Curriculum Planning & Development Division
Ministry of Education

Science Syllabus
Primary
2001

Science Syllabus

Primary

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INTRODUCTION

PHILOSOPHY AND AIMS

What is Science education?
The study of science is an attempt to understand the natural world. Science may be broadly conceived of as comprising a body of knowledge about the natural world and a set of skills and processes by which this knowledge is acquired, synthesised, evaluated and applied. Science education refers to the training necessary for learners to acquire this body of knowledge and the set of skills. This acquisition is realised primarily through the use of problem-solving exercises and practical investigations of the environment.

Why do we need Science education?
There are generally two main goals of a Science education. First, it inculcates scientific literacy for all, so that people can make informed choices in their personal lives and approach challenges in the workplace in a systematic and logical way. This is crucial in preparing the workforce to confidently face an economy and work environment that will be increasingly knowledge-based. Second, it aims to produce competent professionals in the various scientific disciplines who can carry out research and development at the highest level.

The learning of science also provides excellent opportunities for the development of attitudes. Science experiences in the primary school can cultivate an interest in and love for the subject which could continue to grow long after pupils have left school.

These positive attitudes are:
- ***curiosity*** to explore their environment and question what they find
- ***keenness*** to identify and answer questions through carrying out investigations
- ***creativity*** in suggesting novel and relevant ways to solve problems
- ***open-mindedness*** to accept all knowledge as tentative and to change their view if the evidence is convincing
- ***perseverance*** in pursuing a problem until a satisfying solution is found
- ***concern*** for living things and awareness of the responsibility they have for the quality of the environment

How should Science be taught?
The acquisition of scientific skills essentially involves seeking answers to problems. The knowledge obtained from this process can then be organised into general principles from which useful predictions can be made about natural phenomena. For pupils to have meaningful learning, it is important that they be allowed to experience first hand the process of seeking answers to problems. This requires that the pupils physically explore and discover knowledge, be it within their environment or in the

laboratory. They must then be able to effectively integrate and link new concepts to the existing body of knowledge.

The learning of science has been re-mapped into equipping pupils with basic process skills to acquire and manage information. Thus, the focus of learning will now be on the integration of these basic process skills in complex processes such as creative problem solving, decision-making and investigation.

What are the aims of the primary science syllabus?
The primary science syllabus aims to:

- provide primary pupils with experiences which build on their interest in and stimulate their curiosity about their environment
- provide pupils with scientific concepts to help them understand themselves and the world around them
- provide pupils with opportunities to develop skills, habits of mind and attitudes necessary for scientific inquiry
- prepare pupils towards using scientific knowledge and methods in making personal decisions
- help pupils appreciate how Science and Technology influence people and the environment

CONCEPTUAL FRAMEWORK

The approach in this revised syllabus towards the learning of science is based on themes that pupils can relate to their everyday experiences, and to the commonly observed phenomena in nature. The basic aim is to enable pupils to appreciate the links between seemingly different topics and thus allow the eventual integration of scientific ideas. The five themes chosen are: ***Diversity, Cycles, Systems, Energy*** *and* ***Interactions***. These themes encompass a core body of concepts in both the life and physical sciences. This body of concepts has been chosen because it provides a broad based understanding of the environment, and it will help build a foundation upon which pupils can rely for further study. In particular, the relationships between Science and Technology and the environment are explored under the theme of *Interactions*.

Although the content of the syllabus is organised into 5 themes, the topics under each theme are not to be viewed as compartmentalised blocks of knowledge. In general, there are no clear boundaries between these themes. There may be topics common to different themes. Hence, a conscious effort is needed to demonstrate the relationship between themes whenever possible. In particular, it should be noted that *Systems*, *Energy* and *Interactions* are closely related.

Another feature of the syllabus is the spiral approach. This is characterised by the revisiting of concepts and skills at different levels and with increasing degrees of depth. The spiral approach allows the learning of scientific concepts and skills to match pupils' cognitive development. It therefore helps pupils build upon their existing understanding of concepts and facilitates the gradual mastery of skills.

MAIN IDEAS IN EACH THEME

The focus of each theme is given below.

Diversity
Pupils should appreciate that there is a great variety of living and non-living things in the world. Man seeks to organise this great variety to better understand the world in which he lives. There are common threads that connect all living things and unifying factors in the diversity of non-living things that help him to classify them. The study of the diversity in the world will also allow pupils to appreciate its importance as well as the necessity of maintaining it.

Topics:

- *Variety and characteristics of living things*
- *Materials*
- *Classification of organisms and materials*

Cycles
Pupils should recognise that there are repeated patterns of change in nature and understand how these patterns arise. Examples of these cycles are the day and night cycle, life cycles of living things and the recycling of resources. Studying these cycles helps Man to predict events and processes and to understand the Earth as a self-sustaining system.

Topics:

- *Life cycles of plants and animals*
- *Matter*
- *Water*
- *Day and night cycles*
- *Unit of life*
- *Reproduction in plants and animals*

Systems
Pupils should recognise that a system is a whole consisting of parts that work together to perform a function. There are systems in nature as well as man-made systems. Examples of systems in nature are the digestive and respiratory systems. Examples of man-made systems are electrical systems. A study of these systems allows Man to understand how they operate and how parts influence and interact with one another to perform a function.

Topics:

- *Plant parts and functions*
- *Digestive and skeletal / muscular systems*
- *Respiratory and circulatory systems*
- *Electrical systems*

Interactions

Pupils should appreciate that a study of the interactions between and within systems helps Man to better understand the environment and his role in it. There are many types of interactions. There are interactions between the living world and the environment at various levels; i.e. interactions which occur within an organism, between organisms as well as between organisms and the environment. There are also interactions between forces and objects. At the societal level, the interaction of Man with his environment drives the development of Science and Technology. At the same time, Science and Technology influences the way Man interacts with his environment. By studying the interactions between Man and his environment, pupils can better appreciate the consequences of their actions.

Topics:

- *Magnets*
- *Simple machines*
- *Forces*
- *Environmental impact*
- *Ecology*

Energy

Pupils should appreciate that energy affects both living and non-living things. It makes changes and movement possible in everyday life. There are many forms of energy and one form can be converted to another. Man uses energy in many ways, for many different purposes. Man is not the only animal that uses energy; all living things obtain energy and use it to carry out life processes. The study of this theme will allow pupils to appreciate the importance and uses of energy and the need to conserve it.

Topics:

- *Light*
- *Heat*
- *Photosynthesis and respiration*
- *Forms of energy and conversions*

SKILLS AND PROCESSES IN PRIMARY SCIENCE

Scientific inquiry requires and enables the development of process skills. Science process skills encompass both *thinking skills* as well as *practical skills*. The primary science syllabus seeks to develop basic process skills and the use of these skills in more complex integrated processes. The skills and processes taught at the primary level are:

A. Basic Process Skills
- Observing
- Comparing
- Classifying
- Measuring and using apparatus
- Communicating
- Analysing
- Generating
- Evaluating

B. Integrated Processes
- Creative problem solving
- Decision-making
- Investigation

A. <u>Basic Process Skills</u>

- **Observing**
  This is the skill of using our senses to gather information about objects or events. This also includes the use of instruments to extend the range of our senses.

- **Comparing**
  This is the skill of identifying the similarities and differences between two or more objects, concepts or processes.

- **Classifying**
  This is the skill of grouping objects or events based on common characteristics.

- **Measuring and using apparatus**
  This is the skill of knowing the functions and limitations of various apparatus, and developing the ability to select and handle them appropriately for various tasks.

- **Communicating**
  This is the skill of transmitting and receiving information presented in various forms - verbal, tabular, graphical or pictorial.

- **Analysing**
  This is the skill of identifying the parts of objects, information or processes, and the patterns and relationships between these parts.

- **Generating**
  This is the skill of adding to, extending or connecting given ideas by tapping into prior knowledge or gathered information.

- **Evaluating**
  This is the skill of assessing the reasonableness, accuracy and quality of information, processes or ideas. This is also the skill of assessing the quality and feasibility of objects.

B. Integrated Processes

Integrated processes are complex operations which call upon the use of several basic process skills. At the primary level, the integrated processes expected of pupils are:

- **Creative Problem Solving**
  This is a process of analysing a problem and choosing a novel but relevant solution in order to remedy or alter a problem situation.

- **Decision-Making**
  Decision-making is the process of establishing and applying criteria to select from among seemingly equal alternatives. The process of establishing criteria involves consideration of the consequences and values.

- **Investigation**
  This involves formulating questions or hypotheses, devising fair methods and carrying out those methods to find out answers to the questions or to verify the hypotheses.

In science process teaching and learning, teachers should teach each of the basic process skills explicitly through the use of appropriate activities and then meaningfully infuse the teaching of these skills in their lessons.

INTRODUCING SKILLS AND PROCESSES TO PUPILS

The table below shows the different levels at which skills and processes can be introduced. Once introduced, these skills and processes should continue to be developed at the higher levels.

Basic Process Skills	P3	P4	P5	P6
Observing	✓	✓	✓	✓
Comparing	✓	✓	✓	✓
Classifying	✓	✓	✓	✓
Measuring and using apparatus	✓	✓	✓	✓
Communicating (verbal, pictorial)	✓	✓	✓	✓
Communicating (tabular)		✓	✓	✓
Communicating (graphical)			✓	✓
Analysing • identify parts of a system • identify the relationships between these parts • relate the parts to their functions	✓	✓	✓	✓
Analysing • identify patterns and trends in data • identify variables that will affect the investigation		✓	✓	✓
Analysing • identify the relationships between the variables • identify those aspects which make an investigation unfair • specify the variables to be controlled			✓	✓
Generating • suggest many, varied and original ideas with some detail • draw inferences or conclusions from observations (induction) • make predictions	✓	✓	✓	✓
Generating • give reasonable explanations based on evidence		✓	✓	✓
Generating • construct a hypothesis • devise a method to test a hypothesis			✓	✓
Evaluating • decide on the quality and feasibility of an idea or object		✓	✓	✓
Evaluating • decide whether an inference/hypothesis is supported by observations • decide on the effectiveness of the method used in an investigation			✓	✓
Evaluating • construct an idea to explain observations and then test it • decide on the accuracy of data obtained in an investigation				✓

Integrated Processes	P3	P4	P5	P6
Creative Problem Solving		✓	✓	✓
Decision-Making		✓	✓	✓
Investigation			✓	✓

ASSESSMENT

Assessment is an integral part of the teaching-learning process. Pupils are assessed on their understanding of science concepts and mastery of basic process skills and integrated processes. From the results of the assessment, the teacher makes informed decisions about what should be done to enhance the learning of the pupils or to improve his/her teaching methods. The information gained from an assessment should reflect accurately that aspect of learning to be assessed. For example, a paper and pencil test could be used effectively to test for the understanding of science concepts but would not be suitable for assessing pupils' practical skills.

A variety of assessment modes should be used and these include the following:

- paper and pencil test
- practical work
- written assignments
- multimedia presentations
- model-making
- debates
- drama
- creative assignments such as board games, quizzes, posters

Although the first two modes are usually employed in formal assessment, i.e. continual and semestral assessments, the other alternative modes should also be considered for use in formal assessment as they lend themselves well in assessing pupils' creativity and thinking.

SYLLABUS CONTENT

THEMES AND TOPICS ACROSS LEVELS

LEVEL	THEME	TOPIC
P3	Diversity	• Variety and characteristics of living things • Materials
	Cycles	• Life cycles of plants and animals
	Systems	• Plant parts and functions • Digestive and Skeletal/muscular systems
	Interactions	• Magnets
P4	Cycles	• Matter • Water
	Systems	• Respiratory and circulatory systems
	Energy	• Light • Heat
P5	Cycles	• Day and night cycles • Unit of life • Reproduction in plants and animals
	Interactions	• Simple Machines
	Systems	• Electrical systems
	Energy	• Photosynthesis and Respiration
P6	Diversity	• Classification of Organisms and Materials
	Energy	• Forms of energy and conversions
	Interactions	• Forces • Environmental Impact • Ecology

LEARNING OUTCOMES
PRIMARY 3

Learning Outcomes	Remarks
Pupils should be able to: **DIVERSITY**	
a) observe a variety of living things(animals, plants, fungi) and non-living things.	• Pupils are not expected to observe micro-organisms. No laboratory work is expected for micro-organisms.
b) infer that there is a great variety of living and non-living things.	• Pupils could make the inference by observing living and non-living things in the local environment or gathering information from a variety of sources such as print material, CD-ROM, internet sites.
c) infer the following characteristics of living things: - they need water, food and air to survive; - they grow, move, respond and reproduce.	
d) classify living things into broad groups according to common observable characteristics, based on similarities and differences. - plants (e.g. flowering, non-flowering) - animals (e.g. insects, birds, fish, mammals) - fungi - micro-organisms	• No laboratory work is expected for micro-organisms so pupils use print or IT resources. • Pupils are not expected to identify specific living organisms.
e) recognise that there is a great variety of materials.	• Examples of materials: plastics, wood, rubber, glass, fabrics, ceramics and metals
f) compare materials on the basis of the following physical properties: ∗ hardness ∗ strength ∗ flexibility ∗ float/sink in water.	• Materials for comparison are wood, metal, plastic and rubber. • To facilitate common understanding of terms, explanation of key terms for teachers are as follows. Students should be able to understand and apply concepts but not memorise definitions: - The “Hardness” of a material is its ability to resist scratching. A hard material will scratch a softer material. - The “Strength” of a material is its ability to be subject to loads without breaking. - The “Flexibility” of a material is its ability to bend without breaking.

Learning Outcomes	Remarks
g) relate the above properties of the materials to their use.	• The materials are wood, metal, plastic and rubber.
CYCLES	
a) show an understanding that different organisms have different life cycles.	• Pupils should observe and record the changes in a particular plant when grown from seeds or other plant parts e.g. bulbs.
b) compare the life cycles of the butterfly, cockroach and chicken.	• Pupils should observe and record the changes that occur in a particular animal over a period of time e.g. observe the life cycle of a butterfly/beetle, cockroach/ grasshopper or chicken.
c) show an awareness that offspring take the characteristics of their parents, therefore, they closely resemble their parents.	• The idea of heredity can be introduced.
SYSTEMS	
a) show an understanding that an organism is a system which has different parts to carry out different functions.	• Plants and animals have parts/organs to enable them to detect and respond to environmental stimuli and to carry out life processes.
b) identify the following plant parts and state their functions: leaves, stems and roots.	• Pupils need to relate the following plant parts to their role in photosynthesis: - leaves where photosynthesis takes place - roots which anchor the plant and take in water and minerals - stems which support the plant to get sunlight and transport water through the stem to the leaves • Pupils do not need to know the detailed process of photosynthesis and concept of root hairs.
c) identify the following organ systems in humans and state their functions: digestive, respiratory, circulatory, skeletal, muscular.	• The respiratory and circulatory systems will be covered in more details at Primary 4.
d) describe briefly the organs in the human digestive system and relate them to their function.	• Key points are: - digestion takes place in the mouth, stomach and small intestines - food must be physically broken into smaller pieces so that digestive juices in the various organs can act on them - digestion breaks down food into a form which can be absorbed into the blood

Learning Outcomes	Remarks
	• Pupils should appreciate that individual organs of the digestive system have their own functions but the complete digestive process requires the working of the whole system comprising various organs.
e) recognise the interaction between the human skeletal and muscular systems in enabling movement.	• Pupils should appreciate that two or more systems can interact to perform a function.
INTERACTIONS	
a) identify the characteristics of magnets.	• Characteristics are: ∗ magnets are made of iron or steel ∗ magnets have two poles. A freely suspended bar magnet comes to rest pointing in N-S direction ∗ unlike poles attract and like poles repel ∗ magnets attract magnetic materials like iron
b) differentiate between magnets and non-magnets.	
c) make a magnet by the 'Touch'/'Stroke' method and the electrical method.	• Pupils are not required to identify the poles of a magnet that they have made.
d) list some uses of magnets in everyday objects.	

LEARNING OUTCOMES
PRIMARY 4

Learning Outcomes	Remarks
Pupils should be able to: **CYCLES**	
a) state that matter is anything that has mass and occupies space.	
b) describe the three states of matter (solid, liquid, gas) in terms of their maintenance of shape and volume.	
c) differentiate between the three states of matter.	
d) recognise that water can exist in three interchangeable states of matter.	• Melting – solid to liquid • Evaporating / boiling – liquid to gas • Condensation – gas to liquid • Freezing – liquid to solid
e) investigate the effect of heat gain or loss on the state of water.	• Pupils should infer that: ∗ when ice is heated, it melts and changes to water at 0 ^{o}C ∗ when water is cooled, it freezes and changes to ice at 0 ^{o}C ∗ when water is heated, it boils and changes to steam at 100 ^{o}C ∗ when steam is cooled, it condenses to water
f) state the melting point of ice (or freezing point of water) and the boiling point of water and show an understanding of these terms.	
g) investigate the factors which affect the rate of evaporation of water.	• The factors are wind, temperature and exposed surface area. • Pupils should know that evaporation takes place at temperatures below boiling point.
h) show an understanding of the roles of condensation and evaporation in the water cycle.	
i) show an understanding of the importance of the water cycle.	

Learning Outcomes	Remarks
j) show an understanding of the importance of water to life processes.	
k) list some uses of water.	• In home, industries and agriculture
l) describe the impact of water pollution on the Earth's water resources.	
m) show an awareness of the need to conserve water.	• Pupils should gather, organise and interpret data on water use at home and in school. *NE can be incorporated here.*
SYSTEMS	
a) recognise that air is a mixture of gases.	• The gases include nitrogen, carbon dioxide, oxygen and water vapour.
b) name the organs of the human respiratory and circulatory systems and describe their functions.	Key points are: • The human respiratory system is made up of the lungs and air tubes that carry air to and from the lungs. • At the lungs, oxygen is absorbed into the blood and carbon dioxide is removed. • The human circulatory system is made up of the heart and the blood vessels which carry blood to and from the heart. • In humans, the heart pumps blood to all parts of the body, transporting nutrients, digested food, oxygen, carbon dioxide and other substances in the body.
c) compare the ways in which nutrients, water and oxygen are transported within plants and animals.	• Besides the tubes which transport water and minerals, plants have other tubes which transport food to other parts of the plant. These can be compared with the blood vessels in animals.
d) compare how plants, fish and mammals take in oxygen and give out carbon dioxide.	
e) recognise the integration of the different systems in carrying out life processes.	• For example, the digestive system is needed to make food small enough to be absorbed and the circulatory system is needed to transport the digested food to all parts of the body. • Similarly, the respiratory system is needed to take in oxygen and give out carbon dioxide while the circulatory system is needed to transport oxygen to all parts of the body and carbon dioxide from all parts of the body to the lungs.

Learning Outcomes	Remarks
ENERGY	
a) recognise that energy is required to make things work or move.	• Examples of energy: light and heat. Other types of energy will be covered in greater detail at P5 and P6.
b) state that living things need energy to carry out life processes.	
c) recognise that the Sun is our primary source of light and heat energy.	
d) differentiate the ways in which plants and animals obtain their food.	• Pupils should show an understanding that energy from the sun is used by plants to make their food and that animals cannot make their own food. When animals eat plants, the energy stored in the food is passed to them.
e) infer that an object can be seen when it reflects light or when it is a source of light.	
f) investigate the transparency of materials to light.	• Terms such as opaque, translucent and transparent are not required. • Pupils could use a data-logger with a light sensor for the investigation.
g) recognise that a shadow is formed when light is completely or partially blocked by an object.	
h) list some common sources of heat.	
i) state that the temperature of an object is a measurement of its degree of hotness.	
j) use a thermometer.	• Pupils should handle different types of thermometer, such as laboratory thermometer and the temperature sensor used with a data-logger.
k) differentiate between heat and temperature.	• Heat is a form of energy. • Temperature is a measurement of the degree of hotness of an object.
l) show an understanding that heat flows from a hotter to a colder object until both reach the same temperature.	

Learning Outcomes	Remarks
m) relate the change in temperature of an object to the gain or loss of heat by the object.	• Pupils should recognise that ∗ a gain in heat generally causes a rise in temperature ∗ a loss in heat generally causes a fall in temperature • A data-logger and a temperature sensor may be used.
n) list some effects of heat gain/loss in our daily life.	• Examples of heat gain and loss: ∗ contraction/expansion of objects ∗ water cycle
o) identify good and bad conductors of heat.	• Examples of good and bad conductors: Good conductors: metals Bad conductors: wood, plastic, air *(Comparison of ability to conduct heat within each group of materials is not required)*

LEARNING OUTCOMES
PRIMARY 5 EM1/2

Learning Outcomes	Remarks
Pupils should be able to: **CYCLES**	
a) state the composition of the Solar System.	• The Sun, the Earth, the Moon and other planets (names and positions of these other planets are not required).
b) show an awareness that the Earth's position from the Sun is one of the major factors contributing to Earth's ability to support life.	• A combination of factors, like the Earth's atmosphere and its position from the Sun, help to maintain the right environment on Earth to support life.
c) recognise that the Sun is a star that gives out light.	
d) recognise that the Moon and planets in the Solar System do not give out light. They can be seen because they reflect light from the Sun.	
e) show an awareness that there is regularity in the movements of the Earth and the Moon.	• Use models to show that the Moon goes around the Earth and relate the phases of the Moon to this movement. • Observe that the time taken for one complete cycle of phases of the Moon is about 30 days. • Relate the length of a day to the rotation of the Earth about its axis and the length of a year to the movement of the Earth around the Sun.
f) list some uses of man-made satellites.	• Examples of uses of satellites: communication, space exploration and observations of weather patterns
g) show an understanding that a cell is a basic unit of life.	• Each organism is made up of either a single cell or many cells. • Examples of single cell organisms: bacteria, yeast, *Paramecium*

Learning Outcomes	Remarks
h) identify the different parts of a typical plant cell and relate the parts to the functions: • cell wall • cell membrane • cytoplasm • nucleus • chloroplasts	• Examine plant cells under the microscope. Use prepared slides of plant cells or mount onion epidermis / *Elodea* / *Hydrilla* on slides.
i) identify the different parts of a typical animal cell and relate the parts to the functions: • cell membrane • cytoplasm • nucleus	• Examine animal cells under the microscope. Use prepared slides of animal cells or mount cheek cells on slides.
j) show an understanding that a cell divides to produce new cells and that this division is necessary for an organism to grow.	• Observe the budding of yeast under the microscope. Details of cell division are not required.
k) show an understanding that living things reproduce to ensure continuity of their kind and that many characteristics of an organism are passed on from parents to offspring.	• Examples of genetic traits: - tongue rolling - attached / detached ear lobes
l) investigate and compare the various ways in which plants reproduce i.e. by spores, seeds and from other plant parts such as underground stems, suckers and leaves.	• Pupils do not have to distinguish between different types of underground stems.
m) name the following processes in the sexual reproduction of flowering plants : pollination, fertilisation (seed production), seed dispersal and germination.	• Pupils are not expected to give detailed descriptions of the processes but should know the sequence of events.
n) recognise the similarity in terms of fertilisation in the sexual reproduction of flowering plants and animals.	• Pupils need to recognise that in many animals, including humans, females produce eggs and males produce sperm. In flowering plants, the egg and male gametes (a gamete is a sex cell) are produced in the flowers. When an egg and a male gamete fuse, a new individual is formed. • Detailed knowledge of the human reproductive system is not required. But pupils need to know that the ovaries produce eggs, the testes produce sperms and the fertilised egg develops in the womb.

Learning Outcomes	Remarks
INTERACTIONS	
a) identify a force as a push or a pull.	
b) list some simple machines.	• The simple machines are lever, pulley, wheel and axle, inclined plane, gears.
c) manipulate these simple machines to determine their characteristics and uses.	• Pupils are to develop concepts and understanding through manipulation and play. • They are not expected to memorise the characteristics but ought to develop an understanding that each one makes work easier to do by: i. providing some trade-off between the force applied and the distance over which the force is applied ii. changing the direction of the applied force iii. changing the speed and/or direction of rotation • Introduce the idea that examples of levers can be found in the interaction of the skeletal and muscular systems. The muscles provide the forces for the movement of the bones. One such example can be found in the arm.
SYSTEMS	
a) recognise that an electric circuit consisting of an energy source and other circuit components forms an electrical system.	• The components of electric circuits are: dry cells / battery, wires, bulbs, switches. Note: A battery is made up of two or more dry cells. Pupils are not required to differentiate between the terms.
b) show an understanding that a current can only flow through a closed circuit.	• Pupils can demonstrate understanding by the following means: ∗ trace the path of current flow in a closed circuit ∗ distinguish between a closed circuit and an open circuit (*by interpreting circuit diagrams or by carrying out experiments*)

Learning Outcomes	Remarks
c) recognise that - dry cells / battery provides energy in a closed circuit - current transports energy from the dry cells / battery to the bulb - a switch can be used to break or close a circuit.	• Pupils can construct simple electric circuits to develop concepts and understanding through manipulation of the various components.
d) construct simple circuits from circuit diagrams.	• Restrict components to dry cells / battery, wires, switches and bulbs. • Symbols representing circuit components can be used.
e) infer that components of an electrical system affect one another.	• Pupils are to: * infer that the current affects the brightness of bulbs * investigate the effect of some variables on the current in a circuit. These variables to be investigated are: - *number of dry cells / battery* - *number of bulbs* - *arrangement of dry cells / battery*
f) identify electrical conductors and electrical insulators.	• Examples of electrical conductors and insulators: Conductors: metals Insulators: wood, plastic, rubber *(Comparison of ability to conduct electric current within each group is not required)*
g) infer that good conductors of electricity are generally good conductors of heat.	
h) show an awareness of the need for proper use and handling of electricity.	• Example: Touching switches with wet hands may cause nasty electrical shock.
i) show an awareness of the need to conserve electrical energy.	• Briefly mention that the energy resources used to generate electricity come from fuels which are exhaustible. *NE can be incorporated here*. Topic is covered in depth at lower secondary level. • Pupils should be encouraged to demonstrate ways to conserve electrical energy in school and at home. • Pupils should gather, organise and interpret data on electrical energy use at home and in school.

Learning Outcomes	Remarks
ENERGY a) show an understanding that water, light energy and carbon dioxide are needed for photosynthesis and sugar and oxygen are produced. b) Show an understanding that food produced by plants becomes the source of energy for animals. c) recognise that respiration is a process in which energy is made available for life processes to occur.	To facilitate common understanding of terms, explanation of key terms for teachers are as follows. Students should be able to understand and apply concepts but not memorise definitions: • Breathing refers to the movements that cause exchange of gases between the body and its surroundings • Respiration refers to the activity that releases energy from food substances in all living cells

LEARNING OUTCOMES
PRIMARY 6 EM1/2

Learning Outcomes	Remarks
Pupils should be able to:	
DIVERSITY	
a) show an awareness that materials as well as organisms can be grouped based on their properties or characteristics.	
b) classify some common materials.	• Examples of materials: plastics, wood, rubber, glass, fabrics, ceramics and metals • Although pupils may classify materials based on criteria like colour and texture, teachers should direct pupils to classify materials based on the following physical properties: ∗ their degree of transparency to light ∗ whether they are magnetic or non-magnetic ∗ whether they are good or bad conductors of heat ∗ whether they are electrical conductors or electrical insulators Properties covered at P3 should be included.
c) relate the properties of the materials to their uses.	• Properties include those listed in outcome (b) above.
d) differentiate between plants, animals and fungi based on form, nutrition and movement.	• Form includes: ∗ shape ∗ size • Nutrition includes: ∗ How plants make food ∗ How animals obtain food
ENERGY	
a) show an awareness that energy from most of our energy resources is derived in some ways from the Sun.	
b) recognise and give examples of the various forms of energy.	• The forms of energy are kinetic energy, potential energy, light energy, electrical energy, sound energy, heat energy. • Examples of potential energy: gravitational potential energy and chemical energy.

Learning Outcomes	Remarks
c) show an understanding that energy can be converted from one form to another.	• Examples of energy conversion: ∗ (Gravitational) potential energy is converted to kinetic energy in falling objects. ∗ Light energy is converted to chemical energy during photosynthesis. ∗ Chemical energy in dry cells / battery in a closed circuit is converted to electrical energy which in turn is converted to light and heat energy in the filament.
INTERACTIONS	
a) recognise and give examples of the different types of forces.	• The types of forces are gravitational force, elastic spring force, frictional force and magnetic force.
b) show an understanding of the effects of a force.	• Effects are: ∗ A force can move a stationary object. ∗ A force can speed up, slow down or change the direction of motion. ∗ A force can stop a moving object. ∗ A force may change the shape of objects.
c) recognise that friction is a force that opposes motion.	• Pupils are not expected to know the direction of friction for rolling objects such as wheels and balls.
d) recognise that when springs are stretched or compressed, they exert a force on whatever is stretching or compressing them.	
e) recognise that objects have weight because of the gravitational force between them and the Earth.	• Pupils are not required to compare the weight of an object at different locations with different gravitational pull. e.g. on the earth and on the moon.
f) recognise that magnets can exert forces of attraction and repulsion.	• Magnets exert forces of attraction on magnetic materials like iron • Like poles of magnets exert a force of repulsion on each other while unlike poles exert a force of attraction on each other.
g) observe and describe the characteristics of a local environment.	• Pupils should use sensors and data-loggers to study the physical characteristics (e.g.: temperature, amount of light) of the environment (e.g.: school field, eco-garden).

Learning Outcomes	Remarks
h) collect and record information regarding the interacting factors within an environment.	• Examples of interacting factors: ∗ temperature ∗ amount of light
i) identify the following factors that affect the survival of an organism : - the physical characteristics of the environment - availability of food - types of other organisms present	• Pupils could have experiences in building and maintaining terraria or aquaria. • Pupils should appreciate and have a respect for living things and the environment.
j) discuss the effect on organisms when the environment becomes unfavourable.	• Pupils should be aware that some organisms adapt and survive while others die or move to new environments.
k) trace the energy pathway from the sun through living things and identify the roles of various organisms in a food chain and a food web.	• Pupils are expected to show an understanding of - the roles of producers, consumers, decomposers - predator- prey relationship • Decomposers obtain their food by breaking down dead plants and animals.
l) differentiate among the terms organism, population, community.	Key points are: • An organism is a living thing. • A population is defined as a group of plants and animals of the same kind, living and reproducing at a given place and time. • A community consists of many populations living together in a particular place.
m) show an understanding that different habitats support different communities.	• Pupils should go on field trips to explore a variety of environments. *NE can be incorporated here*. • Pupils should infer that the place where populations find all the things they need to live and reproduce is their habitat e.g. garden, field, pond, seashore, tree.
n) recognise that adaptations serve to enhance survival and can be structural or behavioural.	Key point is: • Adaptations enhance survival by enabling the organism to : - cope with physical factors - obtain food - escape predators - reproduce by finding and attracting mates, or dispersing seeds

Learning Outcomes	Remarks
o) give examples of man's impact (both positive and negative) on the environment.	• Examples of man's impact on the environment: * Indiscriminate actions by man lead to the destruction of the environment e.g. deforestation, pollution, global warming. Pupils are not required to give detailed descriptions of these examples. * Local examples of how man can improve the environment e.g. greening of Singapore. *NE can be incorporated here*.
p) show an awareness that man creates materials to meet the technological needs of society.	• Examples of man-made materials: alloys, plastics, ceramics.
q) show an awareness that the development of science and technology affects the environment.	• Pupils are to compare the environmental impact of using natural and man-made materials and suggest ways to prevent pollution. *NE can be incorporated here*.
r) show an awareness that man's interaction with the environment influences the development of science and technology.	• Pupils list some areas in science and technology, which were developed as a result of man's interaction with the environment. Examples are: * biotechnology - genetically modified food that are pest resistant - cultivation of rice that are high yielding, drought-resistant or disease-resistant - use of living organisms to make products, such as in fermentation * telecommunication (examples: handphones, Internet, satellites, fax machines, radio, walkie talkie).

LEARNING OUTCOMES
PRIMARY 5 EM3

Learning Outcomes	Remarks
Pupils should be able to: **CYCLES**	
a) state the composition of the Solar System.	• The Sun, the Earth, the Moon and other planets (names and positions of these other planets are not required).
b) recognise that the Sun is a star that gives out light.	
c) recognise that the Moon and planets in the Solar System do not give out light. They can be seen because they reflect light from the Sun.	
d) show an awareness that there is regularity in the movements of the Earth and the Moon.	• Use models to show that the Moon goes around the Earth and relate the phases of the Moon to this movement. • Observe that the time taken for one complete cycle of phases of the Moon is about 30 days. • Relate the length of a day to the rotation of the Earth about its axis and the length of a year to the movement of the Earth around the Sun.
e) list some uses of man-made satellites.	• Examples of uses of satellites: communication, space exploration and observations of weather patterns
f) show an understanding that a cell is a basic unit of life.	• Each organism is made up of either a single cell or many cells. • Examples of single cell organisms: bacteria, yeast, P*aramecium*
g) identify the different parts of a typical plant cell and relate the parts to the functions: • cell wall • cell membrane • cytoplasm • nucleus • chloroplasts	• Examine plant cells under the microscope. Use prepared slides of plant cells or mount onion epidermal / *Elodea / Hydrilla* on slides.

Learning Outcomes	Remarks
h) identify the different parts of a typical animal cell and relate the parts to the functions: • cell membrane • cytoplasm • nucleus	• Examine animal cells under the microscope. Use prepared slides of animal cells or mount cheek cells on slides.
i) show an understanding that a cell divides to produce new cells and that this division is necessary for an organism to grow.	• Observe the budding of yeast under the microscope. Details of cell division are not required.
j) show an understanding that living things reproduce to ensure continuity of their kind and that many characteristics of an organism are passed on from parents to offspring.	• Examples of genetic traits: - tongue rolling - attached / detached ear lobes
k) investigate and compare the various ways in which plants reproduce i.e. by spores, seeds and from other plant parts such as underground stems, suckers and leaves.	• Pupils do not have to distinguish between different types of underground stems.
l) name the following processes in the sexual reproduction of flowering plants : pollination, fertilisation (seed production), seed dispersal and germination.	• Pupils are not expected to give detailed descriptions of the processes but should know the sequence of events.
m) recognise that in many animals, including humans, females produce eggs and males produce sperm and when an egg and a sperm fuse, a new individual is formed.	
INTERACTIONS	
a) identify a force as a push or a pull.	
b) list some simple machines.	• The simple machines are lever, pulley, wheel and axle, inclined plane and gears.
c) manipulate these simple machines to determine their characteristics and uses.	• Pupils are to develop concepts and understanding through manipulation and play. • They are not expected to memorise the characteristics but ought to develop an understanding that each one makes work easier to do by: i. providing some trade-off between the force applied and the distance over which the force is applied ii. changing the direction of the

Learning Outcomes	Remarks
	applied force iii. changing the speed and/or direction of rotation • Introduce the idea that examples of levers can be found in the interaction of the skeletal and muscular systems. The muscles provide the forces for the movement of the bones. One such example can be found in the arm.
SYSTEMS	
a) recognise that an electric circuit consisting of an energy source and other circuit components forms an electrical system.	• The components of electric circuits are dry cells / battery, wires, bulbs and switches. Note: A battery is made up of two or more dry cells. Pupils are not required to differentiate between the terms.
b) recognise that a current can only flow through a closed circuit.	• Pupils should be able to trace the path of current flow in a closed circuit.
c) recognise that - dry cells / battery provides energy in a closed circuit - current transports energy from the dry cells / battery to the bulb - a switch can be used to break or close a circuit.	• Pupils can construct simple electric circuits to develop concepts and understanding through manipulation of the various components.
d) construct simple circuits from circuit diagrams.	• Restrict components to dry cells / battery, wires, switches and bulbs. • Symbols representing circuit components can be used.
e) infer that components of an electrical system affect one another.	• Pupils are to: * infer that the current affects the brightness of bulbs * investigate the effect of some variables on the current in a circuit. These variables to be investigated are: - *number of dry cells / battery* - *number of bulbs* - *arrangement of dry cells / battery*
f) identify electrical conductors and electrical insulators.	• Examples of electrical conductors and insulators: Conductors: metals Insulators: wood, plastic, rubber *(Comparison of ability to conduct electric current within each group is not required)*

Learning Outcomes	Remarks
g) show an awareness of the need for proper use and handling of electricity.	• Example: Touching switches with wet hands may cause nasty electrical shock.
h) show an awareness of the need to conserve electrical energy.	• Briefly mention that the energy resources used to generate electricity come from fuels which are exhaustible. *NE can be incorporated here*. Topic is covered in depth at lower secondary level. • Pupils should be encouraged to demonstrate ways to conserve electrical energy in school and at home. • Pupils should gather, organise and interpret data on electrical energy use at home and in school.
ENERGY	
a) show an understanding that water, light energy and carbon dioxide are needed for photosynthesis and sugar and oxygen are produced.	
b) show an understanding that food produced by plants becomes the source of energy for animals.	

LEARNING OUTCOMES
PRIMARY 6 EM3

Learning Outcomes	Remarks
Pupils should be able to: **DIVERSITY**	
a) show an awareness that materials as well as organisms can be grouped based on their properties or characteristics.	
b) classify some common materials.	• Examples of materials: plastics, wood, rubber, glass, fabrics, ceramics and metals • Although pupils may classify materials based on criteria like colour and texture, teachers should direct pupils to classify materials based on the following physical properties: ∗ their degree of transparency to light ∗ whether they are magnetic or non-magnetic ∗ whether they are good or bad conductors of heat ∗ whether they are electrical conductors or electrical insulators. Properties covered at P3 should be included.
c) relate the properties of the materials to their uses.	• Properties include those listed in outcome (b) above.
ENERGY	
a) recognise and give examples of the various forms of energy.	• The forms of energy are kinetic energy, potential energy, light energy, electrical energy, sound energy and heat energy. • Examples of potential energy: gravitational potential energy and chemical energy.

Learning Outcomes	Remarks
b) show an understanding that energy can be converted from one form to another.	• Examples of energy conversion: ∗ (Gravitational) potential energy is converted to kinetic energy in falling objects. ∗ Light energy is converted to chemical energy during photosynthesis. ∗ Chemical energy in dry cells / battery in a closed circuit is converted to electrical energy which in turn is converted to light and heat energy in the filament.
INTERACTIONS	
a) recognise and give examples of the different types of forces.	• The types of forces are gravitational force, elastic spring force, frictional force and magnetic force.
b) describe the effects of a force.	• Effects are: ∗ A force can move a stationary object. ∗ A force can speed up, slow down or change the direction of motion ∗ A force can stop a moving object. ∗ A force may change the shape of objects.
c) recognise that friction is a force that opposes motion.	• Pupils are not expected to know the direction of friction for rolling objects such as wheels and balls.
d) recognise that when springs are stretched or compressed, they exert a force on whatever is stretching or compressing them.	
e) recognise that objects have weight because of the gravitational force between them and the Earth.	• Pupils are not required to compare the weight of an object at different locations with different gravitational pull e.g. on the earth and on the moon.
f) recognise that magnets can exert forces of attraction and repulsion.	• Magnets exert forces of attraction on magnetic materials like iron. • Like poles of magnets exert a force of repulsion on each other while unlike poles exert a force of attraction on each other.
g) observe and describe the characteristics of a local environment.	• Pupils should use sensors and data-loggers to study the physical characteristics (e.g.: temperature, amount of light) of the environment (e.g.: school field, eco-garden).

Learning Outcomes	Remarks
h) identify the following factors that affect the survival of an organism : - the physical characteristics of the environment - availability of food - types of other organisms present	• Pupils could have experiences in building and maintaining terraria or aquaria. • Pupils should appreciate and have a respect for living things and the environment.
i) trace the energy pathway from the sun through living things and identify the roles of various organisms in a food chain and a food web.	• Pupils are expected to show an understanding of - the roles of producers, consumers, decomposers - predator- prey relationship • Decomposers obtain their food by breaking down dead plants and animals.
j) differentiate among the terms organism, population, community.	Key points are: • An organism is a living thing. • A population is defined as a group of plants and animals of the same kind, living and reproducing at a given place and time. • A community consists of many populations living together in a particular place.
k) show an understanding that different habitats support different communities.	• Pupils should go on field trips to explore a variety of environments. *NE can be incorporated here*. • Pupils should infer that the place where populations find all the things they need to live and reproduce is their habitat e.g. garden, field, pond, seashore, tree.
l) give examples of man's impact (both positive and negative) on the environment.	• Examples of man's impact on the environment: * Indiscriminate actions by man lead to the destruction of the environment e.g. deforestation, pollution, global warming. Pupils are not required to give detailed descriptions of these examples. * Local examples of how man can improve the environment e.g. greening of Singapore. *NE can be incorporated here*.
m) show an awareness that man creates materials to meet the technological needs of society.	• Examples of man-made materials: alloys, plastics, ceramics.

Learning Outcomes	Remarks
n) show an awareness that the development of science and technology affects the environment.	• Pupils are to compare the environmental impact of using natural and man-made materials and suggest ways to prevent pollution. *NE can be incorporated here*.

GLOSSARY OF TERMS

	Term	Description of meaning
1.	classify	to group things based on common characteristics
2.	compare	to identify similarities and differences between objects, concepts or processes
3.	construct	to put a set of components together, based on a given plan
4.	describe	to state in words (using diagrams where appropriate) the main points of a topic
5.	discuss	to reflect on and explore a topic in speech or writing
6.	differentiate	to identify the differences between objects, concepts or processes
7.	identify	to select and/or name the object, event, concept or process
8.	infer	to draw a conclusion based on observations
9.	investigate	to find out by carrying out experiments
10.	list	to give a number of points or items without elaboration
11.	manipulate	to control an object in order to explore and discover its behaviour
12.	observe	to obtain information through the use of the senses
13.	recognise	to identify facts, characteristics or concepts that are critical to the understanding of a situation, event, process or phenomenon
14.	relate	to identify and explain the relationships between objects, concepts or processes
15.	show an awareness	to display knowledge of a concept or a situation
16.	show an understanding	to recall information (facts, concepts, models, data), translate information from one form to another, explain information and summarise information
17.	state	to give a concise answer with little or no supporting argument
18.	trace	to follow a path