a plant..."** given in annex 5.6.1
- Three copies of exploration instructions contained in annex 5.6.2
- Three copies of the article **"Diverse plants - Diverse life time"** in annex 5.6.3

Teaching learning process :

Step 5.6.1 :
- Get two students to present the verse **"Lifespan of a plant..."** to the class.
- Lead a discussion to highlight the following points.

  - Paddy plant completes the entire life cycle within one year after bearing fruits.
  - Mirabilis plant completes the entire life cycle within two years after bearing fruits.
  - Mango tree live for a number of years bearing fruits.
  - The lifespan of plants vary accodingly.
  - We have different uses from plants having different lifespan.

(15 min)

Step 5.6.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.6.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, high-lighting the following points.

- Plants which complete its life cycle within an year or less are called annual plants.
- Plants which complete its life cycle within two years are called biannuals.
- If the plants that live for a number of years bearing fruits are called perennial plants.
- By reference to the article "Diverse plants - Diverse lifespan " it is possible to get examples for the above plants and proceed with the scientific exploration.

(45 min)

Assesment and evaluation criteria:

- Classifies plants according to their lifespan.
- Gives examples to show the changes that take place in the lifespan of plants.
- Exhibits skills in using annual, biannual and perinnial plants for the development of mankind.
- Uses environmental resources effectively.
- Works in an exploratory manner.

Annex 5.6.1

"Life of a plant..."

The small paddy plant
Dies in contentment
After bearing
The golden crop -
The product of
Its three month's lifespan .....

The lovely Mirabilis,
Wearing garlands
Of brilliant red flowers
Dances in the wind
For two years
Before its final sleep .....

The mighty mango tree
Has now been present
For sixty long years.....
But look! It still grows
And bears fruit
Each year .....

All these.....
Though having
Different lifespans
Would neve leave Earth
For their futrue generation
Would always remain
If their duty is done!
(Hasika Dilhani Jayasekera)

Annex 5.6.2

Instructions for group exploration

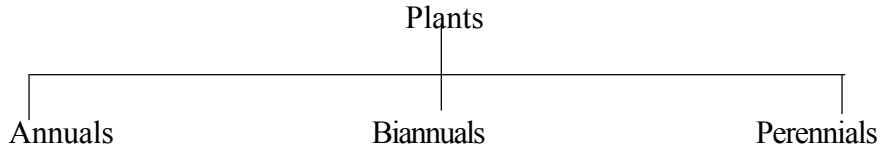
Diverse plants - diverse lifespans

- Focus your attention to the group of plants assigned to your group
  - First group - Annual plants
  - Second group - Biannual plants
  - Third group -Perennial plants
- Refer the article **"Diverse plants - diverse lifespans"**, and list out as many plants as possible which suites the theme.
- Discuss how does the plants assigned to your group differ from the plants in the other groups.
- Find instances how plants assigned to your group are important/harmful to our development.
- Find out whether the differences in lifespan of a plant is productive to us as well as to the plant.
- Be prepared to present your findings innovatively.

Annex 5.6.3

Diverse plants - Diverse life span

Depending on the life span of plants they could be divided into three groups.



Annual plants

The lifespan of these plants ends within a year or less (one season). Some annual plants produce flowers and bear fruits once in a lifetime and end the lifespan. In paddy cultivation the reaping of harvest many times as yala, maha is advantageous but the growth of weeds as annual plants which are difficult to eradicate is adisadvantage. Some annual plants produce fruits many times a year and end the lifespan.

Examples for annual plants :- Maize, Kurakkan, Monarakudumbiya (මොනරකුඩුම්බිය), Gingelly, Raddish, Ladies fingers, Nokhol,Cereals,

Biannual plants

These plants take two years (or two growing seasons) to complete their life cycle. During the first year the plant grows and in the second year form flowers, bear fruits and ultimately die. It is advantageous because crops and other useful things could be obtained for two years. It is disadvantages as weeds.

Examples :- Mirabilis හෙන්දිරික්කා, Karalheba කරල් හැබ, Elephantopus. Chilles, Brinjals, wild parsley (වල් පාස්ලි)

Perennial plants

These plants bear fruits once or many times a year and live for many years. They are called perennial plants. These plants are advantageous because it is possible to reap benefits for many years. These plants are very big, as a result the plants growing underneath receive little sunlight which is a disadvantage.

Examples are Durion දූරියන්, Drumsticks, Bread fruit, Jak, Pomegrenate, Coconut and all the tree species.

Another word about trees

Our granaries get filled up in each and every time when a paddy plant produces seeds and die off. Not only man but also other animals too satisfy their hunger. A large number of plants like vegetables grow and die off after providing nutrition to us for two whole years.

During all these life cycles earth receive a supply of plant nutrients. This is absorbed by plants and diverse plants grow again and again.

In addition to these very big trees which bear flowers and fruits over and over again and protect animals and the environment.

When plants are not there we are no longer there. This statement could be further modified to say when there is no diversity in plants we too are no longer there.

Competency 6.0 : **Uses generation and transmission of waves and their properties to fulfil day-to-day pursuits.**

Competency level 6.1 : **Uses the behaviour of light to fulfill day-to-day pursuits.**

Activity 6.1 : Behaviour of light.

Time : 120 min

Quality inputs :
- Teachers instructions given in annex 6.1.1
- Three copies of instructions for exploration in Annex 6.1.2
- Three copies of article on **'Behaviour of light'** in annex 6.1.3

Teaching learning process :

Step 6.1.1 :
- Demonstrate the activity using lenses of spectacles according to the instructions.
- Lead a discussion to highlight the following points.
  - 'Eye' is the organ sensitive to light.
  - To treat long sightedness and short sightedness convex and concave lenses are used respectively.
  - Exploring about the behaviour of light is very interesting.

(15 min)

Step 6.1.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 6.1.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Reflection and refraction are two types of behaviour of light.
- It is possible to study more by the article on **"Behaviour of light"**

(45 min)

Assesment and evaluation criteria :

- Explains reflection and refraction of light..
- Reveals the connection between the behaviour of light and the phenomena in the environment.
- Demonstrates various phenomena by adjusting light as per required.
- Uses technical know how to overcome defects.
- Shows more enthusiasm about the environment.

Annex 6.1.1

Instructions for Teacher

(1) To demonstrate the activity of a spectacle.

Screen Lens Candle flame

- Obtain a clear image on the screen by adjusting the lens (L). Tell the students that this is the state of a healthy eye.
- Bring the candle flame closer to the lens (L). The image becomes unclear.
- Get a convex lens of a spectacle and move it between lens (L) and the candle flame until a clear image is seen on the screen.
- Explain that this is a demonstration to correct long sightedness.
- Remove the convex lens of the spectacle and arrange the set up as in a healthy eye.
- Make the image to be blurred by moving the candle away from the lens (L).
- Get a concave lens from a spectacle and move it to and front between the lens (L) and the candle, and obtain a clear image on the screen.
- Discuss this with the students. Explain why those who cannot see far use spectacles with concave lenses.
- This is a demonstration to treat short sightedness.

(II) Preparation of workstations.

- Prepare three workstations keeping the necessary items after studying the activities of the exploration instructions and the article on "behaviour of light" .

Annex 6.1.2

Instructions for group exploration

Behaviour of light.

- Focus your attention to the activity assigned to your group.
  First group : To demonstrate the accuracy of laws of reflection of light.

  Second group : To show the diversity in reflection of parallel, converging and diverging beams of light which falls on a plane mirror.

  Third group : To show the behaviour of a beam of light falling perpendicularly and at an angle across two media.
- Refer to the article, "Behaviour of light".
- Get to the respective workstations and get on with the activity.
- Get ready to present your findings innovatively.

Annex 6.1.3

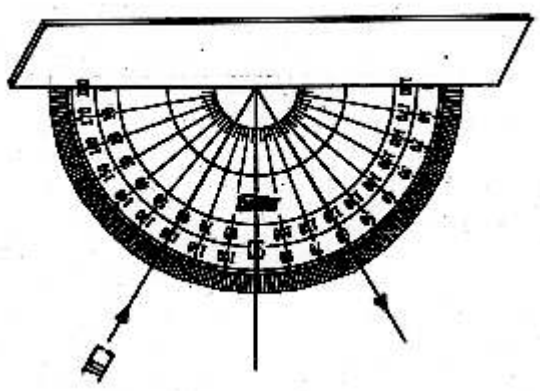
'Behaviour of light'

When light falls on a surface from a source , part of light is absorbed by the surface and also reflected. If the surface is transparent the light is refracted.

Reflection of light If light travelling through a transparent medium falls on a surface and turns back in the same medium is called reflection.

Let us know about reflection of light.

Set up the equipment as shown in the diagram. Use a twine as the normal. Using a laser torch, obtain the reflected beam for various incident beams. Take the readings comparing the angle of incidence and the angle of reflection.

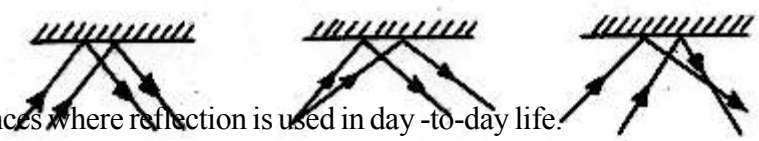


1. The Incident ray, the reflected ray and the normal drawn at the point of incidence are on the same plane.
2. When light is reflected, the angle of incidence and the angle of reflection are equal in magnitude.

Let us know about the diverse types of reflection.

From plane mirrors - light could be reflected.

1. as parallel
2. as diverging
3. as converging



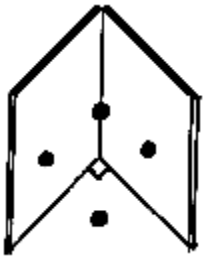
Now let us learn about instances where reflection is used in day -to-day life.

1. Periscope 2. Endoscope (in medical science) 3. Optic fibres

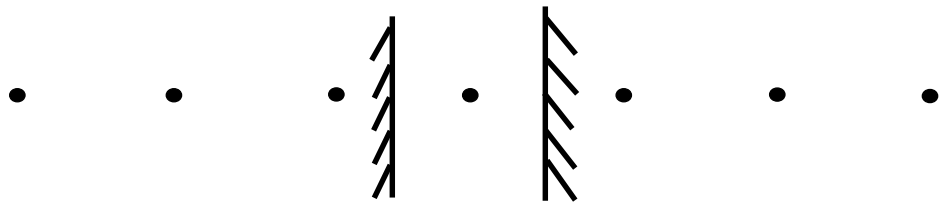
There are other uses of reflection.

1. Kaleidoscope
2. Side mirrors of vehicles
3. To look at your image
4. In jewellery shops.

Let us obtain images by keeping plane mirrors at an angle.



Let us keep plane mirrors in parallel and get images.

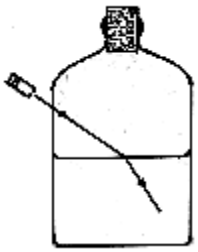


Refraction of light

An inclined ray of light travelling from one transparent medium to another transparent medium, the surface at which the two media contact it either bends towards the normal or away from the normal. This phenomenan is called refraction.

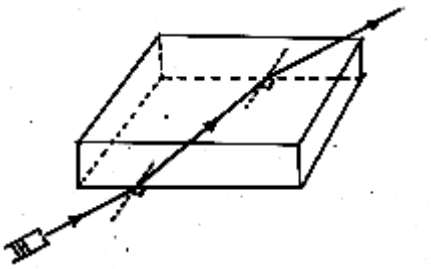
If we consider two transparent media, the medium which has the low particle density is the less denser medium and the one that has a higher particle density is the denser medium. For example if we consider glass and air, glass is the denser medium and air is the less denser medium.
If it is water and air, water is the denser medium and air is the less denser medium.

Let us now find out the behaviour of light travelling through two transparent media.



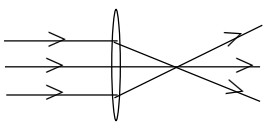
As shown in the diagram a colourless bottle half filled with water is filled with smoke from burning bathies. Make an inclined laser beam of light to fall on to the surface of water and observe the incident ray and the refracted ray.

The path taken by a ray of light passing through a glass block

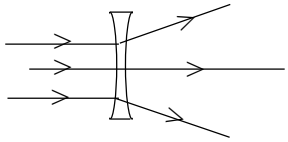


When the ray of light enters the glass block, it bends towards the normal and
when the ray of light passes from the glass to air it bends away from the normal.

When light travelling through lenses after refraction



Convex lens



Concave lens

Light entering a convex lens converge after refraction.
Light entering a concave lens diverge after refraction.
(Lenses shown in the diagrams are longitudinal sections of the lenses)

Let us find out about what happens due to refraction

\• A pencil partialy immersed in water seems to be broken.
- An object in the water seems to be at a lesser depth when seen from above.
- Formation of the rainbow.
- Formation of the mirage.

Simple microsope

When an object placed between a convex lens and focused, a large virtual image is formed. Therefore a convex lens could be considered as a simple microscope.

Let us treat defects in the eye.

The activity of the lens in a healthy eye is given in the diagram

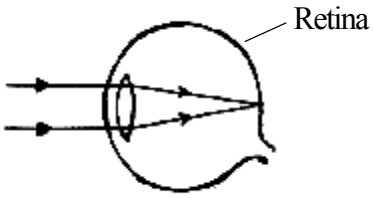


Image of an object at a distance

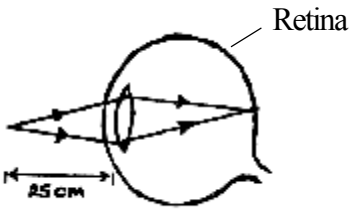
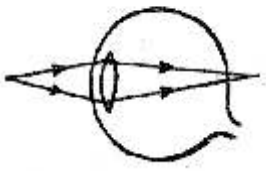
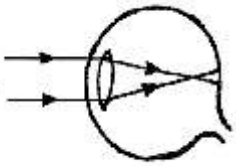


Image of a near object

The activity of the lens in a defective eye

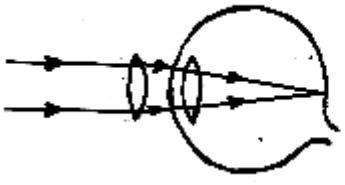


Long sightedness
(Cannot see objects close by)

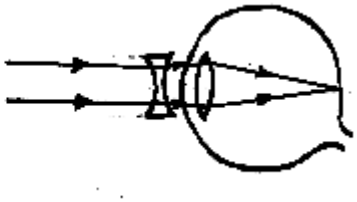


Short sightedness
(Cannot see objects at a distance)

Let us use spectacles to treat eye defects.



A convex lens is used as eye piece



A concave lens to used as eye piece

Convex lens - Centre is thicker than the edge
Concave lens - edge is thicker than the centre.

Competency 6.0 : Uses generation and transmission of waves and their properties to fulfil day-to-day pursuits.

Competency level 6.2 : Uses the behaviour of sound to fulfill day-to-day pursuits.

Activity 6.2 : **Let us enjoy the beauty of sound**

Time : 120 min.

Quality inputs :
- Two copies of exploration instructions given in annex 6.2.1
- Two copies **'Features attributed to sound'** given in annex 6.2.2

Teaching learning process ;

Step 6.2.1 :
- Discuss about the sound generated by a musical instrument as well as scratching of a metal sheet.
- Lead a discussion to highlight the following points.

• Music is charming.
• Scratching a metal sheet is not pleasant.
• All sounds occur due to vibrations.
• Various things occur in and around us which are related to sound.

(15 min)

Step 6.2.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 6.2.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- Sound is a form of energy.
- Reflection, echo, reverberation, resonance are some phenomena related to sound.
- More information about this could be obtained by referring to the article on **'Features attributed to sound'**

(45 min)

Assesment and Evaluation Criteria :

- States phenomena related to sound.
- Highlights diverse nature of phenomena related to sound.
- Explains the differences between musical tunes and noises.
- Makes aware about happenings in nature.
- Explores the background to the foundation of various happenings.

Annex 6.2.1

Instructions for goup explorations

Let us enjoy the beauty of sound

- Your attention is drawn to one of the following features of sound
  - **First group** - reflection of sound, echo and absorption of sound.
  - **Second group** - reverberation, resonance, musical notes and noises
- Find out about the features of sound by referring to the article '**Features attributed to sound**'
- Select the features and make note of them.
- Lead a discussion to highlight any other similar features.
- Get ready to present your findings innovatively.

Annex 6.2.2.

Features attributed to sound

1. Features due to reflection of sound

(a) Megaphone

You may have seen when speakers address small gatherings they use a megaphone. This has a cone of about 30 cm. Sound starts at the apex of the cone and it continues to move forward reflecting from the surfaces of the cone. You also could try out this by using a card board cone.

(b) Speaking tube

During mining a long pipe is used to talk from the surface to underground. Although it is slightly curved, a person who is inside could hear the sound by keepin an ear to that end as a result of the sound striking the wall of the pipe and getting reflected.

(c) Ear truimphet

People who are weak in hearing do not hear when they are spoken to in a low tone. When the ear trumpet is placed in the ear, the sound waves get intensively reflected and the tympanic membrane in the ear of the person who is weak in hearing gets vibrated.

(d) Whispering balcony

In the interior of the dome of St.Pauls' cathedral in London, there is a circular gallery. Words spoken quietly by a person facing towards the wall on one side can be heard distinctly by another person with his ear to the wall on the other side. The sound gets erased off if a screen curtain touches the wall.

(e) Think of an incident where drum beaters are going round a dagoba. The sound of beating could be heard from far off but not from the other side of the dagoba. The reason for this is due to the sound waves deviate and gets reflected.

(f) Sound waves of ultra sonic frequencies are used to find the depth of the sea when sailing ships, to locate shoals of fish by fisherman , information about the treasures at the bottom of the sea. These frequencies are too high to affect the human ear. These waves of ultra sonic frequencies are emitted by machines at the bottom of the ship and the reflected waves too are grasped. The time taken by the waves to reach the bottom and come back is noted. The time taken in relation to the speed of sound waves in sea water is calculated and the depth is determined.

(g) Bats when travelling in the night finds its' way from the reflected ultrasonic sound waves.

(h) In Air ports reflection of ultrasonic sound waves are used in radar equipments.

2. Features due to reverberation of sound

In some lecture halls (Eg. in Churches) the singing of hymns, the sound keeps on for some-time. This is an example for reverberation. Sometimes the voice of the speaker becomes unclear due to this..

At present technology used in construction of lecture halls are carried out in such a way reveberation is made use of in keeping the voice to stay for some time in the hall, without disturbances to the listner.

3. Features due to echo

Sometimes when we stand in front of a barrier and emit a sound, we hear the sound again. This is called the echo. (In this case the source of sound and the barrier must be at least 17 metres apart)
Echo is also a reflection of sound. For sound to reflect the surface of the barrier should be hard and smooth.

Among big rocks, rooms without any furniture, inside dungeons usually we hear echo.

4. Features due to absorption of sound

Places which provide services, like lecture halls, audio labs, film halls are constructed in such a way to allow the listner to grasp the sound without any obstruction. Because of this they have methods to avoid reflection of sound and methods to absorb sound.

Open windows are a good absorber of sound. Sometimes the walls and the floor are lined with sound absorbing substances to prevent echoing. Some of these methods are smooth carpets, coir mats, hanging screens, leaving a space in between walls, having sound absorbing substances inside cavities of walls.

5. Features due to resonance

Sometimes when sound waves are emitted from a sound emanating body, some other bodies too vibrate in accordance.This is resonance.

An example for such an incident is the vibration of glass windows when a train moves along a railway line close by.

Making use of resonance it is possible to break a thin sheet.

6. Features due to musical notes and noices

Music is a language of notes. Music is produced when the notes are arranged according to a logical pattern . These are charming.

Distracting noises are produced when rubbing a shoe on the floor, scratching iron, working of machines in a factory.

Competency 7.0 : Discovers the values of marvels in the environment

Competency level 7.1 : Discovers the values of marvels in the world of animals.

Activity 7.1 : **'Look at us - the wonderful animals.'**

Time : 120 min

Quality inputs :
- Story about **"Parental love"** in annex 7.1.1
- Four copies of exploration instructions given in annex 7.1.2.
- Four copies of the article **'Look at us - the wonderful animals.'** given in annex 7.1.3.

Teaching learning process :

Step 7.1.1 :
- Relate the story of Parental love to the class.
- Lead a discussion highlighting the following points.

  - The story on the snakehead(ලෙලි) is a wonderful experience of Dayangani.
  - There are other wonderful animals too.
  - It is amazing to study about them.

(15 min).

Step 7.1.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore, by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 7.1.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

  - There may be a lot of animals with wonderful characteristics.
  - It is interesting to get involved in a scientific exploration about such animals.
  - We will be discussing some of them in detail in the article **'Look at us - the wonderful animals.'**

(45 min)

Assesment and evaluation criteria :

- Explores animals showing interesting characteristics.
- Points out how animals make use of their special characteristics.
- Exhibits skills in conservation of animals.
- Searches about the value of environment.
- Be sensitive to the surroundings.

Annex 7.1.1.

Parental love

Dayangani walked along the bund of the paddy field enquiring on the environment. "The drought is so severe. Water in the paddy field is also getting dried up. If this continues no fish would be left."

Dayangani paused for a moment. There isn't enough water. Only a puddle. The canal beyond has water.

"Ah! What is this creature rolling in the mud? It is a big snakehead!"

Dayangani observed silently. There are many tiny ones around it.

The snakehead opened his big month.... all tiny ones got in to the mouth.

"Did the snakehead swallowed all the tiny ones?"

Dayangi was a bit frightened. Yet she remained where she was.

'Splash'! The snakehead jumped over the bund into the canal. Dayangani was astonished.

The snakehead swam about freely. It opened the mouth widely.

The tiny ones rushed out of the mouth cheerfully.

Dayangani smiled to herself.

"This is fantastic. How did the snakehead knew that there is water in the canal on the other side?

Dayangani turned back.

"The world of animals is full of mysteries. I would love to explore these marvels." She decided.

Annex 7.1.3

'Look at us - the wonderful animals.'

The science teacher came to the class and provided an opportunity to the student groups to present information about wonderful animals.

1. Vampire Bat - Beware! This bat sucks blood.

The first home land of this animal is the American continent. These animals feed on blood of mammals and birds. In the saliva of vampire bat there is Draculin which prevents blood from clotting. It does not suck blood. What he does is bite the sleeping prey and lick the blood that flows out.

The nose of this bat is cone shaped, and with the help of the heat sensitive organs in it, the bat is able to find the blood vessels in the victim. In the brain of the vampire bat there are sensitive cells with which it is able to hear the sound of breathing of the victim. Movement is by flying, running and walking.

2. The giant among pets...

Giant panda

His native country is China. A popular charismatic animal. An infant panda is about 150g. Male panda is bigger than the female . A female panda is about 100 kg and its length is about 1.5m. There are black patches around the eyes, ears and the body. Other areas are white. Lives around snow capped mountains. Live on land and on trees. Main food is tender shoots of bambo trees. They exchange messages through making noises, secreting a scent, scratching trees and by urinating.

These animals are in danger of extinction due to lack of space to live, drop in birth rate, not getting used to any other food except bamboo shoots.

3. One who received an honourable name

I am proud to introduce my self as ....

Bufo kotagamii

This species is endemic to Sri lanka, lives both on land and in water. It is dark brown or orange. The natural habitat is tropical rain forests, (Singaraja Forest) lowland forests, montane forests and places associated with rivers. There are dark brown knots like structures throughout the skin. In between eyes are three light coloured lines. The male animal is 33 mm - 40mm in length. The female animal is 55mm - 63mm, nocturnal. Naming of this animal by the name of an eminent zoologist, Professor Sarath Kotagama is in itself is of special significance. Lack of space to live is a danger to their existence.

4. Come, my children...come with Papa. I'll carry you.

Sea horse

This is a type of fish. It is seen in the Pacific ocean stretching from north to south America. It is living among water plants, Corals and in places where cover is available. Length of the body is between 2.5c.m. and 30 c.m. It absorbs food from an elongated nose. When it swims it keeps the body in erect posture, eventhough it is a fish.

It's food is small prawns and flagellates. The female sea horse lay eggs in a sack like structure in the male sea horse. The male sea horse protects the eggs and allow the small ones to pass into the sea water.

5. Poison arrow frog

Poison arrow frogs live in tropical rain forests in South America. Their home land is the Amazon forest. It is considered as the most dangerous amphibian in the world. It is about 5 cm in size. In the skin there are yellow, black, green and blue coloured stripes. The poison glands situated all over the skin emit a poison which kills or cripples the enemy. It is said that 1g of poison is capable of killing about one hundred thousand people and that the red indians used the poison in their arrow heads.

6. The architect of a birds' palace!
Weaver bird

Its' home land is Africa, Asia and Australian continents. Body made up of red, yellow and black colours. Build the nest with fine leaf fibres, types of grasses and pieces of sticks. The nest take the shape of an inverted flask. The entrance to the nest is from below or from sides. The female lay eggs in the rounded upper part of the nest. After the female bird lay the eggs and starts hatching, the male bird finish the rest of the nest. The young ones are provided with small insects, which is their food through the holes in the upper part of the nest. It is said that pieces of clay laid inside the nest helps to keep the in vertical position .

7. Look at my size, you tiny fish.

Mekong cat fish

Home land is Mekong plateau. Lives in reservoirs of South East Asian countries. This is the largest fresh water fish. Powerful fish which is not ferocious. Body weight is about 150 kg - 200 kg. Length is about 3m. The teeth of this fish fall after the first two years and only the gum stays on. Uncontrolled hunting and degraded quality of water are two factors which affects its existence. The name is entered in the Red Data Book. International trading of this fish is also prohibited.

8. Cut me ..... I'll become two !

Planaria

Kind of flat worm. There are salt water species, as well as fresh water species. Live on plants in places where humidity is high. Herbivorous animal about 3 to 12 mm in length. The anterior part of the body is sensitive to light. Body has simple appendages. It is as flat as a piece of paper. Eggs develop in the body and grow in a cyst. The fully developed adults come out of the egg. This animal is bisexual having both male and female reproductive systems. If any part of the body is cut each part grows into a new animal. It has the capacity to regenerate.

Competency 8.0 : Exhibits the preparedness in management of natural disasters and associated risks.

Competency level 8.1 : Contributes to minimize the risks associated with drought.

Activity 8.1 : Ferocity of a drought

Time ; 120 min

Quality inputs :
- Verse **'Welcome dear river'** in Annex 8.1.1
- Two copies of exploration instructions in Annex 8.1.2
- Two copies of article **'Scars of drought'** in annex 8.1.3

Teaching learning process :

Step 8.1.1 :
- Allow the students to listen to the Verse **'Welcome dear river'**
- Lead a discussion to highlight the following points.

• Information about a drought of long duration is depicted from the verse..
• In a long lasting drought, trees and animals die.
• As a precautionary measure, a river could be diverted to the dry area.

(15 min)

Step 8.1.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 8.1.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

• Droughts can be scientifically explained.
• It is not possible to avoid droughts by the intervention of man.
• It is possible to avoid, difficult times during droughts to some extent by not destroying the forest cover.

- More information about droughts could be obtained by the article **"Remains of bodies due to drought"**

(45 min)

Assesment and Evaluation criteria :

- Gives reasons for the occurence of short term and long term droughts.
- Explains scientifically how droughts are caused.
- Demonstrates skills as to how to minimize harmful effects of a drought.
- Faces challenges intelligently .
- Acts with unity

Annex 8.1.1

Welcome dear river ...

Welcome dear river
Do glide amongst us
We've awaited you so long
Our burnt up arms
Now flower and sway
To the water's lively song!

Oh forget the days
When you looked away
From our earnest plea
We bear no wrath
For now you've turned back
Giving life to the dying tree!

Come, paint with green
The scorched barren lands
That have been drought's prey
Now that you're here
A thousand droughts
Won't take the colour away!

(Hasika Dilhani Jayasekera)

Annex 8.1.2

Instructions for group exploration

Ferocity of a drought

- Draw your attention to one of the following situations about drought.
  - **First group -** droughts of short duration
  - **Second group -** droughts of long duration
- Arrange appropriate data for the situations scientifically.
- Discuss how you would face the following situations according to the theme assigned to you.
  - Before drought
  - During the drought (facing the drought)
  - After the drought
- Get ready to present your findings to the class innovatively.

Annex 8.1.3

Scars of drought

Droughts of short duration

A climatic condition with no rain and dry climate is considered as a drought. Short term droughts could be considered as a recurring phenomena. Short term droughts could last for a few days or months.

Droughts occur frequently across the Earth. A difference could be seen from place to place and region to region.

Mannar, Kurunegala, Hambantota and athe North Central province are considered as regions where droughts occur frequently in Sri Lanka.

Two instances of droughts in Sri Lanka

Year	-2001
Duration	-June, July, August
Affected - areas	• Hambantota • Moneragala • Matara • Kurunegala • Anuradhapura

Year	-2004
Duration	-March, April
Period	- About two months
Affected areas	- • Kurunegala • Anuradhapura

Droughts in recent history

In our country when monthly rainfall, falls below 50 mm a dry climate prevails. This is only for

a short period. During that period most annual and biennial plants die.

Rise in temperature of the environment has a direct effect on drought. Then low pressure areas develop in the atmosphere and high winds occur and as a result evaporation of water increase. Water levels in the reservoirs decrease.

During periods of drought the animals coming to the natural reservoirs in the forests increase. Grass get dried up and environment is filled with dust.

Management of drought conditions

As a result of the advances in satellite technology, there is an increase in opportunity to get data about climate. The Meteorological department analyse various data and inform about dry climatic conditions.

We could also get information about drought from the behaviour of animals. The sound (නියං කොබෙයියන් කෑගැසීම) and the flight of certain birds (වැහිලිහිණියන්) high in the sky, winged termites coming out of anthills are some of these. During this period the moon is clearly visible. By taking all these into consideration it is possible to store water, use water sparingly and cultivate short term crops.

During drought conditions, based on climatic information and data facts about what could happen in the future should be considered. It is very important to find out whether there is a danger of the drought getting worse or not. Even during the duration of drought, use of water sparingly, using hydro power intelligently, providing welfare activities to the drought affected people, forest fires should be taken into consideration.

Collecting rain water

After the drought an awareness about the diseases caused by drinking water and directing affected patients to obtain necessary treatment is very important.

Long term droughts

This is a long term climatic condition. During this there are long periods without rain. Perennial plants too die off. Big reservoirs dry up. This is as a result of high environmental temperature and high powered winds causing the water to evaporate.

Some animals in the forest may die due to lack of water.

* *

*

Sri Lanka is a small country. As the sea is all around it, the pattern of winds is responsible in getting rain. We have South-West monsoon from May to September and North-East monsoon from November to February. As a result, long term drought is very rare. Due to this reason, definition of drought and the classification of droughts into short term and long term may not be meaningful.

Competency 8.0 : Exhibits the preparedness in management of natural disasters and associated risks.

Competency 8.2 : Contributes to minimize disaster conditions associated with Tsunami.

Activity 8.2 : Let us not be victims to the black waves.

Time : 120 min

Quality Inputs :
- **'Preparedness to risk'** in annex 8.2.1.
- Three copies of exploration instructions in annex 8.2.2.
- Three copies of article. 'Let us not be victims to the black waves' in annex 8.2.3.

Teaching learning process :

Step 8.2.1. :
- Get a student to present the story **'Preparedness to risk'**
- Lead a discussion to highlight the following points.

  - Krakatoa island was destroyed as a result of a volcanic eruption.
  - Sometimes we may also face such a problem in future.
  - Managing the situations before, during and after a volcanic eruption should be done scientifically.
  - There is a possibillity of a tsunami situation occuring as a result of a volcanic eruption as in Krakatoa islands.

(15 min)

Step 5.6.2 :
- Group the class according to the **exploration** instructions.
- Guide them to explore,by providing instruction sheets.
- Direct the students to observe the activities of the other groups as well.
- Give pre and post feed back.
- Encourage the students to give an innovative presentation.

(60 min)

Step 5.6.3 :
- Get one group to present their findings to the class.
- Secondly give that group an opportunity to cover the gaps in their presentation.
- Then allow the other groups to give any constructive proposals.
- Next present teacher's elaboration to cover the missing points.
- After giving an opportunity to all the groups,summarize, highlighting the following points.

- The main reason for the tsunami devestation on 26th December 2004 was due to the fact that the Sri Lankans did not have sufficient scientific understanding about its' background.
- We should know as to how we should act with scientific thinking, before a tsunami, during a tsunami, and after a tsunami.
- You would be able to learn more about the scientific background of a tusunami by referring to the article 'Let us not be victims to the black waves.'

(45 min)

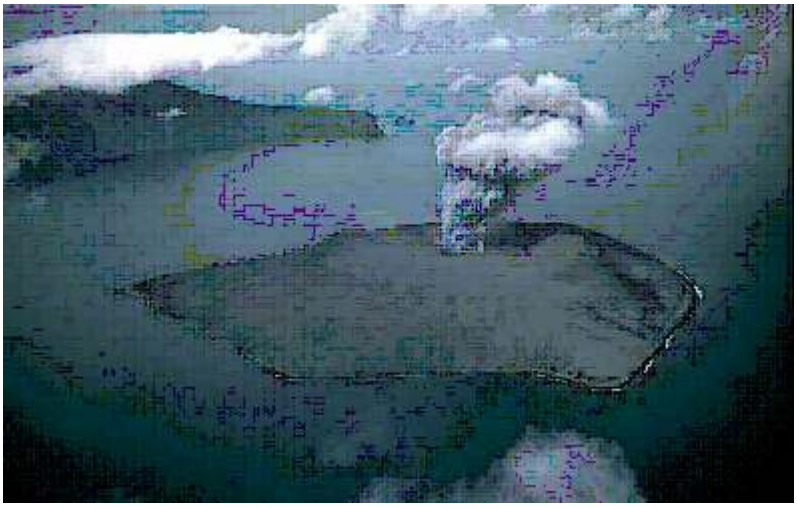
Assesment and evaluation criteria :

- States when a tsunami would occur.
- Reveals the scientific background of a tsunami.
- Demonstrates the skills of minimizing the damages caused by a tsunami.
- Apprehends unexpected situations thoughtfully.
- Acts with unity.

Annex 8.2.1

'Preparedness to risk'

When Nishantha Mama was coming, Chirani ran towards him with a book.
"Mama, this story is about the Krakatoa islands. In 1883, there was a huge volcanic



eruption, and it followed by a gigantic tsunami and the island got completely submerged.
"Do you know, that the sound of the explosion was heard about 3200 km. away. Upto 160km, the glass windows of buildings were shattered. Not only that, the dust cloud that originated was stretched upto 27 km in the atmosphere. Its geo-vibration waves

were heard many times around the earth.

'That tsunami must have affected Sri Lanka too, isn't it Nishantha Mama"?
"Yes, Yes.... according to statistics, Arugam bay (Ampara district), and Hambantota were affected. "Close to that island about 36,000 lives were lost"...
Chirani thought for a moment...

"Mama... is there no way of predicting volcanic eruptions?"

"There is. Before a volcanic eruption gases and fumes escape from the crater. Animals leave the area as they feel the vibrations. During a volcanic eruption area around gets heated, escape of light, dust, ash and pieces of stones are shot out. Vibrations are felt and flow of lava are noticed."

"Mama, can't we nullify the destruction by using modern technology?"
"There are various instruments and methods used to detect a volcanic eruption in advance. I'll tell some of those to you"...
There are Seismographs which measure minor earthquakes associated with volcanoes.
By tiltmeters they take recordings about the changes that take place in the gradient of the ground around the volcano.
The air samples around the volcano are analysed and the level of sulphur dioxide is measured.
By the information gathered from these, people are informed about the eruptions.
"Then Mama, do you say that volcanoes are always harmful?"
Lot of harm is done by volcanoes but useful things also do happen. After volcanic eruption, rocks with valuable minerals are left behind. The soil is made fertile by the ash that is given out.
The volcanic steam is used in producing electricity in countries like Italy, Mexico. It is also used in countries like New Zealand and Iceland to heat buildings.

Nishantha Mama, you said that volcanoes cause tsunamies. Shall we find out more information about tsunamies.

Annex 8.2.2

Instructions for group exploration

Let us not be victims to the black waves!

• One of the following themes is assigned to your group, related to tsunami.

- Group One - Origin of a tsunami
- Group Two - The type of waves in a tsunami
- Group Three - Mitigation of damages caused by a tsunami

- Focus your attention to the article **'Let us not be victims to the black waves.'**
- Explain the theme given to you scientifically.
- Be ready to present your findings to the class innovatively.

Annex 8.2.3

Let us not be victims to the black waves

In Japanese language, tsunami means harbour waves. It is caused by one of the following, earthquakes, land slides at the bottom of the sea or volcanic eruptions may result in huge sea waves which are called tsunami. Earthquakes are caused mainly due to the movement of tectonic plates. Earthquakes are mainly responsible for tsunami situations. Similarly a huge meteorite falling or testing of nuclear weapons in the underneath the sea could also cause tsunami situations.

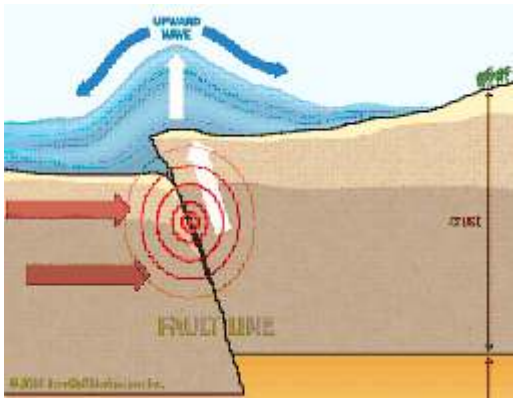
In the earth's crust, there are about twenty tectonic plates. These plates are not joined together. These plates are floating on semi fluid substances. Sri Lanka is situated in the Indo-Australian plate.

During the course of a single year they move 2-20cm relative to each other. These movements are longitudinally, transversely or on top of one another. As a result the plates move away from one another, or come together or push one another.

Due to movement between plates, the sea water gets disturbed. As a result of the gigantic disturbances the water tries to rectify in the face of the earths' gravitational force, a wave is

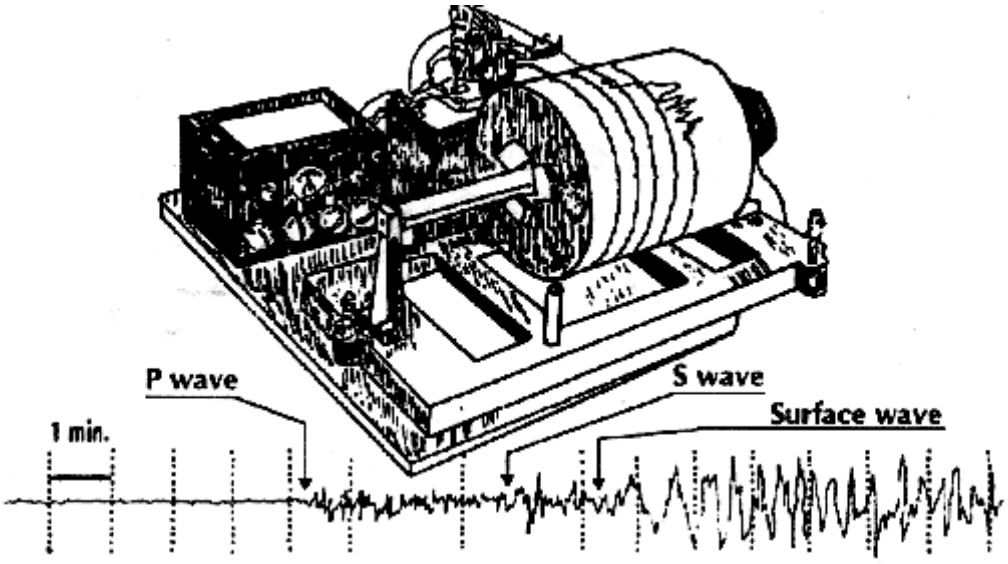
formed at the bottom of the sea.

At the bottom of the sea the length of the wave is about 150km and the height is about 1m which exceeds very rarely. This wave travels at a speed of 800 kmh^{-1}. In normal deep sea, this is not felt by the ships sailing in the deep sea.



The speed of a tsunami depends on the depth of the sea. When it approaches the land the depth decrease, the speed of the tsunami decrease, distance between two waves also decrease as a result part of the energy in the wave is converted to potential energy and the height of the wave increase. When the wave reach the land the height of the wave increase rapidly up to about 40m. As the wave is unable to hold the water it curves forward and break up. A great amount of water enter the land. Because the water has a high speed water enter the land rapidly.

Seismometer



In 1934 Charles Richter invented the Seismometer. This could measure earthquakes and measure the seismic waves and record them. It is a very sensitive instrument. The index of intensity of an earthquake is measured by the Richter scale. The intensity of the earthquake on the 26th December 2004, which caused the tsunami was 9.3 Richter.

If you live in a tsunami vulnerable area

- Construct buildings as far away as possible from the sea.
- Pay attention to pre-tsunami warnings. (Earth quakes, unusual behaviour of animals) sandy shore becomes more visible etc.)
- Pay attention to reports of major earthquakes in shore line regions.
- Construct, high buildings in the coastline.
- Establish pre-tsunami warning systems.

If you are informed about a tsunami.

- Before leaving the area get ready with the following;
  1. Medicines you require regularly
  2. Drinking water
  3. Special things required by infants.
  4. Food stuffs like buiscuts.
  5. A radio working on batteries.
  6. Reading books for children
  7. Important documents and valuables
  8. First aid kit.
  9. Candles/torch/boxes of matches
  10. Clothes
  11. Food for animals
  12. Personal sanitary items.
  13. Excess money

During a tsunami

- During a tsunami, if you see the waves coming, as you cannot over run the waves go to a tall building or a high land.
- Do not try to protect your property.
- Get away from the sea shore, rivers and canals which are open to the sea.
- Do not return to the danger zones until you are fully aware that it is out of danger.
- If you are travelling in a boat, in the sea, get to the deep sea and do not try come to the shore.

After a tsunami

- Get means to provide pure drinking water.
- Pay attention to nutrition and health.
- Get treatments for injuries.
- Take steps to prevent spread of diseases.
- Adjust to personal and mental distortions.
- As soon as possible get adjusted to normal routines.
- Arrange for temporary sheltor.

Assessment and Evaluation

Introduction

"The Transformation Role" of the teacher, launched in the New Millennium, has the creation of a generation of citizens capable of successfully facing the challenges of the future years, as its essence. Hence, you are presented a Student-centered, Competency-Based as well as Activity-Oriented curriculum to help you implement this role effectively.

The present curriculum, implemented in terms of a continuum of exemplar activities developed earlier has, attempted to integrate learning and teaching with assessment and evaluation. The teacher is provided the opportunity of subjecting students to assessment when their groups are involved in Exploration, during the second step of these activities, and to evaluation, when the students are engaged in Explanation and Elaboration, during the third step of the activities. Under assessment, the teacher is expected to move among the students engaged in exploration, observe their tasks at close quarters, provide facilities and guidance to solve their problems in the classroom itself and thereby, bring every student in the class to proximal competency levels. Similarly, the competency levels the students have reached through Exploration should be judged and declared.

The guidance that teachers involved in assessment can provide their students is twofold, i.e., Feedback and Feed-Forward. The task of the teacher, when student weaknesses and inabilities are noticed, is to provide them with feedback in order to help them overcome their learning difficulties and to provide them with feed-forward when their abilities and strengths are identified, in order to help them improve these skills. It is also as important to identify the extent to which the competency levels included in the syllabus have been actualized and for students to be informed of same to ensure continuity of student learning. As such, while teachers are expected to determine, through the evaluation program, the competency levels students have achieved, the teacher should also take action to communicate student progress to students and parents as well as to other relevant parties

Five common criteria have been suggested in order to facilitate assessment and evaluation. While the first three of these criteria are related to the subject content relevant to each competency level, with respect to ability in three subjects taken in order of difficulty. The final two criteria that should be developed based on the learning-teaching process, are two common criteria important in the evaluation of any subject. While the teacher should try to identify the five behavioural changes related to the students while they are working in the classroom, he/she should take action to confirm the development of these behaviours under assessment in order to determine the level of development of these behaviours, under evaluation and inform the students about it. Learning-teaching Evaluation instruments have been prepared and included in this section in order to continue the program on assessment and evaluation at school level, further. The first

task in this regard is to meaningfully group the activities included in the activities continuum. While several varieties of learning-teaching evaluation, based on the subject content related to each group of activities that can help blossom student learning, have been selected, the teacher should take the initiative to take his/her teaching and student learning along these varieties, beyond the timetable and to confirm student learning through regular scrutiny. While the teacher is expected to introduce these instruments to the students before the commencement of the first activity in that group of activities, the teacher is also expected to carry out term-wise assessments while all the activities in that group of activities are implemented within the timetable. Once all the activities in the group of activities have been completed, the students should be provided the opportunity, to present their findings from their exploration as well as to elaborate on them, on a previously determined day. While this elaboration should be implemented in the same way each activity was implemented, the first opportunity for elaboration should be given to the group of students that made the presentation, the second opportunity to the group that formed the audience and the final opportunity should be given to the teacher. When presenting his final review the teacher should make it a point to clarify all unclear areas noticed during Explanation and Elaboration, correct points that were found incorrect, complete those areas found lacking in the presentation and present subject matter that form the basis of learning outcomes while at the same time taking the opportunity to announce the results of the evaluations. Accordingly, while it has to be understood that the teacher should never postpone student assessment to the last, it must not be forgotten that the period where students are engaged in Explanation and Elaboration can be utilized for this purpose. At the stage where Learning-Teaching-Evaluation instruments are introduced initially, the Transaction Role of the teacher comes into focus and at the end of the Learning-Teaching-Assessment activity, the Transmission Role of the teacher is highlighted.

The number of evaluation stages to be completed within the activity continuum of the third part of the Teacher's Instructional Manual and the nature of the questions that can be introduced to term tests as well as final tests under authentic methods of evaluation, in order to make each of these stages of evaluation successful, have been planned. All these innovations will provide the teachers with guidance for further involvement in the teaching task and the student to learn with enthusiasm by enriching the Learning-Teaching process by implementing assessment and evaluation of each activity as well as groups of activities at specific points in time and invigorating the Learning. Teaching Assessment Evaluation process related to examination question based on real life situations.

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Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 01 Instrument 01
Competency level to be coverd : 1.1
Nature of the instrument : Scientific exploration
Aims of the instrument :
- To have an understanding of the occurances in the environment.
- To obtain the skill of following the scientific method.
- To obtain the competency in taking scientific decisions.

Instructions to carryout the instrument :

To the Teacher :
- Divide the class into groups.
- Direct the students groups to select a problem in the environment.
- Example - do mosquito larvae grow in any open vessel containing water.
- Instruct them to come to conclusions following the scientific method.
- Give a suitable opportunity to present their recordings.

To the students :
- Select a suitable problem by a discussion in the group.
- Conduct exploration in the relevant steps.
- Record date methodically.

Evaluation criteria :

Criteria	Names of students									
² Follwoing the steps of the scientific method										
² Setting up a control setup										
² Recording data accurately										
² Presentation										
² Allocation of work in the group										

Enter achievement levels as A, B, C, D

A Very good
B Good
C Ordinary
D Should develop

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 01 instrument 02
Competency level to be coverd : 1.2, 1.4
Nature of the instrument : Impromptu presentation
Aims of the instrument :
- To give the ability to identify laboratory equipments correctly and their proper use.

Instructions to carryout the instrument :

To the Teacher :
- This is an individual activity.
- Keep the laboratory equipments suitable for respective competency levels at random on a common table.
- Label them as 1,2,3 etc.
- Prepare another set of numbered cards to be used as lots.
- Conduct an activity to select a number from the set of cards and identify the instrument and demonstrate its use.

To the students :
- Use the experience you gathered in using laboratory equipment as the basis.
- Draw a lot and identify the respective equipment and demonstrate its use.

Evaluation criteria :

Criteria	Names of students									
• Naming the instrument according to the lot										
• Presenting the use of the instrument										
• Explain the manner in which it is used										
• Demonstrate how it is used										
• Proper presentation										

Enter achievement levels as A, B, C, D
A Very good
B Good
C Ordinary
D Should develop

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 01 instrument 03
Competency level to be coverd : 1.3/2.1,2.2,2.3/3.1, 3.2, 3.3, 3.4
Nature of the instrument : Quiz programme
Aims of the instrument :
- The ability to construct questions which are of quality and validity.
- Development of the skill to ask questions and give answers.
- Development of subject knowledge.

Instructions to carryout the instrument :

To the Teacher :
- Distribute the respective competency levels among the students.
- Get students to construct questions and answers as a group activity.
- Test for their quality and validity.
- Conduct a competition among the groups at an appropriate time.
- Develop suitable rules and regulations.

To the students :
- Divide subject matter among the group and construct questions.
- Think impartially questions constructed suites you and the fellow students.
- Get them approved by the teacher.
- In the questions and answers programme conduct yourself with decipline and patience

Evaluation criteria :

Criteria	Names of students							
• The quality and validity of questions submitted								
• Giving correct answers								
• Observe rules and regulations								
• Companionship								
• Accept victory and defeat indifferently								

Enter achievement levels as A, B, C, D

A Very good
B Good
C Ordinary
D Should develop

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 2, instrument 01

Competency level to be coverd : 4.1, 4.2, 4.4, 4.6, 4.10, 4.11

Nature of the instrument : Practical tests

Aims of the instrument :
- To provide the skill in arranging a correct set up and conducting practical experiments.
- Development of subject knowledge.

Instructions to carryout the instrument :

To the Teacher :
- Prepare work stations, in such a way that the practical experiments in the respective activity plans, are split up into small units which could be carried in a few minutes.
- Change groups after giving a definite time limit.
- Insist that all small groups must rotate through work stations successively to cover all the experiments.

To the students :
- Make sure that all practical experiments must be done.
- Finish your work within the allocated time and arrange them as they were at the begining to be used by the other group.
- Record each experiment.

Evaluation criteria :

Criteria	Names of students											
² Finishing the experiment in the given time.												
² Handling the instruments correctly.												
² Arranging the set up correctly.												
² Recording of results.												
² Working in corporation with the others												

Enter achievement levels as A, B, C, D

A Very good
B Good
C Ordinary
D Should develop

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 02 instrument 02

Competency level to be coverd : 4.2, 4.3, 4.5, 4.7, 4.8, 4.9

Nature of the instrument : Role play -Discussion with a professional

Aims of the instrument :
- Development of subject knowledge.
- To be courteous.
- To be competent in conducting a face to face discussion and also to face such a situation.

Instructions to carryout the instrument :

To the Teacher :
- Group the students in pairs.
- Let them select as to who should be the professional and who should be the person to conduct the discussion.
- Conduct the discussion on a suitable date.

To the students :
- Develop a plan according to the theme as to what questions should be asked and what are the responses.
- Conduct the discussion in a courteous manner.
- Limit the discussion to the time allocated.

Evaluation criteria :

Criteria	Names of students											
• Relevance of questions/answers to the theme.												
• Presentation in a simple manner												
• Accuracy of information												
• Discussion conducted in sequential manner												
• Courteousness												

Enter achievement levels as A, B, C, D

A Very good
B Good
C Ordinary
D Should develop

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 02 instrument 03
Competency level to be coverd : 6.1
Nature of the instrument : Practical presentations
Aims of the instrument :
- Skill in creating an awareness among individuals having obtained a professional understanding in relation to a particular field.
- Developing competency in organizing teaching-learning situations.
- Consolidation of subject knowledge.

Instructions to carryout the instrument :

To the Teacher :
- Divide and distribute the small activities prescribed in relevant activity plans among the groups respectively.
- Direct the groups to explain the concepts while conducting the demonstration simultaneously.
- Insist that all steps in the experiment should be explained.
- Let the students in the audience to join in the discussion and make the event fruitful.

To the students :
- Plan the presentation by allocating work among all the members of the group.
- Assume that the audience gain this experience for the first time in their life and present the facts in a sequential order from simple to complex.
- Invite the audience for a discussion and solve their problems
- It will be more fruitful if you can involve others in the activity.

Evaluation criteria :

Criteria	Names of students											
• Pre planning												
• Performing the experiment methodically												
• Allocation of work												
• Involving the audience												
• Consolidating of the subject matter												

Enter achievement levels as A, B, C, D

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 03 Instrument 01

Competency leve to be coverd : 6.2 / 8.1, 8.2

Nature of the instrument : Literary activities

Aims of the instrument :
- To convince that scientific concepts could be grasped joyfully when it is blended with literature.
- To provide opportunity to investigate the scientific background of phenomena related to environment
- Development of subject knowledge.

Instructions to carryout the instrument :

To the Teacher :
- Emphasise that all students must be directed to do literary activities individually.
- Explain the students that they could present, poems, songs, short stories, essays, slogans, plays like literary activities.
- Make it a point to see that the literary activities are diverse.
- Distribute the themes after explaining to them.
- Find out about the correct usage of language.
- Write all the constructions in an A4 size paper and make a book.

To the students :
- Try your best to present a good product relevant to the theme.
- Make sure to develop something different to the others.
- Give a suitable name to the book

Evaluation criteria :

Criteria	Names of students											
• Relavant to the topic												
• Independent construction												
• Correct use of language												
• Innovativeness												
• Good appearance												

Enter achievement levels as A, B, C, D

A Very good
B Good
C Ordinary
D Should develop

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 03 Instrument 02

Competency leve to be coverd : 4.12

Nature of the instrument : Wall news papers

Aims of the instrument :

- To give an awareness about nanotechnology
- To direct students to explore ways of gathering information.
- To develop creativity

Instructions to carryout the instrument :

To the Teacher :

- Distribute among the groups the content area on Nanotechnology.
- Allow sufficient time to gather relevant information with regard to the themes using different sources.
- Strengthen students with ways and means of making written presentations for a wall newspaper. (Eg.: essays, verses, shortstories, drawings)
- Arrange a wall newspaper usings students creations.

To the students :

- Gather information relevant to the theme given to your group on Nanotechnology using books, magazines, electronic media and resource person.
- Make a diverse collection of articles.
- Use correct language.
- Include your creations in the wall newspaper.

Evaluation criteria :

Criteria	Names of students											
• Using a variety of resources												
• Unerstanding of the Nanotechnology concept												
• Accuracy of the information												
• Creativity												
• Correct language												

Enter achievement levels as A, B, C, D

Instruments for continuation of Teaching-Learning Process

Evaluation Stage : Term 03 Instrument 03

Competency leve to be coverd : 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 /7.1

Nature of the instrument : Exhibition of posters.

Aims of the instrument :
- Development of skills in communication by posters.
- Enhancing of skills in organizing workshops.
- Development of subject knowledge.

Instructions to carryout the instrument :

To the Teacher :
- Divide the subject areas to the groups.
- Give instructions to prepare posters of the same size (bristol board)
- Inform the students that subject area allocated to them must be communicated by big letters and coloured drawings.
- Check the accuracy.
- Conduct a poster exhibition in the classroom.

To the students :
- Try to present the relevant subject area by using different display media.
- Draw large clear diagrams.
- Use attractive colours.
- Submit the poster on the due date.

Evaluation criteria :

Criteria	**Names of students**											
• Relevance to the subject content												
• Attractiveness												
• Group participation												
• Originality												
• Should be able to communicate with an individual at a distance												

Enter achievement levels as A, B, C, D