

# **Science Syllabus**

## **Lower Secondary**

**Special/Express/Normal (Academic)**

**&**

**Normal (Technical)**

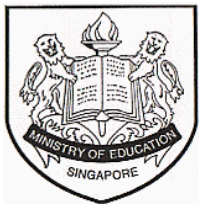
**Curriculum Planning & Development Division  
Ministry of Education**

**Science Syllabus  
Lower Secondary  
Special/Express/Normal (Academic)  
2001**

# Science Syllabus

## Lower Secondary

### Special/Express/Normal (Academic)



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# Preamble

This Lower Secondary Science Syllabus is essentially a continuation and further development of the Primary Science Syllabus. It is also a bridge to, and a foundation for, pursuit of scientific studies at higher levels. The syllabus has also taken into consideration the desired outcomes of education for our lower secondary students as well as the national education emphasis.

This syllabus emphasises the need for a balance between the acquisition of science knowledge and process and thinking skills. In addition, as and where the topics lend themselves, the technological applications, social implications and the value aspects of science are also considered. It also emphasises the broad coverage of fundamental concepts in the physical, biological and environmental sciences.

A thematic approach incorporating elements of a cross-curricular nature is adopted in organising the content of this syllabus using the Science as an Inquiry framework. A brief description of each theme is given. It is hoped that teachers would emphasise the underlying organising principle of the various themes in their teaching. The content of the syllabus has been carefully selected to ensure continuity and progression across the primary and secondary levels.

The aims spelt out in the syllabus provide the guiding principles for the suggested teaching approaches and evaluation methods. A list of process skills, thinking skills and processes for teaching is also provided. In addition, information and suggestions on infusing information

technology and thinking into the teaching and learning of science are included alongside the learning outcomes.

Teachers are advised not to follow the syllabus too rigidly but to exercise their professional judgement in implementing it. Schemes of work should be developed with the interests and abilities of the students uppermost in mind. Teachers are encouraged to use a variety of approaches in their teaching and to incorporate ideas and materials from various sources, in order to enhance the learning of science.

Certain parts of the syllabus have been underlined. The topics concerned are optional for the Normal (Academic) course students.

Asterisks (\*) placed alongside learning outcomes indicate areas of the syllabus where it is anticipated that teachers might use applications of Information Technology, as appropriate. It should be appreciated that the list is not exhaustive.

The “Remarks” column contains teaching strategies. They also include statements that help teachers focus on the key learning points for the respective learning outcomes.

## 1 Overview

## 1.1 PHILOSOPHY AND AIMS

The goal of science education was once thought to be solely to prepare a person for a career in science or engineering. Hence, great emphasis was given to the acquisition of scientific knowledge and understanding. However, the ever-expanding scientific knowledge makes it impossible for the student to acquire all of it, while the ability to access, generate and process information becomes more important. The aims of the syllabus now include the acquisition of knowledge and understanding as well the acquisition of lifelong skills, from discrete process skills, thinking skills to processes such as decision-making and problem solving.

The rapid advances in science and technology require ordinary people to acquire basic scientific and technological literacy so as to enable them to understand and make informed decisions on matters relating to science and technology in everyday life. Also, the realisation that scientific and technological developments are now shaping people's lives makes it necessary that science education should inculcate positive attitudes towards self and society.

Thus, the Lower Secondary Science Syllabus is aimed at preparing students for further studies at upper secondary level as well as developing them into scientifically informed and responsible adults.

The aims are to:

- i) enable students to acquire understanding and knowledge so as:
  - to become confident citizens in a technological world, able to take or develop an interest in matters relating to science and technology;
  - to recognise and appreciate the usefulness and limitations of the scientific method to investigating and solving problems;
  - to be prepared for science studies at upper secondary level and beyond.
- ii) develop abilities and skills that
  - are relevant to the study and practice of science;
  - are useful in everyday life;
  - encourage effective communication;
  - encourage safety consciousness and safe practice.
- iii) develop attributes relevant to the study and/or practice of science such as:
  - concern for accuracy,
  - objectivity,
  - inquisitiveness,
  - initiative,
  - innovativeness,
  - integrity,
  - perseverance,
  - critical analysis.

- iv) stimulate
  - curiosity, interest and enjoyment in science and its methods of inquiry;
  - interest in, and care for, the environment.
- v) promote an awareness:
  - that the study and practice of science are co-operative and cumulative activities and are subject to social, economic, technological, ethical and cultural influences and limitations;
  - that the applications of science are generally beneficial; but the abuse of scientific knowledge can be detrimental;
  - of the importance of the use of IT for communications and as a tool for data collection and analysis.

## 1.2 SYLLABUS FRAMEWORK

The Lower Secondary Science Syllabus is essentially a continuation of the Primary Science Syllabus where the scientific base is developed further and in greater depth. It is also a bridge to, and a foundation for, the pursuit of scientific studies at higher levels. It is based on a spiral curriculum where concepts introduced at the primary level are treated in increasing depth at the lower secondary level, and then at the upper secondary level.

The Lower Secondary Science Syllabus is structured in a similar way to the Primary Science Syllabus. The

topics in the Physical and Life Sciences are organised into 6 main themes. They are **Diversity, Cycles, Energy, Interactions, Models and Systems**, and **Measurement**. The first four themes are similar to those found in Primary Science. The theme **Models and Systems** is an extension of a similar theme **Systems** in Primary Science. The theme **Measurement** is introduced only at the lower secondary level. The concepts introduced in Primary Science under the similar themes are revisited and consolidated in Lower Secondary Science for further development in terms of knowledge, skills and processes.

The Lower Secondary Science Syllabus uses the **Science as an Inquiry** framework to weave the skills, processes and attitudes in science throughout the 6 themes. In addition, the applications and impact of science and technology are included wherever appropriate.

### **Science as an Inquiry**

The Science as an Inquiry framework should not be a separate component from the other 6 themes. It provides for the development of skills and hands-on activities that are the essence of doing science. Students use concepts and integrate process skills acquired to inquire further into the many phenomena learnt. Teachers should integrate the Science as an Inquiry framework into the instruction of the content of all the 6 themes.

## **THEMES AND TOPICS**

### **Diversity**

Students 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. It is important to develop the ability to classify and organise living and non-living things. The study of living and non-living things in terms of properties and changes is greatly facilitated by putting them into groups. Classes of matter such as elements, compounds and mixtures, solutions and suspensions are introduced.

### **Cycles**

Students should recognise that there are repeated patterns of changes in nature and understand how these patterns arise. Examples of these cycles are the nutrient cycles in the ecosystems. Studying these cycles helps Man to predict events and processes and to understand the Earth as a self-sustaining system.

### **Models and Systems**

Students should appreciate that models are simplified representations of phenomena. These models are constructed to facilitate understanding of the phenomena. There are three types of models in the learning of science, namely, physical, conceptual and

mathematical. Examples of models in this syllabus are the atomic model and particulate model of matter.

Students 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. Parts of a system influence one another. Two or more systems can interact with one another to perform a function. Examples of systems in nature are the digestive systems and reproductive systems.

### **Interactions**

Students should appreciate that a study of the interactions between and within systems helps Man to better understand his environment. 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, and energy and matter. In addition, the effects of harmful substances such as drugs and alcohol on the human body would be discussed.

### **Energy**

Students should appreciate that energy is necessary for all living and non-living systems. There are many forms of energy and one form can be converted to another. Man uses energy in many ways. Living things obtain energy and use it to carry out life

processes. Energy makes changes and movement possible in everyday life.

### **Measurement**

Students should recognise the need for Man to quantify his interactions with the environment. Man makes estimations and also accurate measurements of quantities not just when he is engaged in scientific inquiry but also in everyday activities. Direct measurements of quantities include length, mass, volume and time and calculated quantities include density, speed and rate. The study of measurement would enable Man to plan the use of resources efficiently.

Table 1 gives the overview of the topics by levels. The topics are distributed in such a way that there is a balance between physical and life sciences. In this thematic approach of organising the topics, it is hoped that teachers would stress the underlying organising principles when teaching the content.

As shown in Table 1, the themes covered in Sec 1 are **Measurement, Diversity, Models and Systems, Interactions** and **Energy**. In Sec 2, the themes covered are **Cycles, Models and Systems Interactions,** and **Energy**. The themes **Models and Systems, Interactions** and **Energy** are covered in both levels. It is important for teachers to review and

recapitulate the underlying organising principles of these themes and also the concepts taught at Sec 1 when they reintroduce these themes again at Sec 2.

**Table 1 : Overview of Topics by levels**

<b>Sec 1</b>	<b>Science as an Inquiry</b> <ul style="list-style-type: none"> <li>• Science and technology</li> <li>• Attitudes</li> <li>• Science process skills</li> </ul> (To be integrated into the teaching of the content in the various themes)	<b>Measurement</b> <ul style="list-style-type: none"> <li>• Use of measuring instruments</li> <li>• Physical quantities &amp; units</li> </ul>	<b>Diversity</b> <ul style="list-style-type: none"> <li>• Classification of matter</li> <li>• Classification of plant and animal life</li> <li>• Elements, compounds &amp; mixtures</li> <li>• Solutions &amp; suspensions</li> </ul>	<b>Models and Systems</b> <ul style="list-style-type: none"> <li>• Cells- structure, function &amp; organisation</li> </ul>	<b>Interactions</b> <ul style="list-style-type: none"> <li>• Force and its related concepts</li> <li>• Effects of heat</li> <li>• Transmission of heat</li> </ul>	<b>Energy</b> <ul style="list-style-type: none"> <li>• Sources of energy and storage of energy</li> <li>• Photosynthesis and respiration</li> </ul>
<b>Sec 2</b>	<b>Science as an Inquiry</b> <ul style="list-style-type: none"> <li>• Science and technology</li> <li>• Attitudes</li> <li>• Science process skills</li> </ul> (To be integrated into the teaching of the content in the various themes)	<b>Cycles</b> <ul style="list-style-type: none"> <li>• Nutrient cycles in the ecosystems</li> </ul>		<b>Models and Systems</b> <ul style="list-style-type: none"> <li>• Particulate model of matter</li> <li>• Simple concepts of atoms and molecules</li> <li>• Transport in living organisms</li> <li>• Digestion in animals</li> <li>• Sexual reproduction in human beings</li> </ul>	<b>Interactions</b> <ul style="list-style-type: none"> <li>• Chemical changes</li> <li>• Sound</li> <li>• Simple concepts of populations, community and ecosystem</li> <li>• Energy transfer process in the ecosystem</li> <li>• Abuses to life processes</li> </ul>	<b>Energy</b> <ul style="list-style-type: none"> <li>• Light</li> <li>• Electricity</li> </ul>

### 1.3 SCIENTIFIC INQUIRY AND PROCESSES

The Lower Secondary Science Syllabus, as in the Primary Science Syllabus, promotes inquiry whereby

students use concepts and integrate the process and thinking skills acquired to inquire further into the phenomena in the environment. Scientific Inquiry involves science process and thinking skills as well as general inquiry processes such as problem-solving, logical reasoning, decision-making and clarification of values. Science process skills are those employed by scientists to make sense of the natural world.

## SKILLS

- ◆ *Using apparatus and equipment [C1]*  
*This is the skill of knowing the functions and limitations of various equipment and apparatus, and being able to select and handle them appropriately for various tasks.*
- ◆ *Formulating questions [C4]*  
*This is the skill involving the clarification of issues and meaning through inquiry. Good questions focus attention on important information and are designed to generate new information.*
- ◆ *Observing [C2]*  
*This is the skill of using our senses to gather qualitative as well as quantitative information about a particular object, event or phenomenon. This also includes the use of instruments to extend the range of our senses.*
- ◆ *Classifying*  
*This is the skill of grouping objects or events according to common attributes or properties.*

- ◆ *Comparing*  
*This is the skill of identifying the similarities and differences between or among objects or entities.*
- ◆ *Communicating [C3]*  
*This is the skill of transmitting and receiving information presented in various forms - verbal, tabular, graphical or pictorial*
- ◆ *Inferring: Induction [C3]*  
*This is the skill of explaining observations or data or information gathered. Generalisations are then drawn based on the patterns or relations in these areas.*
- ◆ *Inferring: Deduction [C3]*  
*This is also the skill of explaining observations or data or information gathered. This process uses reasoning based on principles and generalisations in order to derive unstated specific consequences.*
- ◆ *Formulating hypothesis [C4]*  
*This is the skill of making a general explanation for a related set of observations or events. It is an extension of inferring.*
- ◆ *Predicting [C4]*  
*This is the skill of assessing the likelihood of an outcome based on prior knowledge of how things usually turn out.*
- ◆ *Analysing [C4]*  
*This is the skill of clarifying information by examining parts and relationships contained in the information.*
- ◆ *Elaborating*

*This is the skill of providing details, examples and other relevant information so as to make one's ideas more comprehensible to others.*

◆ *Establishing criteria*

*This is the skill of setting standards for judging the usefulness or logic of ideas. These criteria are often derived from culture, experience, and instruction and offered as reasons for making a favourable judgement.*

◆ *Verifying*

*This is the skill of confirming or proving the truth of information, using specific standards or criteria of evaluation.*

◆ *Generating possibilities*

*This is the skill of focusing attention on exploring all the alternatives, possibilities and choices beyond the obvious or preferred one.*

◆ *Abstracting*

*This is the skill of selecting the disparate facts or information and translating these to a general pattern of information. It allows an individual to see how two seemingly unrelated things are really connected on a level beyond the literal.*

◆ *Defining the problem*

*This is the skill of consciously clarifying situations that are puzzling in some way. The extent, scope and nature of the problem are identified and clarified.*

## **PROCESSES**

◆ *Planning investigation [C4]*

*This process involves formulating questions or hypotheses for investigating, and devising ways to find answers. It also involves deciding on the type of equipment required and measurements to be made, as well as identifying the variables involved and manipulating the variables so that the effect of only one variable can be observed in any one experiment.*

◆ *Decision-making*

*This is the process of generating and applying criteria to select from among seemingly equal alternatives. Engaging students in decision-making tasks not only teaches them a useful process but enhances their learning by requiring that they understand content well enough to use it.*

◆ *Creative problem solving*

*This is the process of thinking through a problem and choosing a creative solution that meets the requirements. This thinking process is used whenever one faces obstacles and wishes to overcome them so as to arrive at a practical and workable solution.*

It must be pointed out that there is as yet no consensus of opinion among science educators on the number of and categorisation of science process skills and thinking skills. There is also no one definite sequence of priority among the science process skills and thinking skills

listed above. For example, observation may lead to hypothesising but at other times a hypothesis can lead to an observation. All the process skills and thinking skills listed above are seen as part of the total process of investigation.

In science process teaching and learning, effort should initially be directed at teaching explicitly each of the process skills through the use of appropriate activities. Later effort should be directed to helping students integrate some or all of the process skills in experimentation or in carrying out investigative projects.

One way of integrating the process skills will be through scientific problem solving as seen in investigative experiments or projects. This is commonly conceived as the scientific method and the steps are:

- **Make observations**, which may lead to the identification of a problem.
- **Suggest a hypothesis**, which is a tentative explanation of the problem.
- **Test the hypothesis**, through planning and conducting of the investigation that may involve using apparatus and equipment to collect data and making observations and classification.
- **Infer from data**, which may lead to a conclusion on the validity of the hypothesis. If the hypothesis is invalid, then another tentative explanation or

intelligent guess is made. This is then tested again by experiment until a valid hypothesis is established.

It should be noted that when scientists investigate problems, they might follow these steps, but not necessarily in the sequence given. Much time may also be spent on defining the problem and making hypotheses.

In all scientific investigations, the adoption of certain mental attitudes such as curiosity, humility, impartiality, integrity, inventiveness, healthy scepticism, open-mindedness and perseverance is advocated. Attempts should also be made to promote safety consciousness among students and to encourage students to adopt safe practices.

From the types of questions asked by the students, teachers could gather information on their students' 'frame of mind' and the quality of their understanding. Students should be encouraged to ask both closed and open questions. Opportunities should be provided in the classroom for students to ask questions. The classroom environment must be conducive for students to ask questions. To foster this enquiring mind, teachers may want to answer a question with a question.

## 2 EVALUATION

Evaluation is an integral part of the teaching-learning process. It involves gathering information through various assessment techniques and making value judgements and sound decisions. Assessment provides information to a teacher about students' achievement in relation to the learning objectives. With this information, the teacher makes informed decisions about what should be done to enhance the learning of the students or to improve teaching methods.

On the basis of assessment data, a teacher can decide whether to proceed to the next teaching unit, carry out remedial lessons, set enrichment exercises or modify teaching methods. Hence the process of evaluation can help a teacher raise students' performance by identifying the needs of students and taking the right steps in meeting these needs.

Assessment should be carried out regularly through the use of different techniques such as oral questioning, observation checklists, assignments, practical and written tests. When assessment is carried out on a continual basis, the teacher has the feedback required to plan his day-to-day teaching.

The purpose of assessment is to find out whether a student knows and understands sufficiently to apply knowledge effectively after a period of instruction. Before making a judgement about a certain aspect of students' performance, the teacher should ensure that the assessment technique used is reliable. In other words, the information gained from it should reflect accurately the particular aspect of performance the teacher intends to assess. For example, a paper-and-pencil test could be used to test for recall of facts and understanding of science concepts but would not be suitable for assessing students' practical skills and attitudes.

The aims of this subject are the acquisition of knowledge and understanding of science concepts, the ability to use process and thinking skills, and the development of attitudes important to the practice of science. Hence, a variety of assessment techniques must be designed to measure the attainment of these aims.

In summary, evaluation is effective when it is integrated into the teaching-learning process and carried out regularly and comprehensively through the use of a variety of assessment techniques.

## 2.1 ASSESSMENT OBJECTIVES

The assessment objectives for this subject are classified into the three main ideas: **knowledge with understanding; handling, applying and communicating information (science process skills and thinking skills); and exploration and investigation.**

### (I) Knowledge with understanding

Students should be able to demonstrate knowledge and understanding of

- scientific phenomena, facts, concepts and principles;
- scientific vocabulary, terminology and conventions;
- scientific instruments and apparatus including techniques and aspects of safety;
- scientific and technological applications.

### (II) Handling, applying and communicating information (science process skills and thinking skills)

Students should be able to use visual, aural and written (including symbolic, diagrammatic, graphical and numerical) information to:

- locate, select, organise and present relevant information from a variety of sources;

- transpose information from one form to another;
- process numerical and qualitative data;
- identify patterns, report trends and draw inferences;
- present reasoned explanations for phenomena, patterns and relationships;
- make predictions and hypotheses and deduce relationships;
- apply knowledge, including principles, to novel situations and problems;
- communicate ideas and observations effectively.

### (III) Exploration and investigation

Students should be able to:

- follow and carry out instructions accurately and safely;
- identify the problem and then plan and carry out an investigation to solve the problem;
- use and organise techniques, apparatus and materials effectively and safely;
- observe, measure and record accurately;
- interpret, evaluate and establish validity of the observations and experimental data;
- evaluate methods and suggest possible improvements.

## 2.2 MODES OF ASSESSMENT

The following modes of assessment could be used to assess the main objectives of this subject:

- (a) Theory tests
- (b) Assignments
- (c) Practical tests
- (d) Mini investigations

## 2.3 GUIDELINES FOR ASSESSMENT

### (a) Weighting for continual assessment and semestral examinations

The table below shows the weighting for continual assessment and semestral examinations.

Semester	Weighting		
	Continual Assessment	Semestral Examination	Total
I	20%	20%	40%
II	20%	40%	60%
Total	40%	60%	100%

The assessment objectives in the area **exploration and investigation** would generally be assessed in continual assessment. The most appropriate modes of assessment would be practical test/work and/or mini investigative projects.

Given below is one possible way of allocating the 40% weighting for continual assessment. Teachers could vary the weighting allocated to the different modes depending on the needs and characteristics of their students.

Semester	Weighting for Continual assessment		
	Theory test	Practical assessment	Total
I	10%	10%	20%
II	10%	10%	20%
Total	20%	20%	40%

**(b) Format of semestral theory paper**

There will be one paper and the duration is 2 hours. The format of the paper is given below:

Section	Item Type	Marks
A	Multiple choice; 20 - 40 questions. Answer all questions	20 - 40
B	Short-answer; variable number. Answer all questions	30 - 50
C	Free response/ Structured Answer 3 out of 4 or 4 out of 5 questions	30 - 40

The written paper is divided into three sections, Section A, B and C.

**Section A (20 - 40 marks)**

This section will contain 20 - 40 compulsory multiple choice questions. All the questions will be of the direct choice type with 4 options. (20 - 40 marks)

**Section B (30 - 50 marks)**

This section is compulsory and will contain at least 4 short-answer questions. Each question should not carry more than 8 marks.

**Section C (30 - 40 marks)**

This section will contain 4 - 5 free response/ structured questions. Students are required to answer 3 - 4 questions. Each question will carry 10 marks.

- **Syllabus Coverage**

The second semestral examination covers the whole year's work. A maximum of 35% and a minimum of 15% of the total marks for the paper should be allotted to topics which have been tested in the first semestral examination.

- **Weighting of Assessment Objectives for Written Papers**

- I Knowledge with Understanding, approximately 60% of the marks with approximately 30% allocated to recall and 30% to understanding.
- II Handling, Applying and Communicating Information, approximately 40% of the marks.

**(c) Practical Assessment**

Students will be assessed on the following skills:

- C1 Using and organising techniques, apparatus and materials
- C2 Observing, measuring and recording
- C3 Handling and communicating experimental observations and data
- C4 Planning, carrying out and evaluating investigations

Assessments of these skills are based on practical work done by the student, or using data that has been generated in the presence of the students. It is recommended that students in Secondary One be taught C1 and C2 first. Once they have mastered C1 and C2, assessment of these two skills can be conducted. C3 and C4 could be introduced and assessed in Secondary Two. However, schools have the flexibility to adjust the scheduling of the four skills according to their students' needs.

The criteria for assessment of each of the skills are clearly defined in the following generic checklist for practical assessment. ***This generic checklist should be made available to the students.*** Transparency in assessment motivates students to strive for the highest level of achievement. The specific checklist, with details to suit the specific experiment, should not be

made available to students. The specific checklist includes the exact requirement of the assessment and if given to students would defeat the purpose of the assessment. Each skill has a maximum of 6 marks.

**Generic Checklist for Practical Assessment*****C1: Using and organising techniques, apparatus and materials***

- follow written, diagrammatic or oral instructions carefully
- use apparatus and materials safely and correctly
- apply techniques correctly and methodically

***C2: Observing, measuring and recording***

- make careful observations
- make accurate measurements
- take multiple readings where necessary and calculate their averages correctly
- record results in a table drawn with a ruler
- add clear headings to rows
- add clear headings to columns
- include units in the headings but do not repeat them in the body of the table
- record all numerical results to the appropriate number of decimal places
- label diagrams correctly
- state magnification of drawings correctly, where appropriate

**C3: Handling and communicating experimental observations and data**

- select an appropriate calculation
- display results in a meaningful manner e.g. graphs, charts and drawings
- include title for the graph/chart/drawing
- label graph axes fully and include units
- \*plot graph co-ordinates accurately and draw graph lines with ruler from point to point or as a best-fit curve
- include a discussion on trends and patterns in personal and/or class results
- \*include a discussion on inconsistencies/ anomalies in personal and/or class results
- \*comment on possible sources of experimental error and how these might have affected the results
- write a brief conclusion which relates to the aim of the investigation, based on the results obtained

**C4: Mini-investigations (= Planning, carrying out and evaluating investigations)**

- identify the independent, dependent and control variables
- formulate a hypothesis
- produce a logical plan for a simple investigation
- \*evaluate chosen procedures
- suggest modifications to original plan
- carry out the investigations if time permits
- \*deal with any inconsistent results by retesting in systematic way

Asterisk (\*) indicates practical skill, which should be taught at the awareness level and not to be assessed.

The details proposed in each practical skill act as a framework of skills to be assessed. However not all the skills could be assessed in a single assessment activity. The list of skills to be assessed depends on the assessment activity.

# Syllabus Content

SCIENCE AS AN INQUIRY		
Topic	Learning outcomes	Remarks
<b>Science and technology</b>	<p>Throughout the course students are expected to:</p> <ul style="list-style-type: none"> <li>(a) recognise that the study and practice of science involve three major elements: attitudes, processes or methods, and products</li> <li>(b) recognise that the products of science are the tested data collected by scientists for centuries and explain with examples how people working with science have formulated concepts, principles and theories</li> <li>(c) develop an awareness that science is not confined to the laboratory, but is manifested in all aspects of the world</li> <li>(d) discuss the uses and benefits of science and technology to society</li> <li>(e) develop an awareness of the limitations of science and technology in solving societal problems</li> </ul>	

<b>SCIENCE AS AN INQUIRY</b>		
<b>Topic</b>	<b>Learning outcomes</b>	<b>Remarks</b>
	(f) develop sensitivity to the benefits and abuses of the applications of science	
<b>Attitudes</b>	(a) demonstrate during curricular and co-curricular activities, attitudes such as: <ul style="list-style-type: none"> <li>• willingness to have their own ideas questioned</li> <li>• willingness to modify their own views in the face of new evidence</li> <li>• respect for ideas of others</li> <li>• disposition not to jump to conclusions</li> <li>• scepticism for generalisations not based on verifiable (repeatable) observations</li> <li>• objectivity by seeking data and information to validate observations or explanations</li> <li>• interest and enjoyment in studying the marvels of nature</li> <li>• disposition to try, innovate and attempt creative solutions</li> </ul>	

<b>SCIENCE AS AN INQUIRY</b>		
<b>Topic</b>	<b>Learning outcomes</b>	<b>Remarks</b>
	(b) observe laboratory rules at all times when they are in the science laboratories	
<b>Science process skills</b>	<p>(a) acquire and use during appropriate activities throughout the course, the scientific process skills are:</p> <ul style="list-style-type: none"> <li>• defining a problem or asking a question in clear explicit terms that can be verified by experiment</li> <li>• suggesting a possible hypothesis (tentative explanation) for the problem or phenomenon</li> <li>• determining variables to be measured and controlled</li> <li>• designing simple experiments to test whether the hypothesis (suggested explanation) is correct</li> <li>• making careful observations and repeated measurements</li> <li>• communicating concisely and effectively information in verbal and non-verbal form</li> </ul>	

<b>SCIENCE AS AN INQUIRY</b>		
<b>Topic</b>	<b>Learning outcomes</b>	<b>Remarks</b>
	<ul style="list-style-type: none"> <li>• inferring from data</li> <li>• advancing an explanation based on observation/data collected</li> <li>• stating the limits within which the explanation holds</li> <li>• making some verifiable predictions based on known data</li> <li>• generating new ideas or questions from the results of the investigation so as to start the second cycle of investigation</li> <li>• describing trends in data even when patterns are not exact</li> <li>• analysing alternative explanations and procedures</li> </ul>	

<b>MEASUREMENT</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Use of measuring instruments</b>		<p>Students are expected to:</p> <p>(a) acquire and use, during appropriate activities throughout the course, the scientific practical skills are:</p> <ul style="list-style-type: none"> <li>• use of common laboratory apparatus such as the Bunsen burner, handlens, microscope</li> <li>• use of the following measuring instruments: measuring cylinder, metre rule and measuring tape, vernier callipers, electronic balance, spring balance, stop-watch, thermometers</li> <li>• estimation and/or measurements of length, area, volume, mass and time (included are the area of irregular two-dimensional figures, volume and mass of liquids and solids but not of gases)</li> </ul>	
Physical quantities and units		<p>(a) use the appropriate units for length, mass, time and temperature</p>	Students should be aware that there are other units such as volts, ohms, amperes, watts, newtons and joules. These units will be covered in their respective topics.

MEASUREMENT			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		(b) interpret and use the appropriate prefixes, milli- centi- or kilo- in relation to the units of length and mass  (c) explain what is meant by density  (d) calculate density using the formula:  density = mass/volume  (e) explain what is meant by average speed  (f) calculate average speed using the formula Average speed = distance travelled/time taken  (g) determine appropriate units for physical quantities such as area, volume, density and rate	Students should relate density to floating and sinking. Units for density: $\text{g/cm}^3$ ; $\text{kg/m}^3$ .

<b>DIVERSITY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Classification of matter</b>		<p>(a) classify a number of common everyday objects and recognise that there are many ways of classifying the same groups of objects</p> <p>(b) describe the properties of these groups of materials in terms of</p> <ul style="list-style-type: none"> <li>• density</li> <li>• strength</li> <li>• hardness</li> <li>• flexibility</li> <li>• electrical conductivity</li> <li>• thermal conductivity</li> <li>• boiling/melting point</li> </ul> <p>(c) distinguish between the main classes of materials (metals, ceramics, glass, plastics and fibres) in terms of their properties</p>	<p>Students should appreciate that the common everyday objects could be classified in different ways. E.g.</p> <ul style="list-style-type: none"> <li>• according to their properties (physical or chemical),</li> <li>• their uses,</li> <li>• where they can be found</li> </ul> <p><b>Strength</b> refers to the ability to withstand a heavy load without breaking.</p> <p><b>Hardness</b> refers to the ability to withstand scratches.</p> <p><b>Flexibility</b> refers to the ability to bend without breaking.</p>

<b>DIVERSITY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		(d) use data on the properties of different materials to make evaluative judgements about their uses	Illustrate with examples like --plastic, which is easy to mould and a poor conductor of heat, is used to make containers; --aluminium, which is strong and has low density, is used to make the body of aeroplanes.
<b>Classification of plant and animal life</b>		(a) show an understanding of the need to classify living organisms  (b) classify living organisms according to commonly observable characteristics  (c) classify living organisms into major taxonomic groups  (d) construct a dichotomous key  (e) use simplified dichotomous keys in identifying and classifying living organisms	Thinking skill/process to be emphasised • classifying  This learning outcome does not require Prokaryotic and Eukaryotic classification, only general classification of animals and plants is expected.  A dichotomous key classifies objects by dividing them into 2 smaller groups based on





<b>DIVERSITY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
			<p><a href="http://www.pub.gov.sg/NEWater">www.pub.gov.sg/NEWater</a></p> <p>Students could gather information on techniques employed in desalination plants. Students could do a cost –benefits analysis of a desalination plant.</p>
<b>Solutions and suspensions</b>		<p>(a) distinguish among solute, solvent and solution</p> <p>(b) deduce the nature of solutions and suspensions by simple laboratory tests</p> <p>(c) investigate the factors that affect the solubility and rate of dissolving of substances</p>	<p>Thinking skills/processes to be emphasised</p> <ul style="list-style-type: none"> <li>• inferring</li> <li>• experimental inquiry</li> <li>• information gathering</li> </ul> <p>Students should design experiments to investigate the effects of the following factors:</p> <ul style="list-style-type: none"> <li>--temperature</li> <li>--nature of solute/solvent</li> <li>--surface area</li> </ul> <p>pH sensor and data-logging techniques could be used in practical work.</p>

<b>DIVERSITY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		(d) show an awareness of the importance of these factors in homes and industries	
	*	(e) show an understanding that indicators are substances that change colour when an acid or alkali is added to them	
	*	(f) investigate the effect of a variety of acidic, alkaline and neutral solutions on Universal Indicator paper and natural indicators (i.e. obtained from plants)	
	*	(g) investigate the effect on Universal Indicator paper when acidic and alkaline solutions are mixed	
	*	(h) investigate the properties of acidic and alkaline solutions (action of alkalis on ammonium salts NOT required)	

<b>MODELS AND SYSTEMS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Particulate model of matter</b>		(a) show an awareness that matter is made up of small discrete particles which are in constant and random motion using the particulate model	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• inferring</li> </ul> Computer simulation or animation or molecular models could be used to illustrate the concepts.
	*	(b) show an understanding of the simple model of solids, liquids and gases, in terms of the arrangement and movement of the particles	
	*	(c) distinguish among three states of matter (solid, liquid and gas)	
<b>Simple concepts of atoms and molecules</b>		(a) describe an atom as an electrically neutral entity made up of a positively charged nucleus (protons and neutrons) with negatively charged electrons moving round the nucleus	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• identifying attributes and components (analysing)</li> <li>• comparing</li> <li>• information gathering</li> </ul> As an extension, students could do research on development of different atomic models.
		(b) show an appreciation of the relative size of an atom compared to other objects	
		(c) show an awareness that atoms of the same element contain the same number of protons and those of different elements contain different numbers of protons	
	*	(d) recognise that an ion is formed when an atom gains or loses electron(s)	

<b>MODELS AND SYSTEMS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<p>(e) show an understanding of the following:</p> <ul style="list-style-type: none"> <li>• the distinction between atoms and molecules</li> <li>• that molecules of an element consist of a fixed number of the same type of atoms combined together</li> <li>• that molecules of a compound consist of a fixed number of different types of atoms combined together</li> </ul> <p>(f) state the number and types of atoms, given the chemical formula of a compound</p>	Computer simulation/animation or molecular models could be used to illustrate the concepts.
<b>Cells - structure, function and organisation</b>		<p>(a) examine plant cells under the microscope and identify the different parts of a cell viz.</p> <ul style="list-style-type: none"> <li>• cell wall</li> <li>• cell membrane</li> <li>• cytoplasm</li> <li>• nucleus</li> <li>• vacuole</li> <li>• chloroplast</li> </ul>	Students should be able to appreciate that chlorophyll needed for photosynthesis is in the chloroplast. Chloroplast is mainly present in leaves. As an extension, students could observe chloroplasts in <i>Hydrilla</i> or <i>Elodea</i> cells.

<b>MODELS AND SYSTEMS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<p>(b) examine animal cell under the microscope and identify the different parts of the animal cell:</p> <ul style="list-style-type: none"> <li>• cell membrane</li> <li>• cytoplasm</li> <li>• nucleus</li> </ul> <p>(c) compare a typical plant cell and a typical animal cell</p> <p>(d) show an understanding of the functions of the different parts of a cell, including the nucleus which contains genetic material that determines heredity.</p> <p>(e) recognise that multicellular organisms (both plants and animals), cells of similar structures are organised into tissues; several tissues may make up an organ; organs are organised into systems</p> <p>(f) explain the significance of the division of labour, even at the cellular level</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• comparing</li> <li>• identifying attributes and components (analysing)</li> <li>• observing</li> <li>• inferring</li> <li>• information gathering</li> </ul> <p>As an extension, students could do research on the development of the cell model.</p>

<b>MODELS AND SYSTEMS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Digestion in animals</b>		(a) explain what is meant by digestion	<p>Thinking skill/process to be emphasised:</p> <ul style="list-style-type: none"> <li>• identifying attributes and components (analysing)</li> <li>• Inferring</li> </ul> <p>Students should appreciate that food that is not in the simplest form must be broken down in order for the body to absorb.</p> <p>Students could infer that the end products of digestion are used for cellular processes like respiration, growth and tissue repair.</p> <p>Computer simulation or animation could be used to illustrate the digestion of food as the food moves down the digestive system.</p>
	*	(b) explain why most food must be digested	
	*	(c) describe how a digestive system helps in digestion of food and the part played by enzymes in digestion (Only classes of enzymes such as amylase, protease and lipase are needed. Specific names of enzymes not required.)	

<b>MODELS AND SYSTEMS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Transport in living things</b>		<p>(a) observe and infer that diffusion is the movement of molecules from a region of higher concentration to a region of lower concentration</p> <p>(b) observe and infer that osmosis involves the movement of water molecules when 2 solutions of unequal concentration are separated by a partially permeable membrane</p> <p>(c) explain the need for a transport system in human beings and plants</p> <p>(d) explain how diffusion and osmosis are involved in the transport system</p> <p>(e) describe briefly the process of absorption of water and mineral salts by the root of a plant [Cellular treatment NOT required]</p> <p>(f) describe briefly the transport of water and manufactured food substances in the plant [Cellular treatment is NOT required]</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• comparing</li> <li>• analysing</li> <li>• elaborating</li> </ul>

<b>MODELS AND SYSTEMS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
	*	(g) describe briefly how blood acts as a transport medium	
<b>Sexual reproduction in human beings</b>		<p>(a) recognise that heredity is a process where genetic information is transmitted from one generation to another</p> <p>(b) recognise that in sexual reproduction a new individual is formed through the union of an egg and a sperm</p> <p>* (c) recognise that a new individual formed through sexual reproduction receives genetic information from its mother (via the egg) and its father (via the sperm)</p> <p>* (d) state some of the physical changes that occur during puberty and early adolescence</p> <p>* (e) describe briefly the structures and functions of human male and female reproductive systems</p> <p>* (f) describe briefly the menstrual cycle and fertilisation</p> <p>* (g) describe briefly a temporary and a permanent method of birth control</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• information gathering</li> <li>• inferring</li> <li>• observing</li> <li>• analysing</li> <li>• decision making</li> </ul>

MODELS AND SYSTEMS			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<p>(h) state the harmful consequences of sexually transmitted diseases like syphilis, gonorrhoea and AIDS</p> <p>(i) discuss the consequences and issues relating to:</p> <ul style="list-style-type: none"> <li>• abortion</li> <li>• pre-martial sex</li> </ul> <p>(j) show an awareness of some forms of facilitated reproduction in humans</p>	<p>Students to discuss issues using newspaper articles.</p> <p>Examples of facilitated reproduction are <i>in-vitro</i> fertilisation and artificial insemination. Infusion of NE message 6, 'We have confidence in our future.' The first <i>in-vitro</i> fertilisation in Asia took place in Singapore in 1982. Infant was born on 19 May '83, 5 years after the birth of the first <i>in-vitro</i> fertilisation in the world.</p> <p>As an extension, students could do research on the various forms of facilitated reproduction in humans.</p>

<b>ENERGY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Sources of energy and storage of energy</b>	*	(a) describe the different sources of energy viz. solar, geothermal heat, nuclear energy, tides, fossil fuels (e.g. coal, oil and natural gas), biomass	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• analysing</li> <li>• information gathering</li> <li>• decision-making</li> </ul> <p>This learning outcome could be linked to Electricity learning outcome (i).</p> <p>Infusion of national education message on why the need to conserve energy.</p> <p>Students could access information on sources of energy through using CD-ROM or Internet or even conducting a survey.</p>
	*	(b) explain how energy is extracted from these sources and stored for future use	
	*	(c) state that fossil fuels are exhaustible and explain the need to develop alternative sources of energy for wide-scale use	
		(d) discuss the need and ways to reduce energy wastage	
	*	(e) show an understanding of how scientific developments have influenced energy use through the ages	

<b>ENERGY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Light</b>		(a) show an appreciation of the vast difference in speed between light and sound and common moving objects	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• inferring</li> <li>• observing</li> <li>• experimental inquiry</li> </ul> Students are to investigate these phenomena of light in practical activities and make inferences through observations in everyday life.
	*	(b) explain how reflection is affected by a smooth and rough surface	
		(c) give the characteristics of the image formed by a plane mirror	
	*	(d) describe the effects and uses of reflecting surfaces (e.g. plane and curved)	
		(e) describe some effects and consequences of refraction	
		(f) explain the difference between reflection and refraction	
	*	(g) describe the dispersion of white light by a prism	
	*	(h) explain how we see the colour of objects in white light and coloured light such as red, blue and green	

<b>ENERGY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Electricity</b>	*	(a) explain what is meant by current, potential difference and resistance, stating their units	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• experimental inquiry</li> <li>• observing</li> <li>• information gathering</li> <li>• decision-making</li> </ul>
	*	(b) draw and interpret circuit diagrams and set up circuits containing electrical sources, switches, lamps, resistors (fixed and variable), ammeters and voltmeters	
		(c) <u>recognise that the resistance of a circuit can be varied by arranging resistors in series or in parallel</u> [Calculations are <b>NOT</b> required]	
	*	(d) <u>investigate the effect of varying resistance on the current in the circuit using fixed or variable resistors</u>	
	*	(e) discuss qualitatively the chemical, heating and magnetic effects of an electric current and list some applications	
		(f) explain what is meant by power and state its units	

<b>ENERGY</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<p>(g) <u>solve simple problems on the cost of using electrical appliances, using kilowatt-hour as a unit of electrical energy consumption</u></p> <p>(h) state some electrical hazards and precautionary measures to ensure the safe use of electricity in the home</p> <p>(i) discuss the importance of reducing electrical energy wastage</p>	<p>Students could conduct a study to investigate the amount of electrical energy used in their home in a year.</p> <p>This learning outcome could be linked to Sources of energy and storage of energy, learning outcome (d).</p>
<b>Photosynthesis and respiration</b>		<p>(a) briefly outline the process of photosynthesis by which plants manufacture carbohydrates using raw materials</p> <p>(b) trace the primary food source in a food chain to the green plant</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• analysing</li> <li>• inferring</li> <li>• comparing</li> <li>• information gathering</li> <li>• experimental inquiry</li> </ul>

ENERGY			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
	*	<p>(c) <u>show an understanding of the conditions necessary for photosynthesis</u></p> <p>(d) <u>compare the conditions for healthy growth of ornamental plants and large scale crop production</u></p> <p>(e) compare respiration and breathing</p> <p>(f) show an understanding of how plants take in oxygen and remove carbon dioxide</p> <p>(g) describe aerobic respiration and state its importance and construct a word equation for aerobic respiration</p> <p>(h) compare photosynthesis and respiration.</p>	<p>Conditions necessary for photosynthesis. include presence of light, chlorophyll, availability of carbon dioxide and water.</p> <p>Illustrate photosynthesis with a word equation.</p> <p><b>Respiration</b> refers to the cellular release of energy from food substances in all living cells.</p> <p><b>Breathing</b> refers to the movements that caused exchange of gases between the body and its surroundings.</p> <p>As an extension, students could do research on methods such as hydroponics and aeroponics.</p>

<b>INTERACTIONS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Chemical changes</b>		<p>(a) observe the changes that matter (i.e. element, compound or mixture) undergoes through</p> <ul style="list-style-type: none"> <li>• mixing</li> <li>• heating</li> <li>• exposure to light</li> <li>• passing of an electric current</li> </ul> <p>(b) identify a chemical reaction as a process leading to the formation of new products</p> <p>(c) show an awareness that there are different types of reactions such as combustion, thermal decomposition, oxidation</p> <p>(d) use word equations to represent chemical reactions</p> <p>(e) state that materials from a variety of sources can be converted into new and useful products by chemical reactions</p> <p>(f) show an awareness that the following everyday changes involve chemical reactions</p> <ul style="list-style-type: none"> <li>• burning</li> </ul>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• observing</li> <li>• inferring</li> <li>• comparing</li> <li>• decision-making</li> <li>• information gathering</li> </ul> <p>Students should appreciate that a change which does not lead to formation of new product(s) is not a chemical change. Physical change is not included in the Primary Science Revised Syllabus.</p>

<b>INTERACTIONS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<ul style="list-style-type: none"> <li>• cooking</li> <li>• rusting</li> <li>• decay</li> <li>• respiration</li> </ul> <p>(g) show an awareness of energy transfers that accompany chemical reactions, including the burning of fuels and how energy can be controlled and used</p> <p>(h) discuss the possible effects of burning fuels on the environment.</p>	
<b>Concept of force and pressure</b>	*	(a) identify some examples of forces	<p>Examples of forces include gravitational force, frictional force and magnetic force.</p> <p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• predicting</li> <li>• analysing</li> <li>• observing</li> <li>• inferring</li> </ul>
	*	(b) describe and predict the effects of forces: <ul style="list-style-type: none"> <li>• on the state of rest or motion of a body</li> <li>• on the size and shape of a body</li> </ul>	
		(c) use the newton as the S.I. unit of force	
		(d) use a spring balance as one of the ways to measure force	

INTERACTIONS			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		(e) relate pressure to force and area, using appropriate examples	Computer simulation or animation could be used to illustrate the concepts. As an extension, students could do research on how forces are used to make work easier.
<b>Moment of a force</b>	*	(a) <u>state what is meant by moment of a force</u> (b) <u>calculate the moment of a force using the equation:</u> <u><math>moment\ of\ a\ force\ about\ a\ point = force \times perpendicular\ distance\ from\ the\ pivot\ to\ the\ line\ of\ action\ of\ the\ force</math></u> <u>[Principle of moments NOT required]</u> (c) <u>describe the application of forces in levers</u>	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• observing</li> <li>• analysing</li> </ul>
<b>Work</b>		(a) state what is meant by work done (b) <u>calculate work done by a force using:</u> <u><math>work\ done = force \times distance\ moved\ in\ the\ direction\ of\ the\ force</math></u>	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• analysing</li> <li>• observing</li> </ul>

INTERACTIONS			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<p><u>[Restrict calculations to cases where the direction of the force is parallel to the direction of the distance moved.]</u></p> <p>(c) distinguish between situations involving forces where work is done and where work is not done</p> <p>(d) state the unit of work as the joule</p>	<ul style="list-style-type: none"> <li>• inferring</li> </ul>

<b>INTERACTIONS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Effects of heat energy</b>	*	(a) infer that generally, solids, liquids and gases expand when heat is absorbed and contract when heat is given out	Students should appreciate that thermal expansion results in a change in volume of the substance and therefore the density of the substance.  Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• analysing</li> <li>• elaborating</li> </ul>
	*	(b) describe some effects and applications of expansion and contraction in everyday life such as: <ul style="list-style-type: none"> <li>• riveting</li> <li>• gaps in bridges, pavement and MRT lines</li> <li>• thermostats</li> </ul> (c) <u>explain that measurement of temperature makes use of measurable physical properties which vary with temperature such as in liquid-in-glass thermometer, thermocouple and resistance thermometer</u>	
<b>Transmission of heat energy</b>	*	(a) explain what is meant by conduction, convection and radiation	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• analysing</li> <li>• defining problem</li> </ul>
	*	(b) identify and explain applications of heat conduction (e.g. in cooling, heating and insulation)	

<b>INTERACTIONS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
	*	<p>(c) identify and explain applications of heat convection (e.g. in cooling and heating)</p> <p>(d) show an understanding that the rate of heat loss or gain through radiation is affected by the temperature and the nature of the surface</p> <p>(e) identify and explain applications of heat radiation (e.g. radiant heaters, solar radiation)</p> <p>(f) define a problem and then design and construct an insulated container or a model solar heating device</p>	<ul style="list-style-type: none"> <li>creative problem solving</li> </ul> Temperature sensors and data-logging devices could be used in practical work.
<b>Sound</b>	*	<p>(a) describe the production of sounds by vibrating objects</p> <p>(b) recognise that sound transfers energy and that it takes time to travel from one point to another through a medium</p>	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>inferring</li> <li>analysing</li> <li>information gathering</li> </ul> Sound sensor and data-logging techniques could be used.

INTERACTIONS			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
	*	(c) identify sounds of different pitch and relate the pitch to their frequencies	As an extension, students could do research on ultrasound and its uses.
		(d) explain how the ear detects sound [Detailed structure of ear is <b>NOT</b> required]	
		(e) recognise the importance of sound in our society and the adverse effect of noise in our environment	
	*	(f) <u>show an awareness of the uses of ultrasound in medicine and communications</u>	
Abuses to life processes		(a) describe the benefits/uses of drugs e.g. medicinal	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• information gathering</li> <li>• decision-making</li> <li>• analysing</li> <li>• elaborating</li> <li>• generating possibilities</li> </ul>
		(b) list some drugs and inhalants that are commonly abused	List the names of the commonly abused drugs.

<b>INTERACTIONS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
		<p>(c) describe the harmful effects and consequences of drug abuse such as depression, hallucination, addiction and related social problems like crime and transmission of AIDS</p> <p>(d) describe some possible harmful effects of consumption of alcohol on the alcoholic person, his family and society</p> <p>(e) list the harmful substances in tobacco smoke e.g. nicotine, carbon monoxide gas, tar and other cancer-causing substances</p> <p>(f) describe some possible harmful effects of smoking or passive smoking on a person's health such as bronchitis, lung cancer and heart disease</p> <p>(g) discuss ways to encourage people to refrain from smoking</p> <p>(h) suggest ways to avoid being addicted to drugs and alcohol</p>	<p>This objective does not require the knowledge of different categories of drugs.</p>

<b>INTERACTIONS</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Energy transfer process in the ecosystem</b>	(a)	identify energy flow within the ecosystem	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• analysing</li> <li>• elaborating</li> </ul> Some of the food consumed by the animals and the energy produced during respiration is temporarily stored for use in life processes.  Examples of food pyramids are pyramid of energy, pyramid of numbers and pyramid of biomass.
	(b)	describe the energy transfer process through the food chain starting with the green plant as a primary food producer	
	(c)	<u>explain the diminishing energy transfer as illustrated in the food pyramid</u>	
	(d)	construct a food web in a specific habitat (Food chain and food web have been taught at primary level, teachers need not dwell on these topics)	

<b>CYCLES</b>			
Topic		Learning outcomes <i>Meaning of asterisk(*) and underlined outcomes in Preamble</i>	Remarks
<b>Nutrient cycles in the ecosystem</b>	*	(a) show an understanding of the concept of recycling of nutrients trapped in living organisms and explain the role of decomposers in these processes	Thinking skill/process to be emphasised: • analysing  Computer simulation could be used to illustrate the concepts.
	*	(b) describe briefly the carbon and nitrogen cycles  (c) <u>discuss the role of the carbon and nitrogen cycles in helping to maintain a balance in the ecosystem</u>	

**GLOSSARY OF TERMS USED IN THE REVISED LOWER SECONDARY SCIENCE SYLLABUS**

<b>S/NO</b>	<b>TERM</b>	<b>DESCRIPTION OF TERM</b>
1	Calculate	To give a numerical answer based on a given formula with working shown
2	Classify	To group things based on common characteristics
3	Compare	To identify similarities and differences between objects, concepts or processes
4	Construct	To write or form something not by factual recall but by using given information
5	Deduce	To draw conclusion based on the general rules or given information
6	Describe	To state words (using diagrams where appropriate) the main points of a topic
7	Determine	To obtain the quantity by calculation, substituting measured or known values of other quantities into a standard formula
8	Discuss	To give a critical account of the points involved in the topics
9	Distinguish	To identify and understand the differences between objects, concepts and processes
10	Evaluate	To consider all factors relating to the object/event before making a judgement
11	Explain	To give reasons or make some references to theory
12	Identify	To select and/or name the object, event, concept or process
13	Infer	To draw a conclusion based on the observations
14	Investigate	To find out by carrying out experiments
15	List	To give a number of points or items without elaboration
16	Outline	To give the main or essential points of the concepts or processes
17	Predict	To state a likely future event based on the given information or rules
18	Recognise	To identify facts, characteristics or concepts that are critical (relevant/appropriate) to the understanding of a situation, event, process or phenomenon
19	Relate	To identify and explain the relationships between objects, concepts or processes
20	Show an appreciation	To recognise and explain the value of a concept or situation
21	Show an awareness	To have superficial knowledge of the concepts or processes
22	Show an understanding	To recall, explain and apply information
23	State	To give a concise answer with little or no supporting argument
24	Suggest	To provide ideas to a problem or a situation, or apply knowledge to a 'novel' situation

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**Curriculum Planning & Development Division  
Ministry of Education**

**Science Syllabus  
Lower Secondary  
Normal (Technical)  
2001**

# Science Syllabus

## Lower Secondary

### Normal (Technical)



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# PREAMBLE

This Lower Secondary Science Normal (Technical) Syllabus covers the first two-years of a 4-year syllabus designed to provide secondary school pupils in the Normal (Technical) Course with the necessary foundation in science for post-secondary technical courses. The content knowledge and the learning approach of this subject consolidate and build on what the pupil has acquired through science in the primary school. A pupil who has completed primary school education in any of the streams will be adequately prepared to study this subject.

The knowledge and skills to be acquired in this subject have direct relevance to technical courses. Many of these skills and much of this knowledge are in the physical sciences. Topics which are aimed at developing an interest in and a positive appreciation of science and technology have also been included. In addition, some topics on the human body and healthy lifestyles have been included to prepare the pupils for adult life.

The aims spelt out in the syllabus provide the guiding principles for the suggested teaching approaches and evaluation methods. A list of process skills, thinking skills and processes for teaching is also provided. In addition, information and suggestions on infusing information technology and thinking into the teaching and learning of science are included alongside the learning outcomes.

Teachers are advised not to follow the syllabus too rigidly but to exercise their professional judgement in implementing it. Schemes of work should be developed with the interests and

abilities of the students uppermost in mind. Teachers are encouraged to use a variety of approaches in their teaching and to incorporate ideas and materials from various sources, in order to enhance the learning of science.

Asterisks (\*) placed alongside learning outcomes indicate areas of the syllabus where it is anticipated that teachers might use applications of information technology, as appropriate. It should be appreciated that the list is not exhaustive.

The “Remarks” column contains teaching strategies. They also include statements that help teachers focus on the key learning points for the respective learning outcomes.

# 1 OVERVIEW

## 1.1 PHILOSOPHY AND AIMS

The goal of science education was once thought to be solely to prepare a person for a science or engineering career. Hence, great emphasis was paid to the acquisition of scientific knowledge and understanding. However, the ever-expanding scientific knowledge makes it impossible for the student to absorb all of it while the ability to access, generate and process information becomes important. Instead of aiming primarily at the acquisition of knowledge and understanding, the aims now include the acquisition of skills, from discrete process skills, thinking skills to processes such as decision making and problem-solving.

The rapid advances in science and technology, and their relevance to society, require ordinary people to acquire basic scientific and technological literacy so as to enable them to understand and make informed decisions relating to science and technology. Also, the realisation that science and technological developments are now shaping people's lives makes it necessary that science education should inculcate positive attitudes towards self and society, and the role of science and technology in shaping our lives.

Thus, this science syllabus is aimed at preparing students for post-secondary technical education as well as enabling them to become scientifically informed and responsible adults.

The aims are to:

- (i) enable students to acquire knowledge and understanding so as to
  - be suitably prepared for post-secondary technical courses;
  - become confident citizens in a technological world.
- (ii) enable students to develop abilities and skills that
  - will be relevant and useful in the workplace and daily life;
  - encourage safety consciousness and safe practices.
- (iii) develop attitudes which
  - are relevant to the study of science such as concern for accuracy and precision;
  - will enable the students to be responsible and productive citizens.
- (iv) stimulate
  - curiosity, interest, and enjoyment in science;
  - care and concern for the environment.
- (v) promote an awareness of the impact of science and technology on society, industry, business, home and leisure.

- (vi) promote an awareness of the importance of the use of IT for communications and as a tool for data collection and analysis of experimental results.

## 1.2 SYLLABUS FRAMEWORK

The syllabus is written with separate self-contained units which are not hierarchical and conceptually-linked as in traditional science syllabuses. This will free teachers from attempting to present a logically- and comprehensively-linked "whole" syllabus, thus enabling teachers to tailor each unit to suit the abilities of the students. However, a few basic topics such as physical quantities and measurement will still have to be mastered by students so as to facilitate learning in other units.

The units are as follows:

<b>Core Units</b>	1	INTRODUCING SCIENCE AND TECHNOLOGY
	2	KEEPING THE BODY GOING
	3	MATTER
	4	MOVEMENT AND MACHINES
	5	CURRENT IN ACTION
	6	HEAT AT WORK
<b>Elective Units</b>	A	OPTICS
	B	LEISURE
	C	MATERIALS

The six Core Units are compulsory for all students. Other than the unit on **Introducing Science and Technology**

which is to be taught first, there is no particular order in which the units are to be taught. Teachers are encouraged to determine the order based on the abilities and current interests of the students.

The choice of Elective Units should be based on both the students' interest and career inclinations. It is recommended that teachers teach one out of the three Elective Units. However, teachers have the flexibility to teach more than one of the Elective Units if they have more able students. This flexibility allows teachers to tailor the breadth of the syllabus coverage to suit the abilities of their students. It is advisable that **Materials** be taught after **Matter** has been taught.

## 1.3 UNITS AND TOPICS

This science syllabus is a further development of the Primary Science Syllabus. Based on the notion of a spiral curriculum, fundamental concepts introduced at the primary school level are built upon and treated in greater depth at the lower secondary level.

Table 1 shows the topics in the Core and Elective Units. They provide a broad coverage of fundamental concepts and principles in science which are relevant to technical courses. Hence, there is a strong bias to the physical sciences. For most of the units, the contents of each unit are generally comprehensive and are not directly linked to other units. However, within each unit, concepts are systematically developed.

Table 1

<p style="text-align: center;"><b>CORE UNITS</b></p>	<p><b>3 MATTER</b></p> <ul style="list-style-type: none"> <li>• Properties of matter</li> <li>• Solids, liquids and gases</li> <li>• Water, solutions and suspensions</li> <li>• Air pollution</li> <li>• Water pollution</li> </ul>	<p><b>6 HEAT AT WORK</b></p> <ul style="list-style-type: none"> <li>• Temperature and thermometer</li> <li>• Heating and cooling matter</li> </ul>	<p><b>A OPTICS</b></p> <ul style="list-style-type: none"> <li>• Nature and behaviour of light</li> <li>• Mirrors and lenses</li> <li>• Spectrum and filters</li> <li>• Lasers</li> </ul>	
	<p><b>1 INTRODUCING SCIENCE &amp; TECHNOLOGY</b></p> <ul style="list-style-type: none"> <li>• What is science and technology?</li> <li>• Physical quantities and measurement</li> <li>• Energy as a resource</li> </ul>	<p><b>4 MOVEMENT AND MACHINES</b></p> <ul style="list-style-type: none"> <li>• Force</li> <li>• Machines</li> </ul>	<p><b>ELECTIVE UNITS</b></p>	<p><b>B LEISURE</b></p> <ul style="list-style-type: none"> <li>• Sound and echo</li> <li>• Music</li> <li>• Sports</li> </ul>
	<p><b>2 KEEPING THE BODY GOING</b></p> <ul style="list-style-type: none"> <li>• Digestion</li> <li>• Reproduction</li> <li>• Other life processes</li> <li>• Abuses to life</li> </ul>	<p><b>5 CURRENT IN ACTION</b></p> <ul style="list-style-type: none"> <li>• What is electricity?</li> <li>• Currents and circuits</li> <li>• Sources of electricity</li> <li>• Conductors and insulators</li> <li>• Electrical safety</li> </ul>		<p><b>C MATERIALS</b></p> <ul style="list-style-type: none"> <li>• Plastics</li> <li>• Elastomers</li> <li>• Natural fibres</li> <li>• Composites</li> <li>• Semiconductors</li> </ul>

In the Core Units, the student is introduced to the essence of science, its measurement and the impact of science and technology on society. Building on the concepts introduced in Primary Science, the student learns more about matter, particularly that of water and solutions, and air and water pollution. In the unit **Movement and Machines** the student examines forces, their effects and the application of forces as seen in the working of machines. The effects of heating and cooling matter are touched on and illustrated by everyday consequences and applications in the unit **Heat At Work**. For the unit **Current In Action**, the safe use of electricity is emphasised.

The student does not only learn about the physical world. Processes in the human body such as digestion and reproduction as well as abuses to life are dealt with in the unit **Keeping The Body Going**.

The Elective Units are on specialised areas of science and technology. They are either relevant to particular technical courses or chosen to boost interest in and appreciation of science and technology. The treatment of complex technologies is at the basic and qualitative level.

The **Optics** unit offers a spectrum of applications involving mirrors, lenses and lasers. In the **Leisure** unit, topics are in a lighter vein and include the physics of leisure activities such as music and sports. In **Materials**, students find out about the properties and

uses of plastics, elastomers, natural fibres, composites and semiconductors.

It should be pointed out that in all the units, the use of concrete examples to illustrate scientific principles is to be emphasised and advocated rather than of abstract theories and concepts. Also, the applications of science and technology should be included wherever appropriate.

In the teaching and learning process, teachers need to provide opportunities for students to develop and apply thinking and process skills. In addition, there is also a need to provide students with opportunities whereby information technology could be used to facilitate and enhance understanding of scientific processes and concepts.

It is hoped that teachers will incorporate the social, environmental, economic and technological aspects of science wherever possible throughout the syllabus (see Aims (iv) and (v)).

#### 1.4 SCIENTIFIC INQUIRY AND PROCESSES

Continuing with the emphasis on inquiry in the Primary Science Syllabus, this syllabus also promotes inquiry whereby students use concepts and integrate the thinking and process skills acquired to inquire further into the many phenomena in the environment. Scientific inquiry involves thinking skills, science process skills, as well as general inquiry processes

such as planning investigation, decision-making, problem solving, and clarification of values.

## SKILLS

### ◆ Formulating questions

*This is the skill involving the clarification of issues and meaning through inquiry. Good questions focus attention on important information and are designed to generate new information.*

### ◆ Observing

*This is the skill of using our senses to gather qualitative as well as quantitative information about a particular object, event or phenomenon. This also includes the use of instruments to extend the range of our senses.*

### ◆ Classifying

*This is the skill of grouping objects or events according to common attributes or properties.*

### ◆ Using apparatus and equipment

*This is the skill of knowing the functions and limitations of various equipment and apparatus, and being able to select and handle them appropriately for various tasks.*

### ◆ Comparing

*This is the skill of identifying the similarities and differences between or among objects or entities.*

### ◆ Communicating

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

### ◆ Inferring: Induction

*This is the skill of interpreting or explaining observations or pieces of data or information. Generalisations are then drawn based on the patterns or connections in these areas.*

### ◆ Inferring: Deduction

*This is also the skill of interpreting or explaining observations or pieces of information. This process uses reasoning based on principles and generalisations in order to derive unstated specific consequences.*

### ◆ Formulating hypothesis

*This is the skill of making a general explanation for a related set of observations or events. It is an extension of inferring.*

### ◆ Predicting

*This is the skill of assessing the likelihood of an outcome based on prior knowledge of how things usually turn out.*

### ◆ Analysing

*This is the skill of clarifying information by examining parts and relationships contained in the information.*

### ◆ Elaborating

*This is the skill of providing details, examples and other relevant information so as to make one's ideas more comprehensible to others.*

◆ Verifying

*This is the skill of confirming or proving the truth of an idea, using specific standards or criteria of evaluation.*

◆ Generating possibilities

*This is the skill where one focuses one's attention on exploring all the alternatives, possibilities and choices beyond the obvious or preferred one.*

◆ Defining the problem

*This is the skill where one makes conscious effort to clarify situations that are puzzling in some way. The extent, scope and nature of the problem are identified and clarified.*

**PROCESSES**

◆ Planning Investigation

*This process involves formulating questions or hypotheses for investigating and devising ways to find answers. It also involves deciding on the type of equipment required, and measurements to be made, as well as identifying the variables involved and manipulating the variables so that the effect of only one variable can be observed in any one experiment.*

◆ Decision-making

*This is the process of generating and applying criteria to select from among seemingly equal alternatives. Engaging students in decision making tasks not only teaches them a useful process but enhances their*

*learning by requiring that they understand content well enough to use it.*

◆ Creative problem solving

*This is the process of thinking through a problem and choosing a creative solution that meets the requirements. This thinking process is used whenever one faces obstacles and wishes to overcome them so as to arrive at a practical and workable solution.*

It must be pointed out that there is as yet no consensus of opinion among science educators on the number and categorisation of science process and thinking skills. There is also no one definite sequence of priority among the science process skills and thinking skills listed above. For example, observation may lead to hypothesising but at other times a hypothesis can lead to observation. All the process skills and thinking skills listed above are seen as part of the total process of investigation.

In science process teaching and learning, effort should initially be directed at teaching explicitly each of the process skills through the use of appropriate activities. Later, effort should be directed to helping students integrate some or all of the process skills in experimentation or in carrying out investigative projects.

One way of integrating the process skills and thinking skills will be through scientific problem-solving as seen

in investigative experiments or projects. This is commonly conceived as the scientific method:

- **Make observations**, which may lead to the identification of a problem.
- **Suggest a hypothesis**, which is a tentative explanation of the problem.
- **Test the hypothesis**, through planning and conducting of the investigation which may involve using apparatus and equipment, observing, classifying and communicating.
- **Infer from data**, which may lead to a conclusion on the validity of the hypothesis. If the hypothesis is invalid, then another tentative explanation or intelligent guess is made. This is then tested again by experiment until a valid hypothesis is established.

It should be noted that when scientists investigate problems, they may follow these steps, but not necessarily in the sequence given. Also, the Scientific Method is not the only way in which scientific investigations are carried out, though it has generally been accepted by the scientific community. Much time may also be spent on defining the problem and making hypotheses.

In all scientific investigations, the adoption of certain mental attitudes such as curiosity, humility, impartiality,

integrity, inventiveness, healthy scepticism, open-mindedness and perseverance is advocated. Attempts should also be made to promote safety consciousness among students and to encourage students to adopt safe practices.

Opportunities should be provided in the classroom for students to ask questions. Students should be encouraged to ask both closed and open questions. From the type of questions asked by the students, teachers could gather information on their 'frame of mind' and the quality of their understanding.

## 2 EVALUATION

*Evaluation is an integral part of the teaching-learning process. It involves gathering information through various assessment techniques and making value judgement and sound decisions. Assessment provides information to a teacher about the students' achievement in relation to the learning objectives. With this information, the teacher makes informed decisions about what should be done to enhance the learning of the students or to improve the teaching methods.*

On the basis of assessment data, a teacher can decide whether to proceed to the next teaching unit, carry out remedial lessons, set enrichment exercises or to modify teaching methods. Hence the process of evaluation can help a teacher raise students' performance by identifying the needs of students and taking the right steps in meeting these needs.

Assessment should be carried out regularly and through the use of different techniques such as oral questioning, observation checklists, assignments, practical and written tests. When assessment is carried out on a continual basis, the teacher has the feedback required to plan his day-to-day teaching.

The purpose of assessment is to find out how much a student understands, knows and can do after a period of instruction. Before making a judgement about a certain aspect of students' performance, the teacher

should ensure that the assessment technique used is reliable. In other words, the information gained from it should reflect accurately the particular aspect of performance the teacher intends to assess. For example, a paper-and-pencil test could be used to test for recall of facts and understanding of science concepts but would not be suitable for assessing students' practical skills and attitudes.

The aims of this subject are the acquisition of knowledge and understanding of science concepts, the ability to use thinking and process skills and the development of attitudes important to the practice of science. Hence, a variety of assessment techniques must be designed to measure the attainment of these aims.

In summary, evaluation is effective when it is integrated into the teaching-learning process and carried out regularly and comprehensively through the use of a variety of assessment techniques.

### 2.1 ASSESSMENT OBJECTIVES

The assessment objectives for this subject are classified into the four main areas: **knowledge with understanding; handling information; exploration and investigation; and attitudes development.**

#### (I) Knowledge with understanding

Students should be able to demonstrate knowledge and understanding of:

- scientific phenomena, facts, concepts and principles;
- scientific vocabulary, terminology and conventions;
- scientific instruments and apparatus including techniques and aspects of safety;
- scientific and technological applications.

## **(II) Handling information**

Students should be able to:

- locate, select, organise and present relevant information from a variety of sources;
- transpose information from one form to another;
- process numerical and qualitative data;
- use information to identify patterns, report trends and draw inferences.

## **(III) Exploration and investigation**

Students should be able to:

- follow and carry out instructions accurately and safely;
- observe, measure and record accurately;

- use appropriate practical techniques and procedures;
- interpret, evaluate and establish validity of the observations and experimental data;
- raise questions for investigations;
- plan and carry out an investigation.

## **(IV) Attitudes development**

Students should:

- be able to work co-operatively in a group;
- show objectivity, perseverance and integrity;
- demonstrate healthy scepticism;
- show concern for accuracy and precision;
- show interest in and care for living things and the environment.

## **2.2 MODES OF ASSESSMENT**

The following modes of assessment could be used to assess the main objectives of this subject:

- (a) Paper -and- pencil tests
- (b) Written work
- (c) Practical test/work
- (d) Mini investigations
- (e) Observation checklist of attitudes

## 2.3 GUIDELINES FOR ASSESSMENT

### (a) Weighting for continual assessment and semestral examinations

The table below shows the weighting for continual assessment and semestral examinations.

Semester	Weighting		
	Continual Assessment	Semestral Examination	Total
I	20%	20%	40%
II	30%	30%	60%
Total	50%	50%	100%

The assessment objectives in the areas of **exploration and investigation**, and **attitudes development** would generally be assessed in continual assessment. The most appropriate modes of assessment would be practical test/work and observation of students.

Given below is one possible way of allocating the 50% weighting for continual assessment. Teachers could vary the weighting allocated to the different modes

depending on the needs and characteristics of their students.

Modes	Weighting	
	Semester I	Semester II
Written test/work	5%	10%
Practical test/work	10%	15%
Observation checklist of attitudes	5%	5%
Total	20%	30%

**(b) Format of semestral paper**

There will be one paper and the duration is 1½ hours. The format of the paper is given below.

Section	Item Type	Marks
A	Multiple choice; 30 to 40 questions. Answer all questions	30 to 40
B	Structured, short answer; variable number. Answer all questions	50 to 60

The written paper is divided into two sections, Section A and B.

**Section A** (30 - 40 marks)

This section will contain 30 - 40 compulsory multiple choice questions. All the questions will be of direct choice type with 4 options. (30 - 40 marks)

**Section B** (50 - 60 marks)

This section will consist of at least 10 questions of variable mark value (3 to 8 marks). A minimum of 50 marks should be allotted to this section.

- Syllabus Coverage**

The second semestral examination covers the whole year's work. A maximum of 35% and a minimum of 15% of the total mark for the paper should be allotted to topics which have been tested in the first semestral examination.

- Weighting of Assessment Objectives for Written Papers**

The weighting for **Knowledge with Understanding** should not exceed 70%. The weighting for **Handling Information** and **Exploration and Investigation** should not be less than 30%.

**(c) Practical Assessment (25%)**

The assessment of the skills in Exploration and Investigation will be done through assessment of daily practical work throughout the year, practical tests and mini investigations.

Students will be assessed on the following skills:

- C1 Using and organising techniques, apparatus and materials
- C2 Observing, measuring and recording
- C3 Handling experimental observations and data
- C4 Planning, carrying out and evaluating investigations

### 3 SYLLABUS CONTENT

#### CORE UNITS

#### 1 INTRODUCING SCIENCE AND TECHNOLOGY

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Throughout the course students are expected to:</i>	<i>Remarks</i>
<b>What is Science and Technology?</b>	(a) recognise that the study and practice of science involve three major elements: attitudes, processes or methods, and products  (b) acquire the skills of conducting simple investigations  (c) develop an awareness that science is not confined to the laboratory, but is manifested in all aspects of the world  (d) discuss the uses and benefits of science and technology to society  (e) develop sensitivity to the benefits and abuses of the applications of science	Science is the study of nature and how it affects us and the environment. Technology is the application of scientific knowledge.

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
<b>Physical quantities and measurement</b>	(a) use the appropriate units for length, mass and time  (b) interpret and use the appropriate prefixes milli-, centi- or kilo- in relation to the units of length and mass  (c) determine appropriate derived units for area and volume  (d) acquire, during appropriate activities throughout the course, the following skills: <ul style="list-style-type: none"> <li>• use of common laboratory apparatus correctly with due consideration to safety (especially in relation to heating of solids and liquids)</li> <li>• use of the following measuring instruments: measuring cylinder, metre rule and measuring tape, spring balance, electronic balance, stop-clock or stop watch, thermometers, voltmeters, ammeters, multimeters</li> <li>• estimation of and measurement of length, area, volume, mass and time (excluding the volume and mass of gases)</li> </ul>	
<b>Energy as a resource</b>	* (a) outline the utilisation of energy in society, e.g. in home, work, industry, leisure and transport	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• analysing</li> <li>• decision-making</li> </ul>

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	* (b) give examples of devices and processes in everyday life which use energy and describe the change in the form of energy	<ul style="list-style-type: none"> <li>• elaborating</li> </ul>
	* (c) compare the different sources and storage of usable energy viz. geothermal, solar, nuclear, tides, dammed-up water, fossil fuels (e.g. coal, oil and natural gas), wind and their limitations	Students could access information on sources of energy through using the CD-ROM or Internet.
	* (d) state that fossil fuels are exhaustible and discuss the need and ways to reduce energy wastage	Infusion of national education message – We must conserve energy because Singapore is totally dependent on imported fossil fuels to meet its energy needs.

## 2 KEEPING THE BODY GOING

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>Digestion</b>	(a) explain what is meant by digestion (b) explain why a digestive system is necessary * (c) describe briefly how the different parts of a digestive system helps in the digestion of food with mention of the role played by enzymes (names of enzymes are not required)	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• identifying attributes and components (analysing)</li> </ul> Computer simulation or animation could be used to illustrate the digestion of food as the food moves down the digestive system.
<b>Reproduction</b>	(a) state the physical changes that occur during puberty and early adolescence (b) describe the functions of the various parts of the human male and female reproductive systems (c) describe briefly the menstrual cycle and fertilisation (d) compare a temporary and a permanent method of birth control (e) state the harmful consequences of sexually transmitted diseases like syphilis, gonorrhoea and AIDS	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• analysing</li> <li>• information gathering</li> <li>• decision-making</li> </ul>



<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
		<p>and excretion.</p> <p>Students could search for information using Internet or CD-ROM on various malfunctions and their remedies.</p>
<b>Abuses to life</b>	<p>(b) state briefly that malfunctions of vital organs can be caused by various factors (e.g. unhealthy lifestyles, diseases, heredity)</p> <p>(c) list the ways that modern medicine can remedy malfunctions of vital organs (e.g. drugs, transplants, artificial organs, life support systems)</p> <p>(a) list some drugs and inhalants that are commonly abused</p> <p>(b) describe the harmful effects and consequences of drug abuse such as depression, hallucination, addiction and related social problems like crimes and transmission of AIDS</p> <p>(c) describe some possible harmful effects of consumption of alcohol on the alcoholic person, his family and society</p> <p>(d) list some harmful substances in tobacco smoke e.g. nicotine, carbon monoxide gas, tar and other cancer-causing substances</p>	<p>Unhealthy lifestyles include lack of exercise, lack of sleep and unbalanced diet.</p> <p>Visit to a dialysis centre or Institute of Health is encouraged.</p> <p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• information gathering</li> <li>• decision making</li> <li>• analysing</li> <li>• elaborating</li> <li>• generating possibilities</li> </ul> <p>Newspaper articles or cuttings could be used.</p>

<i>Topics</i>	<i>Learning outcomes</i>	<i>Remarks</i>
	<i>For the meaning of asterisk(*), please read Preamble</i> (e) describe possible harmful effects of smoking or passive smoking on a person's health such as bronchitis, lung cancer and heart disease  (f) suggest ways to avoid being addicted to drugs, alcohol and smoking	

### 3 MATTER

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>Properties of matter</b>	(a) describe materials in terms of physical properties such as hardness, elasticity, solubility, density, boiling/melting point, electrical and thermal conductivities  (b) compare materials in terms of their physical properties  (c) classify materials/substances into different groups (e.g. metals, non-metals, ceramics, plastics and fibres)  (d) relate knowledge of the properties of materials to their everyday use	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• comparing</li> <li>• classifying</li> <li>• analysing</li> </ul> Students should examine samples of the various materials to study their properties and make comparison.
<b>Solid, liquids and gases</b>	* (a) compare the three states of matter in terms of properties, e.g. density, compressibility, maintenance of shape and volume  * (b) observe and record the changes that take place when matter is heated/cooled	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• observing</li> <li>• inferring</li> </ul> Computer simulation could be used to illustrate the concepts and processes.

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
<b>Water, solutions and suspensions</b>	(a) explain what is meant by the terms solute, solvent and solution	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• elaborating</li> <li>• experimental inquiry</li> <li>• information gathering</li> </ul>
	(b) deduce the nature of solutions and suspensions by simple laboratory tests	Examples of simple laboratory tests include: <ul style="list-style-type: none"> <li>• passing a beam of light</li> <li>• filtering using filter paper</li> </ul>
	(c) recognise that water dissolves many substances	
	(d) investigate the factors that affect the solubility of solutes in water	Students should design experiments to investigate the effects of the following factors: temperature, nature of solute/solvent, surface area
	(e) give examples of uses of solvents and solutions in the home, industry, agriculture and medicine	
<b>Air pollution</b>	(a) state the names and sources of common pollutants of air (carbon monoxide, sulphur dioxide, oxides of nitrogen, chlorofluorocarbons and lead compounds)	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• generating possibilities</li> <li>• decision-making</li> </ul>

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	(b) list the possible harmful effects of air pollutants introduced into the atmosphere through human activities (acid rain, greenhouse effect, ozone depletion and lead poisoning)  (c) discuss some ways to reduce air pollution	Students could appreciate that an increase in the greenhouse effect leads to global warming.  Infusion of national education message – Clean air is important, in order for our city-state to be a good home to four million people who have to live, work and play in the same small space.
<b>Water pollution</b>	(a) state common types and sources of water pollution  (b) describe the effects of water pollution on living things  (c) discuss some methods of water pollution control  (d) discuss the steps taken in Singapore to clean rivers, namely, the Clean Rivers project	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• generating possibilities</li> <li>• information gathering</li> <li>• decision-making</li> </ul> Infusion of national education message – Besides importing our water, Singapore also taps rainwater from local sources. Controlling water pollution is essential if we are to have a clean supply of water in the future.

## 4 MOVEMENT AND MACHINES

Topics	Learning outcomes <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	Remarks
<b>Force</b>	<p>* (a) give examples of different forces: pushing, lifting, stretching, twisting, pressing, gravitational, frictional and magnetic forces</p> <p>* (b) infer the effects of forces such as:</p> <ul style="list-style-type: none"> <li>• change in state of rest or motion of a body</li> <li>• change in size and/or shape of a body</li> </ul> <p>* (c) describe and predict changes in movement of a body as a result of the application of two or more forces in a straight line</p> <p>(d) use newton as the unit of force</p> <p>(e) use a forcemeter or spring balance to measure force</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• inferring</li> <li>• predicting</li> <li>• observing</li> <li>• elaborating</li> </ul> <p>Computer simulation or animation could be used to illustrate the concepts.</p> <p>Data-capture could be used in practical work.</p>
<b>Machines</b>	<p>(a) list the advantages of using simple machines</p> <p>(b) investigate how a lever can be used as a force multiplier</p> <p>(c) investigate the effort used when an inclined plane is used to raise a load</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• experimental inquiry</li> <li>• inferring</li> <li>• observing</li> <li>• analysing</li> </ul> <p>Simple machines include levers, inclined planes, wedges, pulleys</p>

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	<p>* (d) explain with specific examples how a wedge functions like an inclined plane to reduce the effort used</p> <p>(e) investigate the effort used when the following is used to lift a load: single fixed pulley; single movable pulley; block and tackle</p> <p>* (f) explain the functions of gears and give everyday examples of their use</p>	<p>and gears.</p> <p>Students are to develop concepts and understanding through manipulation and investigation, and by relating to everyday examples. Students should dismantle toys or simple equipment to explain how simple machines are used to make work easier.</p>
		<p>Computer simulation or animation could be used to illustrate the concepts.</p>

## 5 CURRENT IN ACTION

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>What is electricity?</b>	(a) describe electricity as a useful form of energy in our life  (b) state the importance of reducing electrical energy wastage	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• decision-making</li> </ul> Infusion of national education message – We must conserve energy because Singapore is totally dependent on imported fossil fuels to meet its energy needs.
<b>Currents and circuits</b>	(a) explain what is meant by current, voltage and resistance and state their units  (b) use voltmeter/ammeter/multimeter for electrical measurements  * (c) draw and interpret circuit diagrams and set up circuits comprising electrical sources (cell and battery), switches, lamps, resistors (fixed), ammeters and voltmeters	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• observing</li> <li>• comparing</li> </ul> Students could use computer simulation to investigate and set up electrical circuits.  Light sensor and data-capture technique could be used in practical work.

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
<b>Sources of electricity</b>	(d) identify series and parallel circuits	Students should be encouraged to investigate the different types of circuits (series and parallel) and to explain why parallel circuits are widely used in households.
	* (e) explain why parallel circuits are widely used in household while series circuits are not	
	* (f) describe briefly different types of lamps/bulbs and their energy consumption	
	* (a) outline the process from the production of electricity to using it in our home with reference to the energy conversions that take place	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> </ul> <p>Computer simulation or animation could be used to illustrate the process of production of electricity to using it at home.</p> <p>Visit to a power plant is encouraged.</p>
<b>Conductors and insulators</b>	(b) state the importance of batteries as a source of electricity, giving some examples of their use	
	(a) state what insulators and conductors are, giving some examples	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• analysing</li> </ul>
	(b) relate the conducting properties of materials to their use in the various parts of electrical appliances/circuits	Students could examine some electrical appliances e.g. iron or hair dryer and explain why certain

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
		materials are used for making certain parts of the appliances.
<b>Electrical safety</b>	(a) state the hazards of: <ul style="list-style-type: none"> <li>• damaged insulation</li> <li>• overloaded circuit</li> <li>• damp conditions</li> </ul> (b) identify a fuse and its rating           (c) * state how a fuse works and the effect or danger of using one of incorrect rating           (d) identify a circuit breaker and state its function           (e) list some precautionary measures to ensure the safe use of electricity	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• analysing</li> <li>• elaborating</li> <li>• inferring</li> </ul> Computer simulation or animation could be used to illustrate the concepts.

## 6 HEAT AT WORK

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>Temperature and thermometer</b>	(a) explain what temperature is	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• analysing</li> <li>• inferring</li> </ul>
	(b) use liquid-in-glass laboratory and clinical thermometers (Six's thermometer is excluded)	Students should be aware that there are other types of thermometers, e.g. digital thermometer.
	(c) describe the components of liquid-in-glass thermometers and the functions of those components	
<b>Heating and cooling matter</b>	(a) explain that heat is a form of energy, giving some examples of the sources and the energy conversions that take place	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• inferring</li> <li>• analysing</li> <li>• information gathering</li> </ul>
	(b) state the importance of heat energy in our life	
	(c) describe some common situations and applications to illustrate when too much heat is undesirable and how the excess heat is removed	Temperature sensor and data-capture could be used in practical work.
	* (d) infer that generally, solids, liquids and gases expand when heated and contract when cooled	Computer simulation or animation

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	(e) recognise that when the temperature of a substance increases, the substance has absorbed heat; when the temperature of a substance decreases, the substance has lost heat	could be used to illustrate the changes of state when matter is heated or cooled.
	* (f) infer that a change of state is brought about by adding or removing heat energy without any change in temperature	
	(g) describe some everyday examples/applications involving the removal/addition of heat energy in the change of state	
	(h) describe some consequences and applications of expansion and contraction in everyday life	

**A OPTICS**

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>Nature and behaviour of light</b>	* (a) explain that light is a form of energy, giving some examples of the sources and energy conversions that take place  * (b) explain, with everyday examples, the terms: luminous, non-luminous, opaque, transparent, translucent and reflecting  * (c) show that light travels in a straight line  * (d) explain the formation of shadows and eclipses	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• inferring</li> </ul> Computer simulations could be used to illustrate the concepts. Light sensor and data capture techniques could be used in practical work.
<b>Mirrors and lenses</b>	(a) compare the characteristics of the image formed by a plane mirror and by a pin-hole camera	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• analysing</li> <li>• inferring</li> <li>• elaborating</li> </ul> Students are to develop concepts and understanding through manipulation and investigation.  Computer simulation could be used to illustrate the concepts.

Topics	Learning outcomes <i>For the meaning of asterisk(*), please read Preamble</i>	Remarks
	* (b) describe the effects and uses of different reflecting surfaces (plane and curved)  * (c) distinguish between a convergent beam and a divergent beam  (d) explain the use of converging lenses such as those in the human eye and the magnifying glass  (e) state the use of lenses in correcting short sightedness and long sightedness in the human eye	Students could observe their own image using two different sides of a spoon.
<b>Spectrum and filters</b>	(a) describe the dispersion of white light by a prism          * (b) describe the effect and uses of different types of light filters	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• elaborating</li> </ul> Students are to develop concepts and understanding through manipulation and investigation.  Computer simulation could be used to illustrate the concepts.  Students could appreciate the use of light filters for stage lighting, in car lights and photography, including digital cameras.

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	* (c) explain that the colour of objects is due to the reflection and absorption of light of certain colours	
<b>Lasers</b>	(a) compare laser light with white light  (b) state examples of the use of lasers such as in compact/laser discs player, laser pointer and medical applications  (c) state the safety precaution when using lasers	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• comparing</li> </ul> Students could appreciate the use of lasers in cosmetic applications. An example of a medical/cosmetic application is laser eye surgery.

**B LEISURE**

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>Sound and echo</b>	<p>(a) recognise that sounds are produced by vibrations</p> <p>* (b) identify sounds of different pitch and relate the pitch to their frequencies</p> <p>* (c) show an awareness that loudness is measured in decibels, and state some common sources of sounds and their typical levels on the decibel scale</p> <p>(d) state the approximate range of audible frequencies for someone of normal hearing</p> <p>* (e) explain how echoes are produced</p>	<p>Thinking skills/processes to be emphasised:</p> <ul style="list-style-type: none"> <li>• inferring</li> <li>• elaborating</li> <li>• analysing</li> </ul> <p>Sound sensor and data capture techniques could be used in practical work to measure sound level of some common sources and study the relationship between pitch and frequency.</p> <p>Computer simulation could be used to illustrate the concepts.</p> <p>Students should be aware that sound level above a certain decibel could damage their hearing.</p>

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
<b>Music</b>	(f) state the ways to reduce echoes and reverberations  (a) recognise the importance of sound and music in our society and noise control in our environment  (b) recognise that sounds from musical instruments are produced by the vibrations of stretched strings, air columns and stretched membranes  * (c) investigate how the pitch of the sound varies with the tension, length and mass of the stretched strings  (d) relate how a string instrument (e.g. guitar/piano) is made to produce sounds of different pitch	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• experimental inquiry</li> <li>• inferring</li> <li>• analysing</li> <li>• information gathering</li> </ul> Students are to develop concepts and understanding through manipulation and investigation.  Sound sensor and data capture techniques could be used in practical work.
<b>Sports</b>	(a) identify the various types of forces at play in sports such as swimming, running, sailing and archery  (b) describe the effect of the position of centre of gravity in sports involving balance as well as other sports such as high jump	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• inferring</li> <li>• information gathering</li> <li>• decision-making</li> </ul>

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	(c) show an awareness of how the following have been used (to better performance and minimise injuries) and or misused (to enhance performance) in sports: <ul style="list-style-type: none"> <li>• nutrition</li> <li>• sports equipment</li> <li>• accessories</li> <li>• drugs</li> </ul> (d) show an awareness of the importance of sports in keeping a person healthy and fit	Students could search for information using CD-ROM, Internet or newspapers on uses and abuses of science and technology in sports.

**C MATERIALS**

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i> <i>Students are expected to:</i>	<i>Remarks</i>
<b>Plastics</b>	(a) describe the structure of plastics (using blocks to represent monomers) (b) state the raw materials used in the manufacture of plastics (c) give some common examples of plastics and relate their uses to their properties (d) state the advantages and disadvantages of using plastics compared to other materials (e) state some problems associated with the disposal of plastics	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• comparing</li> <li>• elaborating</li> <li>• inferring</li> <li>• information gathering</li> </ul> Students could search for information on the various types of materials using CD-ROM & Internet.  Students should examine samples of various types of materials such as plastics, elastomers, composites and fibres. (Relate this topic to what students learn in Technical Studies)  Infusion of national education message – Most plastics cannot be disposed of easily without causing land, water or air pollution. We need to take care of what resources we have by way of land,

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
		nature, water and air.
<b>Elastomers</b>	(a) explain what is meant by elastomers (b) give examples of elastomers such as natural rubber and silicone rubber (c) relate the uses of elastomers to their properties	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• inferring</li> <li>• analysing</li> </ul>
<b>Natural fibres</b>	(a) describe the structure of natural fibres (b) give some examples of natural fibres such as cotton, silk and wool and their sources (c) relate the uses of some natural fibres to their properties	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• inferring</li> <li>• analysing</li> </ul>
<b>Composites</b>	(a) describe what is meant by the term composites (b) give examples of composites (e.g. plywood, fibre glass, reinforced concrete, carbon-carbon composites, concrete and cemented carbides) and relate their uses to their properties	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• inferring</li> <li>• analysing</li> </ul>
<b>Semiconductors</b>	(a) explain what is meant by semiconductor (b) give examples of semiconductors	Thinking skills/processes to be emphasised: <ul style="list-style-type: none"> <li>• elaborating</li> <li>• information gathering</li> </ul>

<i>Topics</i>	<i>Learning outcomes</i> <i>For the meaning of asterisk(*), please read Preamble</i>	<i>Remarks</i>
	(c) recognise that semiconductors are used in the electronics industries to make devices such as transistors, diodes, thermistors and computer chips.	Visit to a wafer/semiconductor plant is encouraged.

# GLOSSARY OF TERMS

<b>S/No</b>	<b>Term</b>	<b>Description of term</b>
1.	classify	to group things based on common characteristics
2.	compare	to identify similarities and differences between objects, concepts or processes
3.	deduce	to draw a conclusion based on the general rules or given information
4.	describe	to state in words (using diagrams where appropriate) the main points of a topic
5.	discuss	to give a critical account of the points involved in the topics
6.	distinguish	to identify and understand the differences between objects, concepts and processes
7.	explain	to give reasons or make some reference to theory
8.	identify	to select and/or name the object, event, concept or process
9.	infer	to draw a conclusion based on observations
10.	investigate	to find out by carrying out experiments
11.	list	to give a number of points or items without elaboration
12.	outline	to give the main or essential points of the concepts, processes
13.	predict	to state a likely future event based on how things normally turned out

<b>S/No</b>	<b>Term</b>	<b>Description of term</b>
14.	recognise	to identify facts, characteristics or concepts that are critical (relevant/appropriate) to the understanding of a situation, event, process or phenomenon
15.	relate	to identify and explain the relationships between objects, concepts or processes
16.	show an awareness	to have superficial knowledge of the concepts or processes
17.	show an understanding	to recall, explain and apply information
18.	state	to give a concise answer with little or no supporting argument
19.	suggest	to provide ideas to a problem or a situation, or apply knowledge to a 'novel' situation (there is no unique answer)

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