SCIENCE
SYLLABUS
Lower Secondary
Express Course
Normal (Academic) Course

Year of Implementation: from 2013

Ministry of Education
SINGAPORE

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CONTENTS

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, the pursuit of scientific studies at upper secondary 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 is based on the *Science Curriculum Framework* and emphasises the need for a **balance between the acquisition of science knowledge, skills and attitudes**. The learning outcomes in the Skills and Processes domain have the key words describing the skills underlined. In addition, as and when 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 natural and physical world.

The aims spelt out in the syllabus provide the guiding principles for the suggested teaching approaches and evaluation methods.

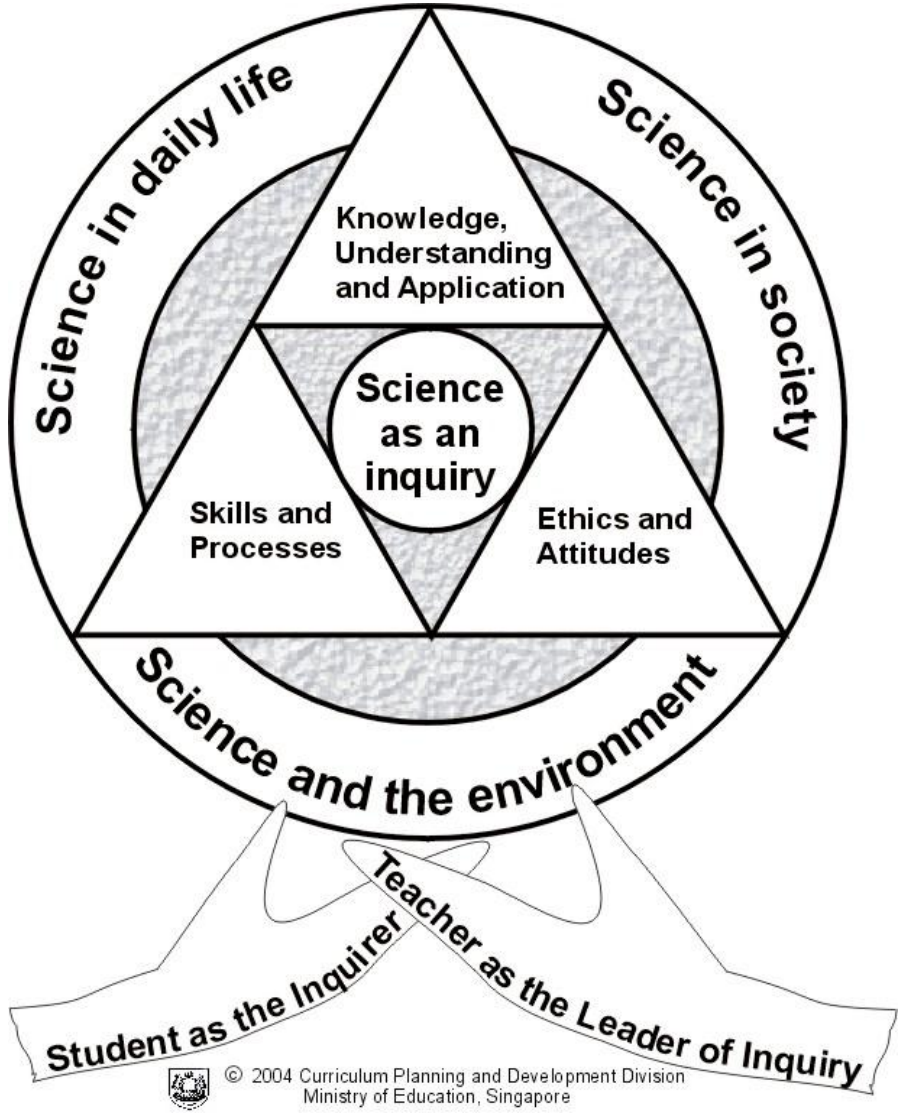
Teachers are advised not to follow the syllabus too rigidly but to exercise their professional judgement in implementing it. Schemes of work should be developed with the interests and abilities of the students uppermost in mind. Teachers are encouraged to use a variety of approaches in their teaching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

Certain learning outcomes in the syllabus have been marked with an asterisk. These learning outcomes are optional for the Normal (Academic) course students.

SCIENCE CURRICULUM FRAMEWORK

The *Science Curriculum Framework* is derived from the *Policy Framework for the Teaching and Learning of Science*. It encapsulates the thrust of science education in Singapore to prepare our students to be sufficiently adept as effective citizens, able to function in and contribute to an increasingly technologically-driven world.

Central to the curriculum framework is the inculcation of the spirit of scientific inquiry. The conduct of inquiry is founded on three integral domains of (a) Knowledge, Understanding and Application, (b) Skills and Processes and (c) Ethics and Attitudes. These domains are essential to the practice of science. The curriculum design seeks to enable students to view the pursuit of science as meaningful and useful. Inquiry is thus grounded in knowledge, issues and questions that relate to the roles played by science in daily life, society and the environment.



The science curriculum seeks to nurture the student as an inquirer. The starting point is that children are curious about and want to explore the things around them. The science curriculum leverages on and seeks to fuel this spirit of curiosity. The end goal is students who enjoy science and value science as an important tool in helping them explore their natural and physical world.

The teacher is the leader of inquiry in the science classroom. Teachers of science impart the excitement and value of science to their students. They are facilitators and role models of the inquiry process in the classrooms. The teacher creates a learning environment that will encourage and challenge students to develop their sense of inquiry. Teaching and learning approaches centre around the student as an inquirer.

The following table shows the description of each domain which frames the practice of science:

Knowledge, Understanding and Application of	**Skills and Processes**	**Ethics and Attitudes**
• 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	Skills • Posing questions • Formulating hypothesis • Defining the problem • Generating possibilities • Predicting • Observing • Using apparatus and equipment • Comparing • Classifying • Inferring • Analysing • Evaluating • Verifying • Communicating Processes • Creative problem-solving • Planning investigation • Decision-making	• Curiosity • Creativity • Objectivity • Integrity • Open-mindedness • Perseverance • Responsibility

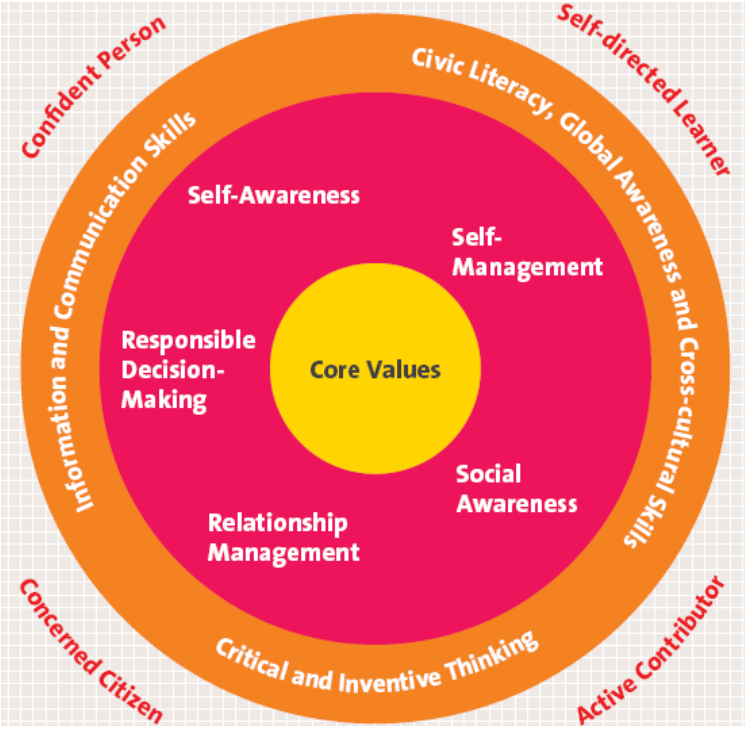
The domains are contextually linked to the roles played by science to establish its relevance and relationship to modern-day living:

Science in daily life - Personal perspective focusing on the individual	**Science in society** - Social perspective focusing on human interactions	**Science and the environment** - Naturalistic perspective focusing on man-nature relationship
• Using scientific skills in everyday life, e.g. observing trends and patterns and analysing data from media reports • Being adaptable to scientific and technological advances e.g. use of IT tools and on-line resources • Making informed decisions that are related to science and technology e.g. consumption of GM food, health choices	• Engaging in meaningful scientific discourse with others e.g. social and moral issues related to advances in science • Understanding role and impact of science and technology in society e.g. life sciences, computers • Contributing to the progress of science knowledge e.g. working with scientists on research projects	• Understanding the place of humanity in the natural world e.g. man's connections with living things and the environment • Showing awareness of safety and biological issues, e.g. SARS, AIDS, Bird Flu • Demonstrating care and concern for the environment e.g. understanding the causes and effects of global warming

21ST CENTURY COMPETENCIES AND SCIENTIFIC LITERACY

The 21st Century Competencies

The *21st Century Competencies Framework* encapsulates the thrust of education for the future, to prepare our students to be confident people, self-directed learners, concerned citizens, and active contributors – outcomes of individuals able to thrive in and contribute to a world where change is the only constant.



The competency domains gaining prominence in the 21st century are Civic Literacy, Global Awareness and Cross-cultural Skills, Critical and Inventive Thinking, and Information and Communication Skills. The competencies encompassed in these domains have been termed the *21st Century Competencies.*

Scientific Literacy

Science education for the future involves teaching students more than just the basic concepts of science. Students need to be equipped with the *skills* to be able to use scientific knowledge to identify questions, and to draw evidence-based conclusions in order to understand and make decisions about the natural world and the changes made to it through human activity. They also need to *understand* the characteristic features of science as a form of human knowledge and inquiry, and be aware of how science and technology shape our material, intellectual and cultural environments. Lastly, they need to be equipped with *ethics and attitudes* to engage in science-related issues as a reflective citizen[1].

A strong foundation in scientific knowledge and methodologies will include the development of reasoning and analytical skills, decision and problem solving skills, flexibility to respond to different contexts and possessing an open and inquiring mind that is willing to explore new territories and learn new things. These are skills and habits of mind that are aligned to the desired 21st century competencies.

[1] Adapted from Assessing Scientific, Reading and Mathematical Literacy, a Framework for PISA 2006, OECD.

AIMS

The aims of the Lower Secondary Science syllabus are to:

i) cultivate students' perception of Science as a collective effort and a way of thinking rather than just a body of facts;

This involves promoting awareness that the study and practice of science are co-operative and cumulative activities. These activities are subject to social, economic, technological, ethical and cultural influences and limitations. In addition, the applications of science are generally beneficial but the abuse of scientific knowledge can be detrimental.

ii) engage students in Science-related issues that concern their lives, the society and the environment; and

This involves stimulating the students' curiosity, interest and enjoyment in science and matters relating to science and technology as well as developing the students' interest and care for the environment.

iii) help students develop the domains that are integral to the conduct of Science Inquiry.

This includes (i) acquisition of knowledge and understanding to become confident citizens in a technological world and for further studies, (ii) developing skills and abilities and (iii) developing attributes relevant to the study and/or practice of science.

SYLLABUS FRAMEWORK

The Lower Secondary Science Syllabus comprises:

- The knowledge, skills and attitudes that all students should acquire, which are designed for 85% of the curriculum time.
- The 15% freed up curriculum time, known as the white space, to enable teachers to use more engaging teaching and learning approaches, and/or to implement customised school-based programmes as long as the aims of the syllabus are met. This enables teachers to make learning more meaningful and enjoyable for their students.

A Knowledge, Understanding and Application

This component of the Lower Secondary Science Syllabus comprises *knowledge of Science* chosen to provide a broad based understanding of the environment, and it will help build a foundation upon which students can rely on for further study. It is structured in a similar way to the Primary Science Syllabus based on themes that the students can relate to in their everyday experiences, and to the commonly observed phenomena in nature. The aim is to enable students to appreciate the links between different themes/topics and thus allow the integration of scientific ideas. The four themes chosen are: **Diversity; Models; Systems;** and **Interactions**. The first and latter two themes are similar to those found in Primary Science.

In addition to the above themes, *knowledge about Science* is highlighted in an introduction, **The Scientific Endeavour** which builds on the students' learning of Primary Science as a way of exploring and understanding the physical and natural world. It aims to deepen students' understanding of what Science is and how it is practised and applied, i.e. the nature of Science. The coverage of these ideas is not limited to the topic itself but should be reinforced through the subsequent topics.

To help teachers and students appreciate and understand the introductory topic and themes, *Essential Takeaways* and *Key Inquiry Questions* are included for each of them. The *Essential Takeaways* articulates the big ideas while the *Key Inquiry Questions* guide the teachers and engage the students in uncovering the important ideas at the heart of the introduction/theme. They can also use these questions to raise more specific questions for the respective topics under each theme.

Although this component of the syllabus is organised into an introduction and 4 themes, the content and *Essential Takeaways* should not be viewed as compartmentalised blocks of knowledge. In general, there are no clear boundaries between these themes. There may be topics common to different themes. Hence, a conscious effort is needed to demonstrate the relationship between themes whenever possible.

B Skills and Processes

In this syllabus, teachers are encouraged to provide opportunities for students to use concepts and integrate skills and processes to inquire about phenomena around them.

The skill sets identified are similar to that of Primary Science (note: Lower Block refers to Primary and Lower Secondary) and are aligned to the essential features of inquiry as shown in the table on the right.

It must be pointed out that there is no one definite sequence of priority among the skills and processes listed below. For example, observation may lead to hypothesising but at other times a hypothesis can lead to an observation. All the skills and processes listed below are seen as part of the total process of scientific inquiry.

In science teaching and learning, effort should initially be directed at teaching explicitly each of the skills through the use of appropriate activities. Later effort should be directed to helping students integrate some or all of the skills in scientific inquiry.

Table showing alignment of Lower Block Skill sets (consisting of skills and processes) to the essential features of inquiry

<table>
<tr><th>Lower Block Skill sets</th><th>Engaging with an event, phenomenon or problem through:</th><th>Collecting and presenting evidence through:</th><th>Reasoning; Making meaning of information and evidence through:</th></tr>
<tr><td rowspan="2">Skills</td><td>• Posing questions
• Formulating hypothesis
• Defining the problem
• Generating possibilities
• Predicting</td><td>• Observing
• Using apparatus and equipment</td><td>• Comparing
• Classifying
• Inferring
• Analyzing
• Evaluating
• Verifying</td></tr>
<tr><td colspan="3">Communicating</td></tr>
<tr><td>Processes</td><td colspan="3">Creative problem-solving, Planning investigation and Decision-making</td></tr>
<tr><td rowspan="2">Essential Features of Inquiry</td><td>Question</td><td>Evidence</td><td>Explain Connect</td></tr>
<tr><td colspan="3">Communication</td></tr>
</table>

Skills

Posing 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.

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.

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.

Generating possibilities
This is the skill of exploring all the alternatives, possibilities and choices beyond the obvious or preferred one.

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

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.

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.

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

Inferring
This is the skill of interpreting and explaining observations, data or information gathered.

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

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

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

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

Processes

Processes are complex operations which call upon the use of several skills.

Creative problem-solving
This is the process of thinking through a problem and generating and applying criteria to select an innovative 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.

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
Decision-making is the process of establishing and applying criteria to select from among seemingly equal alternatives. The process of establishing criteria involves consideration of the consequences and values and the ability to defend the reasons for the decision.

C Ethics and Attitudes

In all scientific inquiry, the adoption of certain mental attitudes such as *curiosity, creativity, objectivity, integrity, open-mindedness, perseverance* and *responsibility* are advocated. Attempts should also be made to promote safety consciousness among students and to encourage students to adopt safe practices.

Curiosity
This is the attitude of desiring to explore the environment and question what is found.

Creativity
This is the attitude of seeking innovative and relevant ways to solve problems.

Objectivity
This is the attitude of seeking data and information to validate observations and explanations objectively.

Integrity
This is the attitude of handling and communicating data and information with integrity.

Open-mindedness
This is the attitude of accepting all knowledge as tentative and the willingness to change their views if the evidence is convincing.

Perseverance
This is the attitude of pursuing a problem until a satisfactory solution is found.

Responsibility
This is the attitude of showing care and concern for living things and awareness of our responsibility for the quality of the environment.

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.

Table 1 shows an overview of the Lower Secondary Science Express/Normal (Academic) syllabus.

Table 1: Overview of Lower Secondary Science Express/Normal (Academic) Syllabus

Designed for 85% of the curriculum time.[2]		White Space
1. The Scientific Endeavour		The 15% freed up curriculum time is to enable teachers to use more engaging teaching and learning approaches, and/or to implement customised school-based programmes as long as the aims of the syllabus are met. This enables teachers to make learning more meaningful and enjoyable for their students.
Themes	**Topics**	
Diversity	2. Exploring Diversity of Matter by their Physical Properties 3. Exploring Diversity of Matter by its Chemical Composition 4. Exploring Diversity of Matter Using Separation Techniques 5. Understanding Diversity of Living Things	
Models	6. Model of Cells – the Basic Units of Life 7. Model of Matter - The Particulate Nature of Matter 8. Model of Matter - Atoms and Molecules 9. Ray Model of Light	
Systems	10. Transport System in Living Things 11. Human Digestive System 12. Human Sexual Reproductive System 13. Electrical Systems	
Interactions	14. Interactions through the application of forces 15. Energy and Work Done 16. Transfer of Sound Energy through Vibrations 17. Effects of Heat & its Transmission 18. Chemical Changes 19. Interactions within Ecosystems	

[2] There is no change in the recommended curriculum time, which remains as 6 periods per week (Express) and 5 periods per week (Normal (Academic)). Each period is 35-40 minutes.

TEACHING AND LEARNING THROUGH INQUIRY

What is scientific inquiry?

Scientific inquiry may be defined as the activities and processes which scientists and students engage in to study the natural and physical world around us. In its simplest form, scientific inquiry may be seen as consisting of two critical aspects: the what (content) and the how (process) of understanding the world we live in[3].

Teaching science as inquiry must therefore go beyond merely presenting the facts and the outcomes of scientific investigations. Students need to be shown how the products of scientific investigations were derived by scientists and be provided opportunities to: ask questions about knowledge and issues that relate to their daily lives, society and the environment; be actively engaged in the collection and use of evidence; formulate and communicate explanations based on scientific knowledge.

Through inquiry learning, students will be able to acquire knowledge and understanding of their natural and physical world based on their own investigations, apply the skills and processes of inquiry and develop attitudes and values that are essential to the practice of science.

[3] Reference: Chiappetta, E. L., Koballa, T., Collette, A. T. (2002). *Science instruction in the middle and secondary schools*. Upper Saddle River, NJ: Merrill Prentice Hall.

What are some characteristics of teaching and learning of science as inquiry?

Inquiry-based learning may be characterised by the degree of responsibility students have in posing and responding to questions, designing investigations, and evaluating and communicating their learning (student-directed inquiry) compared to the degree of responsibility the teacher takes (teacher-guided inquiry). Students will best benefit from experiences that vary between these two inquiry approaches.

Essential features of science as inquiry	**More ← Amount of Student Self-Direction → Less** **Less ← Amount of Guidance from Teacher or Material → More**			
Question Students engage with an event, phenomenon or problem when they …	pose a *question*	select among questions	sharpen or clarify question provided	accept given question
Evidence Students give priority to evidence when they …	determine what constitutes evidence and collects it	are directed to collect certain data	are given data and asked to analyse	are given data and told how to analyse

Essential features of science as inquiry	More ← Amount of Student Self-Direction → Less Less ← Amount of Guidance from Teacher or Material → More			
Explanation Students construct explanations when they …	formulate their own explanation after summarising evidence	are guided in process of formulating explanation from evidence	are given possible ways to use evidence to formulate explanation	are provided with evidence
Connections Students evaluate their explanations when they …	examine other resources and form links to explanations	are directed toward sources of knowledge	are given possible connections	are provided with connections
Communication Students communicate and justify their explanations when they …	form reasonable and logical argument to communicate explanations	are coached in development of communication	are provided guidelines for communication	are given steps and procedures for communication

Adapted from *Inquiry and the National Science Education Standards*, National Research Council (2000).

What are some strategies for conducting inquiry-based learning and teaching?

A primary purpose for inquiry-based instruction is for students to learn fundamental science concepts, principles, and theories as well as to develop science process skills and attitudes that are essential for scientific inquiry. Science teachers are already using a variety of teaching strategies in their lessons such as discrepant events, inductive and deductive activities and problem solving to achieve this end. It is important to use *real life situations*, where possible, as the starting point for the development of scientific ideas through inquiry.

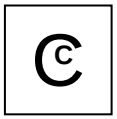
To further emphasise the learning of science as inquiry, teachers can incorporate in these strategies the essential features of **Question, Evidence, Explanation, Connections** and **Communication** and provide students with experiences that varies between guided (partial) and open (full) inquiry.

Teachers are also encouraged to use a variety of strategies to facilitate the inquiry process. Selected strategies are highlighted to help teachers plan and deliver lessons that will engage students in meaningful learning experiences and cultivate their interest and curiosity in science. These strategies can be mixed and matched. A brief description of each of these strategies is given as follows:

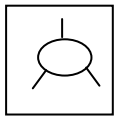
Strategies for inquiry-based learning and teaching

Brainstorming
Brainstorming is a strategy for generating creative ideas and solutions.

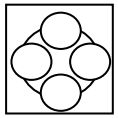
Case Study
The case study approach is a strategy which uses real and hypothetical cases to help students develop critical skills such as analysing, inferring and communicating.



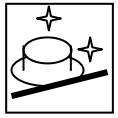
Concept Cartoon
In concept cartoons, minimal language is used. Visual images are utilised to present concepts or questions relating to one central idea or word.



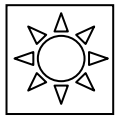
Concept Mapping
Concept mapping is a strategy to present meaningful relationships among concepts. Concept maps are useful in organising and linking concepts or ideas.



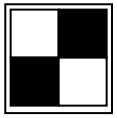
Cooperative Learning
In cooperative learning, activities are structured such that each student assumes certain responsibilities and contributes to the completion of tasks. In working with others, students are exposed to different points of views and solutions in accomplishing a common goal.



Demonstration
Demonstration is commonly used to scaffold the learning process. This approach is recommended when the learning activity is not safe or too complex for students to set up on their own.

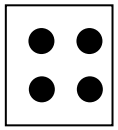


Field Trip
A field trip is any learning activity outside the school. It provides opportunities for students to explore, discover and experience science in everyday life.



Games
Games engage students in play or simulations for the learning of concepts or skills. This is useful in helping students to visualise or illustrate objects or processes in the real world.

Investigation
In scientific investigation, students engage in activities that mirror how scientists think and what they do in a decision making process, such as asking or posing questions and planning or designing investigations.

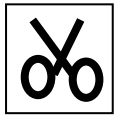


Learning Centres
Learning centres are various stations at which individuals or groups of students carry out selected activities. The activities may be designed to accommodate a variety of learning styles and challenge multiple intelligences.

Mindmapping
A mind map radiates from a central image or key word. The branches connect related concepts and ideas to the central image. Every word and image is itself a potential sub-centre of ideas or concepts. The visual presentation of related information enhances understanding. The association would be to facts as well as relationship between the facts.

Model Building
Model building is an activity in which students design and construct a representation of a concept or object.

Problem Solving
Problem solving engages students in finding solutions to problems by applying scientific knowledge and skills.



Projects

Projects are learning activities that require students to find out about an object, event, process or phenomenon over a few weeks or even months.

Questioning

Questions are useful tools in the scientific inquiry process. Both teachers and students should engage in cycles of questions-answers-questions throughout the learning process.

Role Play, Drama, Dance and Movement

Role play, drama, dance and movement allow students to express their understanding of scientific concepts and processes in a creative way.

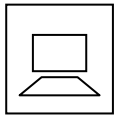
Stories

Stories of science in everyday life and of scientists can capture students' interest and engage them in talking about science. Either the teacher or students can be the story creator or teller.

Strategies for Active and Independent Learning (SAIL)

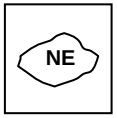
The SAIL approach emphasises learning as a formative and developmental process in which instruction and assessment point the way for students to continuously learn and improve. Learning expectations and rubrics are used to describe what students should know and be able to do. This would help students know where they are in the learning process and how they can improve.

Teachers are also encouraged to leverage on the planned learning activities to infuse Information and Communication Technologies and National Education.



Information and Communication Technologies (ICT)

ICT supports the inquiry process and also facilitates student collaboration and self-directed learning. For example, online collaborative tools allow students to share and discuss their ideas or findings within the school, and also extend their learning through consulting field experts. Internet-enabled devices could be used to facilitate data collect and analyse in situated learning. Students can also explore and visualise abstract concepts using simulations tools to manipulate the variables to deduce a relationship between the variables.



National Education

National Education is infused into the curriculum to allow students to see how scientific phenomenon and developments can contribute to or affect the nation.

Where appropriate, students should have opportunities to develop attitudes which are relevant to the study of science. Teachers are also encouraged to incorporate the ethical aspect of science wherever possible throughout the syllabus.

Ethics and Attitudes

In scientific inquiry, the adoption of certain mental attitudes such as curiosity, creativity, objectivity, integrity, open-mindedness, perseverance and responsibility is advocated. Students can also discuss the ethical implications of science and technology.

What are some features of an inquiry classroom?

An inquiry classroom is visibly different from a traditional classroom in the following ways:

Traditional	Inquiry
Students often work alone	Students often work in groups
Emphasis on mastery of facts	Emphasis on understanding of key concepts
Follows a fixed curriculum closely	Allows for pursuit of student questions
Activities rely mainly on textbooks and workbook materials	Activities rely on primary sources
Students are viewed as "blank slates"	Students are viewed as thinkers with their own theories about the world
Teachers tend to disseminate information to students	Teachers facilitate an interactive learning environment
Teachers tend to seek correct answers	Teachers seek to understand student learning
Assessment tends to be separate from teaching	Assessment is interwoven with teaching

Adapted from *In search of understanding: the case for constructivist classrooms*, Brooks & Brooks (1993).

What are some misconceptions about inquiry-based learning and teaching?

1: *All science subject matter should be taught through student-directed inquiry.*
Whereas student-directed inquiry will provide the best opportunities for cognitive development and scientific reasoning, teacher-guided inquiry can better focus learning on the development of particular science concepts. Thus, students will best benefit from experiences that vary between these two inquiry approaches.

2: *Inquiry cannot be carried out by students effectively as they will not be able to discover anything worthwhile.*
Although it is important that students are provided with opportunities to pursue their own questions and discover some things for themselves, scientists and students often engage in inquiry to solve problems or understand events by reading relevant materials such as science magazines /journals and on-line scientific literature, and seeking advice from experts in the specific field. They may be engaged in inquiry without actually making their own discoveries.

3: *Inquiry teaching occurs whenever students are provided with hands-on activities.*
Although participation by students in hands-on activities is desirable, it is equally important that they are mentally engaged with scientific reasoning and methods. Research indicates that science process skills are best learnt when used to understand specific scientific content. Understanding content without process or vice versa is insufficient to nurture students as inquirers.

ASSESSING TEACHING AND LEARNING

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

Why Assess?

Assessment measures the extent to which desired knowledge, skills and attitudes are attained by students. While it complements the teaching and learning process, it also provides formative and summative feedback to teachers, students, schools and parents.

- Assessment provides feedback to *students,* allows them to understand their strengths and weaknesses. Through assessment, students can monitor their own performance and progress. It also points them in the direction they should go to improve further.

- Assessment provides feedback to *teachers,* enables them to understand the strengths and weaknesses of their students. It provides information about the students' achievement of learning outcomes as well as the effectiveness of their teaching.

- Assessment provides feedback to *schools.* The information gathered facilitates the placement of students in the appropriate stream or course, and the promotion of students from one level to the next. It also allows the schools to review the effectiveness of their instructional programme.

- Assessment provides feedback to *parents,* allows them to monitor their children's progress and achievement through the information obtained.

What to Assess?

The aims of the Lower Secondary Science are the acquisition of knowledge, understanding and application of the science concepts, the ability to use process skills, and the development of attitudes important to the practice of science. The assessment objectives of the syllabus are aligned to the three domains in the *Science Curriculum Framework* as shown below:

i. Assessment of Knowledge, Understanding and Application of Science Concepts
ii. Assessment of Skills and Processes
iii. Assessment of Ethics and Attitudes

How to Assess?

Assessment measures the extent to which desired knowledge, skills and attitudes are attained by students. As it serves many purposes, it is important to match the type of assessment to the specific purpose for which it is intended. Before making a judgement about a certain aspect of students' performance, the teacher should ensure that the assessment mode used will generate information that reflect accurately the particular aspect of performance the teacher intends to assess.

In an inquiry-based classroom, the assessment can take many forms. In addition to the written tests, teachers can also conduct performance based assessment using the following modes:

- Practicals
- Projects
- Teacher observations
- Checklists
- Reflections / Journals
- Model-making
- Posters
- Games and quizzes
- Debates
- Drama / Show and Tell
- Learning Trails

Teachers can also assess students through the use of portfolio. It is a systematic collection of students' work and provides a comprehensive picture of their achievement. The work collected provides a continuous record of the students' development and progress in the acquisition of knowledge, understanding of scientific concepts, application of process skills, and development of attitudes. It also provides opportunity for the students to have self-evaluation and reflections by revisiting their own portfolio.

The assessment modes listed above are by no means exhaustive. Adopting a variety of assessment modes enables the teachers to assess different aspects of the teaching and learning.

Using real-world situations for written assessment

For meaningful assessment, teachers can use real-world situations involving Science in daily life, society and the environment as the starting points for the construction of questions in order to mirror the application of scientific knowledge in real-life contexts. The real-world situations chosen should be significant and engaging.

Examples of questions using real-world situations as the starting point for their construction can be found in the Teaching and Learning Guide.

1. THE SCIENTIFIC ENDEAVOUR			
Description	This introduction builds on students' learning of Primary Science as a way of exploring and understanding the physical and natural world. It aims to deepen students' understanding of what Science is and how it is practised and applied, i.e. the nature of Science.		**Key Inquiry Questions in the Scientific Endeavour include:** ▪ Why did this event, phenomenon or problem happen? ▪ What is Science? ▪ How does Science affect our lives?
Essential takeaways	**SE 1:** Science is a study of the physical and natural world.	**SE 2:** Scientific knowledge is derived partly from systematic observation, experimentation and analysis and partly from human imagination and creativity. Scientific knowledge is subject to change.	**SE 3:** Scientific knowledge can be applied to bring benefits and harm.
Learning Outcomes	• Show an awareness that Science is not confined to the laboratory, but is manifested in all aspects of our lives • Show a healthy curiosity about the natural and physical world.	• Show an appreciation of Science being a human endeavour, with scientific knowledge contributed by different civilizations over the centuries • Understand how scientific knowledge is built from systematic collection and analyses of evidence and rigorous reasoning based on the evidence • Show an awareness that scientific evidence is subject to multiple interpretations • Recognise that scientific evidence can be quantitative or qualitative, and can be gathered through one's senses or instruments as extensions of one's senses • Use scientific inquiry skills such as posing questions, planning and carrying out investigations, evaluating experimental results and communicating findings *(Estimation and measurement skills, knowledge of S.I units, and using appropriate units for the respective physical quantities, should be infused into the respective topics)* • Show attitudes such as creativity, objectivity, integrity, open-mindedness and perseverance in carrying out scientific inquiry	• Discuss the uses and benefits of science and technology to society. • Relate applications of science to some social and ethical issues • State some current limitations of science and technology in solving societal problems • Recognise the need to be responsible towards society and the environment in using technology and scientific knowledge. • Demonstrate safety consciousness and adopt safe practices when carrying out investigations.

**optional for* Normal (Academic) syllabus

Theme: Diversity There is a great variety of living and non-living things in the world. Such diversity in the natural and man-made world helps to maintain a balance in the ecosystem and provide Man with useful resources. This complexity may be organised through common characteristics and unifying factors to better understand the world we live in. The study of living and non-living things in terms of their properties and changes is greatly facilitated by putting them into groups. **Essential Takeaways:** - The diversity of the rich resources in the natural world is important for the continual survival of living things. - Humans have to use the rich resources in nature responsibly and sustainably. - Man continually seeks to understand the complexity in the natural world by studying it in a systematic manner.	**Key Inquiry Questions in Diversity include:** • How does the diversity of living and non-living things contribute to our lives? • How do we classify things in our world? • How do we find out the properties and characteristics of the things around us?

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
2. Exploring Diversity of Matter by their Physical Properties • explain the choice of the main classes of materials (metals, ceramics, glass, plastics, fibres) in the production of common household items, in terms of their properties, e.g. - density - strength - hardness - flexibility - electrical conductivity - thermal conductivity - boiling/melting point	• make estimations and measure accurately length, volume and mass (including volume and mass of liquids and solids but not of gases) of matter using appropriate instruments (metre rule, measuring tape, vernier calipers, measuring cylinder, displacement can, electronic balance) and methods • calculate density using the formula (density = mass/volume) and use the appropriate unit • predict whether an object will sink or float by comparing its density with that of its surrounding medium • classify a number of common everyday objects and recognise that there are many ways of classifying the same group of objects • use data on the properties of different materials to evaluate their uses • communicate their findings on classification and justify their reasons	• display the habit of sustainable use of materials, e.g. preferential choice of products made from biodegradable materials, practising the 3Rs: reduce, reuse, recycle • evaluate the environmental impact of excessive use of paper and disposal of plastics • demonstrate precision and accuracy in making measurements (taking into consideration parallax and zero errors)

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
3. Exploring Diversity of Matter by its Chemical Composition • recognise that substances can be classified as elements, compounds and mixtures • distinguish among elements, compounds and mixtures • state that elements are the basic building blocks of living and non-living matter • recognise that elements are classified according to their properties • show an understanding that compounds are substances consisting of two or more chemically combined elements • show an understanding that mixtures are made up of two or more elements and/or compounds that are not chemically combined • distinguish among solute, solvent and solution • show an understanding that solutions and suspensions are mixtures	• classify elements as metals and non-metals based on their characteristic properties • investigate the factors that affect the solubility and rate of dissolving of substances	• evaluate how the disposal of harmful pure substances (e.g. mercury) and mixtures (e.g. sewage) impact the environment
4. Exploring Diversity of Matter Using Separation Techniques • show an awareness of basic principles involved in the following separation techniques: magnetic attraction, filtration, evaporation, distillation and paper chromatography • explain how the constituents of a mixture can be separated based on their properties, using the following techniques: magnetic attraction, filtration, evaporation, distillation, paper chromatography. • state some examples of the applications of the various separation techniques in everyday life and industries • show an awareness of the techniques involved in	• separate constituents of mixtures using the appropriate separation techniques	• show an appreciation of why water is a precious resource and the need to conserve it • show objectivity and accuracy in systematic investigations involved in the separation of mixtures

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
obtaining drinking water from non-potable sources (e.g. distillation of sea water in desalination plants, and filtration and *reverse osmosis of sewage water)		
5. Understanding Diversity of Living Things • show an awareness of biodiversity as the variety of life on earth, including variety within each species of plant and animal • recognise that classifying living things into major taxonomic groups enables us to make sense of the biodiversity around us • show an awareness that bacteria could have beneficial or harmful effects (e.g. bacteria in the digestive tract could help in digestion or cause infections) • recognise the importance of biodiversity to the stability of natural systems, and its benefits to humans (provision of resources like food, medicine, raw materials, etc.)	• construct and use simplified dichotomous keys in identifying and classifying living organisms	• discuss the reasons for the depletion or extinction of some plants or animals (e.g. hunting, disease, invasive species, changes to or destruction of habitat) • show an awareness of how teamwork and perseverance are important in the study of biodiversity

**optional for* Normal (Academic) syllabus

Theme: Models Models are representations of phenomena, constructed to facilitate understanding of processes and structures that cannot be observed directly, or to make reasonable predictions. Models used in the learning of science include physical, conceptual and mathematical models. As models are approximations of actual phenomena, they are inherently inexact. Thus, models of phenomena change as Man strives to improve the models for representing, explaining and predicting phenomena. **Essential Takeaways:** - Models are simplified representations of phenomena. - Models are constructed to explain phenomena. - Models can be used to make predictions.	**Key Inquiry questions in Models include:** • Why are models important? • How do we know that the models used are good representations of the real system?

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**

6. Model of Cells – the Basic Units of Life
• show an understanding of the functions of the different parts of a typical cell, including the nucleus which contains genetic material that determines heredity.
• recognise that in multicellular organisms (both plants and animals), cells are the basic building blocks that are organised into tissues, organs and systems
• show an understanding that typical plant and animals cells are models used to represent their various forms
• explain the significance of the division of labour, even at the cellular level
	• use the microscope safely and correctly to identify the different parts of a typical cell (plant or animal) viz.
	  • cell wall
	  • cell membrane
	  • cytoplasm
	  • nucleus
	  • vacuole
	  • chloroplast
	• infer whether an organism is an animal or a plant, based on its cellular composition
		• show an awareness of the moral and social issues related to organ donation/sale and *application of genetic science

7. Model of Matter - The Particulate Nature of Matter • show an awareness that according to the Particulate Nature of Matter, matter is made up of small discrete particles which are in constant and random motion • show an understanding of the simple model of solids, liquids and gases, in terms of the	• *use of models to explain melting and boiling in terms of conversion of the three states of matter • use of models to explain expansion and contraction, and the conservation of mass during these processes • compare the properties of solids, liquids and gases (e.g. volume, shape, density,	• show an appreciation of how in practice, models are constructed to explain phenomena • show an appreciation of scientific attitudes such as creativity and open-mindedness in creating models to explain the fundamental nature of things and the willingness to re-examine existing models

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
arrangement and movement of the particles	compressibility) in terms of the arrangement and movement of the particles	
8. Model of Matter - Atoms and Molecules • 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 • show an awareness that atoms of an element have a unique number of protons • recognize that atoms have mass that is contributed by the mass of nucleus • show an understanding that a molecule is a group of two or more atoms chemically combined together • state the number and types of atoms, given the chemical formula of a compound (writing of chemical formula is not required)	• compare the relative size of an atom to other objects • compare atoms and molecules	• show an appreciation of how in practice, models are constructed, justified and continuously revised as they are used to probe new phenomena and collect additional data (e.g. the various atomic models) • show an appreciation of scientific attitudes such as creativity and open-mindedness in creating models to explain the fundamental nature of things and the willingness to re-examine existing models • show an awareness that technologies resulting from knowledge of the atom have created social and ethical issues, risks and costs (e.g. atomic bomb)
9. Ray Model of Light • show an understanding that the ray model represents the path taken by light • recognise that light travels in a straight line, forming shadows when blocked (e.g. eclipse) • explain how reflection is affected by a smooth and rough surface using the ray model of light • describe the effects and uses of reflecting surfaces (e.g. plane and curved) • *show an understanding that the change in the	• investigate the effects of reflection and *refraction in practical activities and make inferences through observations in everyday life (e.g. as the moon orbits the earth, different parts of it reflects light from the sun, resulting in different moon phases) • investigate the characteristics of the image formed by a plane mirror	• evaluate the impact of light produced by technology, on society and the environment (e.g. city lights can improve night visibility but cause light pollution, disorientation of birds, and use up a lot of electrical energy)

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
speed of light in different media causes refraction (calculation of angles not required) • describe some effects of refraction • describe the dispersion of white light by a prism using the ray model of light • *explain how we see the colour of objects in white light and coloured light such as red, blue and green		

**optional for* Normal (Academic) syllabus

Theme: Systems Systems are defined by placing boundaries around inter-related entities to make them easier to study. There are systems in nature as well as man-made systems. Any change to a part of the system could affect the rest of the system to different extents. That is, a part of the system may not work (well) if another is missing or not working (well). Conversely, when the parts are put together, they can perform functions that cannot be carried out by the parts alone. **Essential Takeaways:** - A system is a whole consisting of parts that work together to perform a function. - Parts of a system can influence one another and hence the whole system. - Inputs to a system can determine the outputs of the system.	**Key Inquiry questions in Systems include:** • How do parts of a system or different systems work together to perform a function? • How could parts of a system affect the function of other parts?

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
10. Transport System in Living Things • *explain the need for a transport system in multi-cellular organisms • identify the parts of the human circulatory system and their respective functions (include heart, blood vessels and blood) • state how diffusion facilitates the transport of substances in animals (e.g. diffusion of digested food molecules and oxygen from blood to tissues) • show an awareness of how the various parts of the plant transport system work together to transport useful substances within the plant • state how diffusion facilitates the transport of substances in plants (e.g. diffusion of gases and mineral salts into and out of plant cells) • state how osmosis facilitates the absorption of water at the roots	• infer from investigations that particles move from a region of where they are of higher concentration to a region of lower concentration	• show curiosity in exploring how different systems (digestion, respiratory and excretory) work with the transport system in transporting useful substances in the body and transporting waste substances from the body to be removed

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
11. Human Digestive System • explain the importance of the digestive system • identify the main parts of a digestive system and how they work together to perform a function • 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.)	• infer that the end products of digestion are used for cellular processes like respiration, growth and tissue repair	show an awareness of the importance of hygiene habits and food handling practices in preventing food-borne diseases
12. Human Sexual Reproductive System • recognise that the sexual reproductive system facilitates heredity (the transfer of genetic information from one generation to another) • recognise that the union of the nuclei of an egg and a sperm (inputs of a system) forms a new individual (output of a system) • recognise that a new individual formed through sexual reproduction receives a unique combination of genetic information from its mother (via the egg) and its father (via the sperm), resulting in variation between individuals. • state some of the physical changes that occur during puberty and early adolescence as a result of the effect of hormones on other systems (details of hormonal system NOT required) • describe briefly the structures of human male and female reproductive systems and how they work together for fertilisation to take place • describe how each part of the female reproductive system is involved in the menstrual cycle • outline how temporary and permanent birth control methods prevent conception by disrupting certain processes and/or disrupting the functions of	• evaluate the consequences and issues relating to: - abortion - pre-marital sex	• show an appreciation of the social and moral issues relating to abortion and pre-marital sex • suggest reasons for the world's growing human population (e.g. advances in medicine, improved sanitation)

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
certain organs in the reproductive system • state the harmful consequences of infections that are transmitted through sexual reproductive system, i.e. sexually transmitted infections (STIs) like syphilis, gonorrhoea and AIDS • state that some bacterial STIs can be cured by antibiotics, but not viral STIs		

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
13. Electrical Systems • explain what is meant by current, potential difference and resistance of an electrical system, stating their units • draw and interpret circuit diagrams and set up circuits containing electrical sources, switches, lamps, resistors (fixed and variable), ammeters and voltmeters • *explain how arrangement of the components of an electrical system affects the outputs of the system (e.g. how series or parallel arrangement of resistors affects the brightness of the bulb) • explain qualitatively the chemical, heating and magnetic effects of an electric current and list some applications • explain what is meant by power, relate it to an output of an electrical system and state its S.I. unit • state how changes made to an electrical system can cause some electrical hazards • state some precautionary measures to ensure the safe use of electricity in the home	• *investigate the effect of varying resistance on the current in the circuit using fixed or variable resistors • *solve simple problems on the cost of using electrical appliances, using kilowatt-hour as a unit of electrical energy consumption	• discuss the importance for Singapore, which has no natural resources of her own, to conserve energy and how this could help reduce contribution to global warming • demonstrate precision and accuracy in making measurements (taking into consideration parallax errors)

**optional for* Normal (Academic) syllabus

Theme: Interactions Interactions exist between the living world and the environment at various levels: (i) within organisms, (ii) between organisms, (iii) within the environment, and (iv) between organisms and the environment. These interactions are often accompanied by the transfer of energy between matter, application of forces between matter, or transfer/exchange of matter. As a result of interactions, changes can occur. These changes could be small or big, fast or slow, reversible or irreversible, predictable or erratic. **Essential Takeaways:** - Interactions occur through the transfer of energy and/or matter, as well as the application of forces. - Interactions can lead to changes or stability in the system. - The interaction of Man with his environment drives the development of Science and Technology. At the same time, Science and Technology influences the way Man interacts with his environment.	**Key Inquiry questions in Interactions include:** • How does knowledge of interactions between and within systems help Man better understand his environment? • What are the interactions between physical phenomena and life processes?

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
14.Interactions through the application of forces • state that forces can - change the state of rest or motion of a body - change the size and/or shape of a body - bring about turning effects in objects (e.g. levers) - exert pressure on objects • identify some examples of contact forces (e.g. frictional force) and non-contact forces (e.g. gravitational force and magnetic force) and predict their effects on an object (e.g. how tides are caused by gravitational interaction between the oceans and the moon) • relate pressure to force and area, using appropriate everyday examples (e.g. high heel shoes, cutting edge of a knife) • *show an appreciation of some daily life phenomena associated with atmospheric pressure (e.g. use of suction cups, drinking from straws) and pressure due to liquid (e.g. submarines have depth limits)	• compare mass and weight • make measurements of (length, time) mass and force, using their respective S.I. units • *investigate pressure using the formula, pressure = force/area • solve problems of objects in motion using the concept of speed	• demonstrate precision and accuracy in making measurements (taking into consideration parallax errors) • show curiosity about the destructive power of forces of nature (e.g. tsunamis, volcanoes, earthquakes, hurricane/typhoon)

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
15. Energy and Work Done • identify energy as the ability to do work • show understanding that work is done when object moves in the same direction as the force is applied • show understanding that energy is transferred when work is done • show an awareness that energy is conserved when it is converted from one form to another • state the S.I. unit of work as the joule	• infer that energy can be transformed from one form to another • compare between situations involving forces where work is done and where work is not done	• show an appreciation of the uses of various sources of energy (e.g. geothermal energy is used for heating; biofuels are used to power vehicles; fossil fuels, solar, hydro-electric, wind energy are used to generate electricity) and their impact on the environment • demonstrate precision and accuracy in making measurements (taking into consideration parallax errors)
16.Transfer of Sound Energy through Vibrations • explain that sounds are produced due to interactions between molecules of a medium caused by a vibrating source • recognise that sound transfers energy and that it takes different lengths of time to travel from one point to another through different media • *identify sounds of different pitch and relate the pitch to their frequencies • outline how the ear detects sounds in terms of the vibrations of the eardrum and ear bones, and the subsequent interpretation of sound by the brain	• infer that the loudness of sounds can be changed by changing the size of vibrations and *pitch by the frequency	• recognise the importance of sound in our society (e.g. for communication, music for pleasure, ultrasound in medicine) and the adverse effect of noise in our environment • demonstrate precision and accuracy in making measurements (taking into consideration parallax errors)
17.Effects of Heat & its Transmission • describe some effects and applications of expansion and contraction in everyday life • state the S.I. unit of temperature and use the appropriate unit for it • explain what is meant by conduction, convection and radiation	• infer that generally, solids, liquids and gases expand when heat is absorbed and contract when heat is given out • infer that thermal expansion results in a change in volume of the substance and therefore the density of the substance • infer from experiments that different materials	• show open-mindedness in becoming aware of the various proposed causes (man-made and natural) of the recent climatic change – global warming • demonstrate precision and accuracy in making measurements (taking into consideration parallax errors)

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
• identify and explain applications of heat conduction and convection (e.g. in cooling, heating and insulation) • show an understanding that the rate of heat loss or gain by a body through radiation is affected by the (i) nature of its surface and (ii) temperature difference between the body and its surroundings • identify and explain applications of heat radiation (e.g. radiant heaters, solar radiation)	have different rates of heat flow	
18. Chemical Changes • identify a change which leads to formation of new product(s) as a chemical change. • show an awareness that there are different types of chemical reactions such as combustion, thermal decomposition, oxidation (e.g. cellular respiration) and neutralisation • use word equations to represent chemical reactions • show an awareness that chemical reactions involve a rearrangement of atoms, which are not created or destroyed	• infer that mass is conserved during a chemical reaction • Investigate the changes that matter (i.e. element, compound or mixture) undergoes through - mixing - heating - exposure to light (e.g. photosynthesis) - passing of an electric current - oxidation (e.g. rusting) • investigate the following chemical reactions/changes: - effect of acidic, alkaline and neutral solutions on indicators (include litmus paper, Universal Indicator and natural indicators obtained from plants) - reactions between acids and alkalis; acids and metals; and acids and carbonates	• show an awareness of how chemical reactions can benefit our lives (e.g. cooking, respiration) and cause harm to our health and environment (e.g. rusting, decay and burning), as well

**optional for* Normal (Academic) syllabus

Learning Outcomes		
Knowledge, Understanding and Application	**Skills and Processes**	**Ethics and Attitudes**
19. Interactions within Ecosystems • show an understanding of an ecosystem as the interactions between a community and its physical environment • explain the importance of various physical factors like air, water, temperature, light, minerals and acidity/alkalinity, to the life of the organisms • recognise how adaptive traits (structural or behavioural) and changes in environmental conditions can affect the survival of organisms • show an understanding of the interrelationship among the various organisms in a community (Examples of interrelationships are predator-prey relationship, mutualism and parasitism) • explain the importance of conserving the environment • show an understanding of how respiration and photosynthesis are related to the flow of energy through food chains and food webs • describe how nutrients trapped in living organisms are recycled within the environment, through the actions of decomposers	• investigate an environment using measurement instruments such as datalogger probes to collect data on physical quantities such as pH, temperature and light intensity • compare photosynthesis and respiration • compare respiration and breathing in terms of the roles they play in the interactions between living things and their environment • infer the role of decomposers in recycling of nutrients in the environment	• *show an awareness of how some cultures practise sustainable living through their interactions with the environment • evaluate the impact of human activities and technologies on the environment (e.g. motor vehicles and modern lifestyle)

**optional for* Normal (Academic) syllabus

GLOSSARY OF TERMS

S/No	Term	Description of Terms
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 a conclusion based on the general rules or given information
6.	describe	to state in 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 reference to theory
12.	identify	to select and/or name the object, event, concept or process
13.	infer	to draw a conclusion based on 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

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5.	Mr Abu Bakar B Farid	Lead Teacher	Ngee Ann Secondary School
6.	Mr Ng Vic Meng	HOD Science	Tampines Secondary School
7.	Mrs Choy Hui Peng	Teacher	Presbyterian High School
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