Supplement to the Science Education
Key Learning Area Curriculum Guide

Science (Secondary 1 to 3)
Curriculum Framework

Curriculum Development Council
2025

Contents

Membership of the Ad Hoc Committee for the Revision of the Science (S1-3) Curriculum

(From May 2023)

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Chapter 1 Introduction

Science Education is one of the eight Key Learning Areas in the Hong Kong school curriculum. Science (Secondary 1-3) is a core subject in the Science Education Key Learning Area at the junior secondary level. This curriculum framework serves as supplement to the Science Education Key Learning Area Curriculum Guide (Primary 1 - Secondary 6) (SE KLACG (P1-S6)) (CDC), elaborating on the rationale, aims as well as the structures and organisations of the Science (S1-3) curriculum. Other suggestions on curriculum planning, learning and teaching, assessment, and learning and teaching resources should be referred to the SE KLACG (P1-S6).

Science (Secondary 1-3) Curriculum Framework was prepared by the Curriculum Development Council (CDC). Schools may pilot the Junior Secondary Science curriculum in the 2025/26 and 2026/27 school years, with gradual implementation from Secondary One starting from the 2027/28 school year.

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1.1 Background

To dovetail with the national direction of "Invigorating the country through science and education", the Education Bureau (EDB) has been continuously promoting STEAM education in primary and secondary schools through measures such as optimising curriculum, enhancing teacher training, and providing resource support. These measures aim to create a conducive learning atmosphere for science and Innovation and Technology (I&T), inspire students' creativity and potential in science from an early age, and recognise on the contributions and major achievements made by our country in scientific development.

To further enhance the scientific literacy of students at junior secondary levels and to foster in them the spirit of innovation, an Ad Hoc Committee was set up in May 2023 by the Curriculum Development Council Committee on Science Education to launch the curriculum renewal. The Committee reviewed the curriculum comprehensively and made revisions to enable the curriculum in line with technological advancement of the society, as well as students' learning needs. The updating of the curriculum reinforces the articulation of science education from primary to junior secondary levels, and enhances the implementation of science education spanning nine years. The updated Science (S1–3) curriculum framework was submitted to and endorsed by the Curriculum Development Council in June 2025.

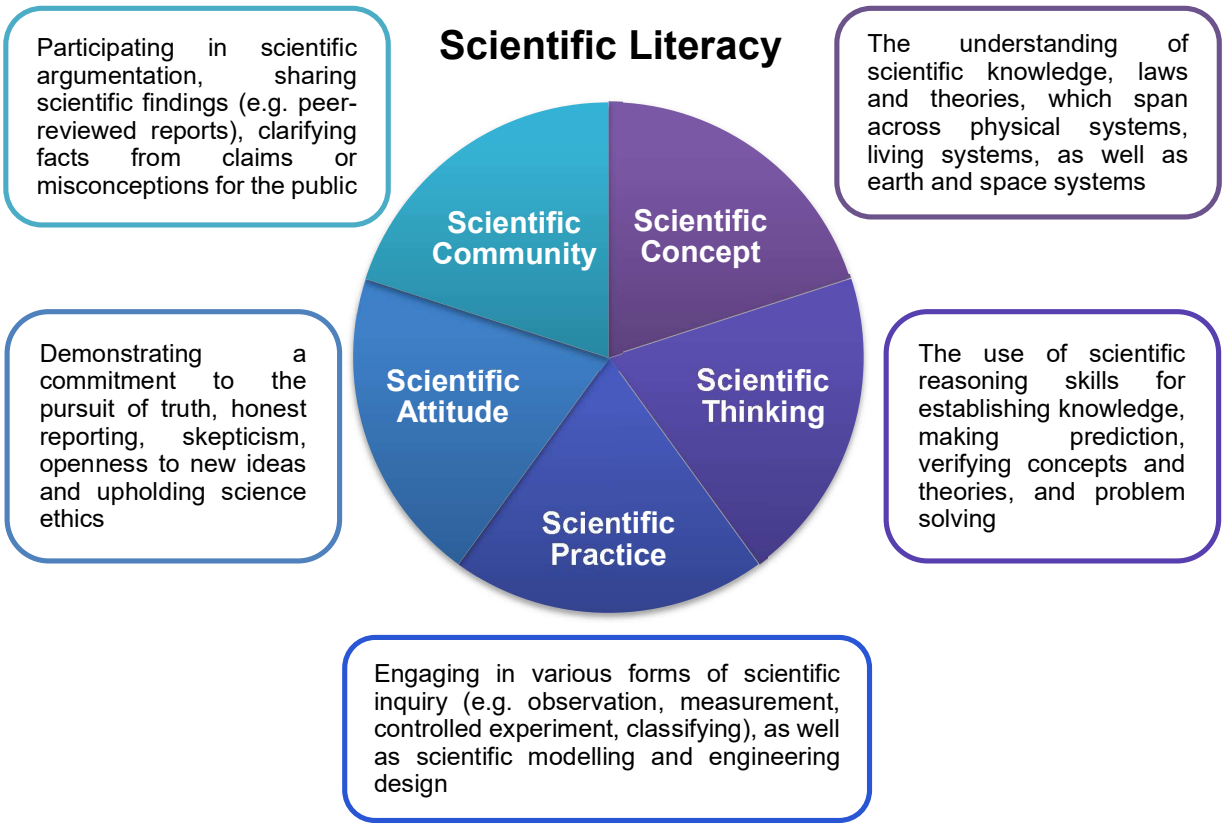
1.2 Curriculum Rationale

The curriculum rationale of Science (S1-3) Curriculum is "**Enhancing Scientific Literacy, Fostering the Spirit of Innovation**".

Enhancing Scientific Literacy

This curriculum aims to develop students' **scientific literacy** aims to enhance their ability to understand and apply scientific thinking to explain phenomena, solve real-life problems, and make informed judgements and decisions on science-related issues through the analysis of scientific information. This curriculum equips students with the **scientific concept** and the mastery of different scientific methods for conducting **scientific inquiry** thereby conducive to the understanding of the nature of science. It also seeks to strengthen students' **scientific thinking** skills, such as reasoning, making prediction and problem solving. Scientifically literate students can actively engage in the **scientific community**, discussing issues related to science, technology, society and environmental sustainability. Through this process, students develop **proper values and scientific attitudes**, empowering students to take responsible actions to promote sustainable development.

The fostering of students' scientific literacy is depicted by the following aspects:



Fostering the Spirit of Innovation

Innovation is a process of creating or improving deliverables, which often involves the integration and application of different knowledge and theories, and the use of creativity to **curate original ideas or diverse ideas**, and **propose alternatives which bring about improvements**. This curriculum aims on nurturing students' spirit of innovation through various cross-disciplinary learning and teaching activities, such as "**Engineering Design**" and "**Discussion on Socio-scientific Issues**", guiding them to explore and investigate real-world problems, thereby fostering in students the **system thinking** to understand the interconnections between various underlying factors in the context. To equip students for a rapidly changing and uncertain world, the curriculum also encourages the use of digital technologies, such as **artificial intelligence**, in scientific inquiry. Students are encouraged to devise innovative solutions from multiple perspectives, engage in data-driven problem solving, constructing scientific models based on observations, through which students could develop **critical thinking skills**, **computational thinking skills** and **creativity**, as well as fostering the spirit of innovation.

Computational Thinking • using computational models, simulations and other tools to generate data • identifying relevant hypotheses and conducting controlled experiments • using data to analyse relationships among components within a system • using data to make predictions about changes in a system over time • debugging and refining computational models
Critical Thinking • identifying assumptions and generally accepted ideas in scientific explanations or solutions • considering multiple perspectives on socio-scientific issues • evaluating the strengths and limitations of scientific solutions based on logical, practical or ethical criteria • reflecting on the chosen scientific solution in comparison with possible alternatives
Creativity • making connections between concepts in different disciplines • generating diverse and original ideas when addressing scientific problems • proposing innovative methods to improve existing solutions • reflecting on the steps taken to solve scientific problems

1.3 Curriculum Aims

The Science (S1-3) curriculum aims to provide students with diverse and engaging learning experiences in science, building upon their science learning at primary level to sustain their curiosity and interest in the subject. The curriculum focuses on helping students establish a solid foundation of scientific knowledge while consolidating their scientific inquiry skills, equipping students to pursue further studies in senior secondary science and innovation-related subjects, nurturing them to become life-long learners of science.

Moreover, the curriculum encourages students to participate in scientific inquiry and cross-disciplinary learning activities, nurturing their scientific literacy and ability to integrate and apply knowledge and skills from different domains for creative problem solving. It also aims to cultivate students' ability to think critically and rationally about issues related to individual, societal and global contexts with a view to fostering proper values and scientific attitudes, as well as encouraging responsible actions for promoting sustainable development and making meaningful contributions to our country and the world.

The broad aims of the Science (S1-3) Curriculum are to enable students to:

- sustain and develop curiosity and interest in science and appreciate the wonder of nature;
- develop a basic understanding of the nature of science and recognise the usefulness and limitations of science and the evolutionary nature of scientific knowledge;
- acquire scientific knowledge and scientific inquiry skills to engage in scientific reasoning and scientific inquiry;
- use scientific models and the language of science to communicate science-related ideas;
- develop the ability to integrate and apply knowledge and skills of science and other related disciplines to foster creative problem solving and innovation;
- recognise the connections between science, I&T, the environment, society and engineering, and think critically about science-related issues;
- be aware of the impact of human activities on the environment and act sensibly for its sustainable development; and
- become life-long learners in science for personal development and prepared for further studies or professional development in science, technology and engineering related fields.

Chapter 2 Curriculum Structure and Organisations

To put the curriculum aims and rationale into practice, the Science (S1-3) Curriculum is designed to facilitate students acquire "Knowledge and Understanding", "Skills and Processes", as well as "Values and Attitudes" through *learning targets* set out in the curriculum. This curriculum highlights "Scientific Inquiry" and "Cross-disciplinary Connections" as two *curriculum emphases*, aiming to nurture students' scientific literacy and their ability to integrate and apply cross-disciplinary knowledge and skills creatively. The curriculum comprises thirteen *curriculum units*, covering different science domains including biology, chemistry, physics and earth science, along with learning elements of scientific inquiry.

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2.1 Learning Targets

2.1.1 Knowledge and Understanding

Students should

- acquire basic scientific knowledge and understand some phenomena, facts, concepts and basic principles in science;
- recognise the connections and overarching coherence across different disciplines of science;
- learn the vocabulary, terminology and convention used for scientific communication;
- apply scientific knowledge and skills to solve simple daily life problems; and
- learn the scientific methods for generating, validating and communicating scientific knowledge; and
- recognise the usefulness and limitations of science and the evolutionary nature of scientific knowledge.

2.1.2 Skills and Processes

Students should

- recognise how scientific claims are supported by data, methods and reasoning in science;
- use apparatus and equipment properly for conducting practical work;
- formulate hypotheses, make quantitative and qualitative measurements, control variables, assess and minimise uncertainty in measurements, make conclusions based on the results for supporting or refuting the hypothesis set;
- evaluate the appropriateness of the design (e.g. fair-testing, field work) in scientific investigations;
- represent data appropriately using tables, graphs and charts;
- be able to think scientifically, critically and creatively;
- be able to integrate and apply knowledge and skills to solve problems collaboratively in real-life contexts;
- participate actively in group discussion and work effectively with other members in group; and
- develop the ability to distinguish between fact, myth and belief, and make informed decisions based on evidence.

2.1.3 Values and Attitudes

Students should

- develop curiosity and interest in science and appreciate the wonder of the Nature;
- show respect to life and the environment;
- develop proper values and attitudes towards adopting healthy lifestyles;
- be aware of the relationship between science, innovation and technology, environment, society and engineering, and develop an attitude of responsible citizenship;
- be aware of the safety risks and hazards in everyday life, and take proper actions to reduce risks;
- develop trust in claims made in reliable sources of information and science literature;
- maintain scientific integrity and make honest reporting in scientific investigations;
- appreciate the development and application of innovation and technology to make important contribution to solve societal and environmental problems; and
- recognise the effects of human activities on the environment and act proactively to promote environmentally sustainable practices.

2.2 Curriculum Emphases

Scientific Inquiry and **Cross-disciplinary Connections**, are two important Curriculum Emphases.

2.2.1 Scientific Inquiry

Scientific inquiry is a process in which scientists study and explain natural phenomena through systematic observations and experiments. This process involves using procedures such as defining science questions, formulating hypotheses, conducting experiments, and analysing data. Through scientific inquiry, scientists infer and interpret scientific phenomena, construct scientific models, develop evidence-based explanation, engage in argument from evidence, and communicate scientific findings. Scientific inquiry do not follow a fixed approach; instead, scientists explore scientific phenomena through various scientific methods, such as conducting controlled experimentations and observation studies.

Teachers can organise diverse scientific inquiry activities for students, guiding them to engage in scientific processes like scientists, enabling students to participate and enjoy the process of learning science and thereby enabling them to conduct scientific investigation with confidence. These important learning experiences will help students develop interests in exploring science in their daily life and nurture in them the scientific inquiry skills systematically. The curriculum emphasises three aspects of scientific inquiry skills: Scientific Reasoning, Experimenting and Data Processing.

<u>Scientific Reasoning</u>

R1 Using specific data to induce a general trend, conclusion or model
R2 Using a set of general observations, trend or model to deduce a specific result
R3 Making inference to the best possible explanation to the observed phenomenon
R4 Making informed decision based on the probability of phenomenon to be occurred

<u>Experimenting</u>

E1 Formulating a hypothesis based on observed phenomenon
E2 Identifying independent variables, dependent variables and control variables
E3 Making qualitative observations and quantitative measurements
E4 Commenting accuracy and precision in a scientific measurement
E5 Setting up a controlled experiment to minimise confounding factors to identify causation
E6 Choosing from alternative experimental methods or improving the method for a scientific investigation

E7 Commenting the reliability of a scientific measurement or a scientific investigation

Data Processing

D1 Using scientific notation, significant figures and ratio for expressing and comparing scientific data

D2 Using tables and graphs for data analysis

D3 Using scientific formula for scientific inference

D4 Identifying outliers and handling data from repeated measurements to assess the uncertainty incurred

Ways of Scientific Inquiry

Through arranging various types of scientific inquiry activities in a systematic manner, students can learn about scientific inquiry effectively through a series of tasks such as solving scientific problems, practising experimental skills, verifying scientific theory and making scientific inference. Below are some types of scientific inquiry activities for teachers' reference:

(a) Observation

Observation involves using our sensory organs and scientific instruments to collect information about phenomena, objects or events, focusing on their qualitative and quantitative aspects. Arranging scientific observation activities allows students to examine the fine details of events or phenomena and understand the order in which they occur. Key aspects include:

- using multiple sensory organs simultaneously for observation
- paying attention to the relationships between objects and their surroundings
- differentiating between similarities and differences
- exploring the sequence of events
- using instruments to gain deeper insights into specific details

(b) Classifying

Classifying involves organising objects or events into reasonable groups based on their similar characteristics or properties. This method is commonly used in science to help students understand the way to organise and classify terms systematically. Key aspects include:

- performing initial classifications based on observed external properties (e.g. colour, shape and size)
- conducting in-depth classifications based on inferred internal properties (e.g. microscopic structures)
- explaining the logics of the performed classifications

(c) Controlled experiment

Controlled experiments ensure that the results are solely influenced by the independent variable, thus establishing the causal relationships between variables. Through designing controlled experiments, students can systematically observe the impact of one variable on another. Key aspects include:

- identifying the independent variable and dependent variables in the experiment, and ensuring the fairness by setting control variables
- keeping other factors constant (e.g. environmental conditions, measurement tools) for avoiding confounding factors from influencing the experimental results
- conducting repeated measurement to examine the precision of experimental results
- repeating the experiment under different environmental conditions or with the use of different apparatuses to assess the reproducibility of the experiment

(d) Pattern seeking

Pattern seeking involves analysing data to determine whether variables show correlations or trends. This process aids in understanding the phenomena, establishing scientific theories or models, and making predictions. Key aspects include:

- interpreting a scatter plot and drawing a "line of best fit"
- finding correlations among variables from data trends (e.g. positive correlation, negative correlation or no correlation)
- recognising that the presence of correlation between variables does not imply a causal relationship

Key Practical Tasks

Conducting Key Practical Tasks (KPTs) is a vital learning experience for students studying science. This curriculum specifies a series of KPTs for each learning unit to provide sufficient opportunities for scientific inquiry and experimentation at junior secondary science levels. When teaching relevant topics, teachers need to systematically plan and arrange KPTs to enhance students' learning of scientific inquiry, reasoning, and manipulating skills while consolidating the understanding of scientific concepts. Teachers can design practical tasks and relevant assessments based on students' abilities, teaching contexts, and the availability of school resources, to facilitate students acquiring scientific inquiry skills. The table below outlines the KPTs included in each unit:

Unit	Key Practical Tasks
Looking at Living Things	• Examine plant and animal tissues under a microscope • Identify whether vascular tissues are present in different plant samples
Human Reproduction and Heredity	• *Construct a model of DNA to demonstrate the double helix structure as well as the base pairing*
Earth and Space	• Observe the effect of chlorine bleach or water purification tablets on microorganisms in water under a microscope • Separate substances from mixtures with apparatus provided (e.g. filter funnel and filter paper, sieve and bar magnet) • Design an experiment to distinguish between freshwater and seawater samples
Living Things and the Environment	• Investigate the necessary conditions for photosynthesis • Investigate how the carbon dioxide content in a container be affected by the presence of living organisms
Matter and Energy	• Perform practical work to heat a substance and plot a temperature-time graph to show the temperature change during the process • Investigate the properties of substances under different phases (e.g. compressibility) • Investigate the physical properties of substances (e.g. thermal conductivity of metal rods) • Find out the density of some objects (e.g. make a density column using different liquids)

Unit	Key Practical Tasks
Atomic World	• Investigate the factors affecting the rate of dissolving of substances • Compare the change in mass of different substances before and after burning (e.g. paper and iron wool) • Test the physical properties of a compound and its constituent elements (e.g. iron, sulphur and iron (II) sulphide) • Investigate the observable changes (e.g. temperature, pH value or the colour change of pH paper / acid-alkali indicator) when an acid is mixed with an alkali
Force and Motion	• Investigate the free-falling motion of different objects • Design an experiment to compare the roughness of different surfaces • Investigate the action and reaction force exerted on objects • Investigate the changes in atmospheric pressure at different altitudes using mobile devices
Making Use of Electricity	• Measure the current and voltage in series circuits and parallel circuits • Investigate the factors affecting the strength of the electromagnet (e.g. number of turns of the coil, length of iron bar) • Investigate the factors affecting the resistance of a wire • Investigate the effect of varying resistance on the current in the circuit
Healthy Body	• Perform practical work to identify food substances (e.g. glucose, starch, lipids, proteins and vitamin C) in food samples • Investigate the factors affecting the amount of vitamin C in different food samples • *Investigate the chemical digestion by enzymes (e.g. amylase, protease, lipase)* • *Investigate the effects of different types of physical exercise on breathing rate and heart rate*
Light and Sound	• Perform practical work using mobile devices to find out how the loudness of a note changes with distance from the source • Perform practical work to find out the refractive index of an unknown liquid • Perform practical work about total internal reflection of light (e.g. investigate a “light bending” water jet) • *Perform practical work to find out the magnification of images formed by convex lenses*

Unit	Key Practical Tasks
Our Planet Earth	• Investigate the electrolysis of water using microscale apparatuses • Design different chemical tests to infer the presence of water in unknown liquid samples • *Investigate factors affecting the rate of the reaction between calcium carbonate and acids* • *Design an experiment to separate mixed plastic samples by type*

(Note: The KPTs in the core part of the course are shown in black font, while the KPTs in the extended part are shown in *blue italics*. For descriptions of the core part and extended part of the curriculum, see Chapter 2.3.2.)

Curriculum Support Materials – Scientific Practices

When planning and arranging scientific inquiry activities, teachers can refer to the learning and teaching resource "*Junior Secondary Science Curriculum Support Materials – Scientific Practices*" developed by the Education Bureau to further understand the scientific inquiry skills required by the curriculum and the steps involved in conducting scientific investigation. These support materials include teaching notes, science assessment items and examples of practical tasks. Teachers can adapt the materials and activities with reference to students' abilities and the teaching context.

2.2.2 Cross-disciplinary connections

This curriculum focuses on cross-disciplinary learning, fostering students' ability to connect knowledge and skills across different subjects. It also focuses on enabling students to understand and solve real-world problems from multiple perspectives. In junior secondary science, cross-disciplinary learning spans various domains, including science, innovation & technology, environment, society and engineering. Students are encouraged to transcend the boundaries of individual subjects by integrating and applying cross-disciplinary knowledge and skills, enabling them to explore scientific issues and develop innovative solutions.

The curriculum incorporates diverse cross-disciplinary learning activities, such as **Scientific modelling**, **engineering design**, and **Exploring Socio-scientific Issues (SSI)**. To enable students in active scientific discussions, modelling and problem-solving, teachers may adopt suitable learning and teaching strategies, such as project learning, problem-based learning and inquiry-based learning, with reference to students' abilities, modes of learning and the classroom context. The following rubrics outline the suggestions for designing cross-disciplinary learning activities. Teachers can use these rubrics to evaluate existing teaching practices and develop new cross-disciplinary activities:

A quality cross-disciplinary learning activity should –
1. arouse students' learning needs and interests
2. guide students to explore and pose scientific problems to be solved
3. be challenging to sustain learning engagement
4. include acquisition of science concepts and opportunities for practicing scientific skills
5. include the development of prototypes or tangible products to visualise the learning process
6. allow students co-design part of the products, prototypes or solutions to the problem
7. enable students to deal with problems that can be reflected from different perspectives
8. leave room for exploring or discussing unexpected answers
9. provide space for students to reflect and give feedbacks

(a) Scientific modelling

Scientific modelling enables students to integrate science, mathematics and information technology for knowledge construction while exploring and understanding scientific phenomena. Scientific models can be expressed in different forms, including flowcharts, diagrams, equations or computer models.

At junior secondary levels, students will learn some scientific models in different science topics, including water cycle, food web and particle models. Teachers should provide opportunities for students to explore scientific phenomena, encourage students to raise science questions from phenomena, conduct inquiries and make attempt to construct scientific models for describing and explaining scientific phenomena.

Teachers can make appropriate use of suitable educational technology, such as online platforms or AI tools, to facilitate students in constructing, testing, revising and evaluating their models. Teachers could provide a scientific context (e.g. constructing predictive model with the use of environmental data) and prompt students in formulating an investigable scientific question. Students are then guided to use the data for developing a scientific model for addressing the scientific questions or seek patterns between variables. These activities are not only engaging and challenging but also enhance students' scientific knowledge while developing their problem-solving skills. Students can apply their scientific inquiry skills in authentic situations, thereby arising their motivation and interests in learning science. Teachers can make reference to the following aspects to plan for scientific modelling activities:

Considerations on planning a "Scientific Modelling" activity

Activity focuses (examples):

- provide opportunities for students to pose scientific questions from phenomena
- facilitate students to construct initial models using their existing knowledge and use these models to explain scientific phenomena
- facilitate students to conduct experiments to collect data and use models to predict experimental results
- facilitate students to evaluate whether the data obtained from the experiment can be used to support, revise, or refute the model

Activity themes (examples):

- construct scientific models for weather forecasting on Mars (Unit 5)
- construct a model to simulate the blood flow in a cholesterol-clogged vessel (Unit 11)

Skills involved in the activity (examples):

- able to explain the functions and relationships of various components within a scientific model
- able to construct models using appropriate tools (e.g. AI tools)
- able to revise models for analysis and comparison
- able to justify the selected model with supporting evidence

(b) Engineering Design

The engineering design learning process enables students to recognise the interconnections between science, engineering and other disciplines, while enhancing their capabilities to integrate and apply knowledge and skills to solve real-life problems. Engineering design is a systematic approach to address daily life challenges under practical constraints. While sharing key components with scientific inquiry, such as analysing data and constructing explanations, engineering design differs in several aspects. For example, engineering design involves identifying an engineering problem and developing prototypes, whereas scientific inquiry involves the formulating hypothesis and examining it through conducting experiments. The following shows the main components of an engineering design activity:

The main components of an engineering design	
Asking and Defining Problems	• Identify engineering problems (i.e. situations that needed to be changed or improved)
	• Identify constraints and find out the criteria to achieve the expected outcome in solving the problem
	• Consider the needs of users and the expectations of the community
Developing Prototypes	• Propose different design solutions
	• Recognise the strengths and limitations of the prototypes
Conducting Investigations	• Conduct scientific tests and summarise the performance of the prototypes under a range of conditions
Analysing Data	• Analyse data to determine the optimal settings of the prototypes
	• Conduct cost estimation
Constructing Designing Solutions	• Analyse and select the optimal design based on different criteria
	• Present the advantages and the limitations of the finalised design
Evaluation	• Analyse feedback received and propose further improvements to the design

In the course of science learning at the junior secondary level, students can organise students into groups for engineering design activities, allowing time for students to propose diverse designs, develop their own solutions to tackle the engineering problems, build prototypes and conduct scientific tests. Teachers can make reference to the following aspects to plan for engineering design activities:

Considerations on planning a "Engineering Design" activity
Activity focuses (examples): • ensuring the tasks are built on meaningful and engaging contexts • facilitating students to participate in an engineering design task that involves problem-solving skills and is relevant to the context set • facilitating students to use knowledge and skills learnt in science, mathematics and technology • encouraging students to exercise creativity in engineering design within practical constraints Activity themes (examples): • design and make a device to harvest solar energy at daytime (Unit 5) • design and make a water-saving device to be fixed on water tap (Unit 5) • design and make a heat insulating house model (Unit 7) • design and make a "water rocket" or a "balloon car" (Unit 9) Skills involved in the activity (examples): • able to propose engineering problems • able to identify the needs of users/stakeholders • able to construct different prototypes/construct effective and original prototypes/propose effective improvements to existing solutions • able to design effective scientific methods to test prototypes • able to carry out cost estimation for the project • able to identify the advantages and limitations of different solutions • able to propose reasonable criteria to select the optimal design solution

(c) Exploring Socio-scientific Issue

This curriculum is to enable students to think critically about science-related issues, understand the impact of human activities on the environment, and take responsible actions to promote environmental sustainability. Allowing students to discuss and explore Socio-scientific Issues (SSI) can provide learning opportunities for them to use scientific knowledge to distinguish facts, myths and ideas, make evidence-based scientific arguments and make informed decisions. SSI learning activities can be divided into three parts, including selecting SSIs, exploring SSIs, and making scientific reporting and evaluation.

<table>
<tr><th colspan="2">Socio-scientific Issue (SSI)</th></tr>
<tr><td colspan="2">SSI refers to scientific issues related to human life and involving different disciplines (e.g. I&T, environment, society). SSI usually does not have clear solutions, and different stakeholders may have different point of views.</td></tr>
<tr><th colspan="2">Scientific Argumentation</th></tr>
<tr><td colspan="2">Scientific argumentation is a systematic process to analyse and explain natural phenomena. Scientists share and express scientific observations and conclusions through scientific argumentation in scientific communities, which is very important for constructing and communicating scientific knowledge. A scientific argument usually consists of the following three main parts:
Claim: A statement that answer a scientific question
Evidence: Qualitative observations or quantitation data that support the claim
Reasoning: A justification based on scientific knowledge or principles that explain why the evidence supports the claim</td></tr>
<tr><th colspan="2">Major Component of SSI-based Learning Activity</th></tr>
<tr><td>Selecting SSI</td><td>• Select SSI relevant to students' daily experience / curriculum content</td></tr>
<tr><td rowspan="4">Exploring SSI</td><td>• Propose the related cross-disciplinary knowledge, facts, concerns and myths of the SSI</td></tr>
<tr><td>• Consider the perspectives of different stakeholders</td></tr>
<tr><td>• Select suitable approaches to investigate the SSIs (e.g. literature review, experimentation, debate, role playing)</td></tr>
<tr><td>• Apply scientific reasoning and knowledge to explore the SSI</td></tr>
<tr><td rowspan="2">Scientific Communication</td><td>• Analyse the evidence and make informed suggestions or decisions based on evidence</td></tr>
<tr><td>• Select a suitable format for presenting their findings (e.g. oral presentation, poster design or written report)</td></tr>
<tr><td>• Present their work and conduct evaluations</td></tr>
</table>

Arranging SSI-related learning and teaching activities can help students understand how scientific knowledge is applied in society and its importance to society, ethics, economy and the environment, and understand interconnectedness of the development of science and technology on different aspects. To let students exploring SSI, teachers may consider adopting different activity modes, such as group discussions, mock debates, role plays and project-based studies. In these activities, students may express different views, either supporting or opposing particular claims. Teachers can guide students to conduct experiments or find reliable data, and teach them about proposing scientific arguments. Through the SSI exploration, students can reflect on their own arguments and revise their claims in response to peer feedback, thereby deepening their understanding of relevant scientific concepts.

Considerations on planning a SSI activity

Activity focuses (examples):

- making explicit the underlying values of knowledge in science, mathematics and technology, and the innovation and technology solutions are situated to solve societal or environmental problems
- facilitating students to make evidence-based decisions or recommendations based on reliable source of information (e.g. peer-reviewed science journals)
- facilitating students in developing proper values and attitudes as well as to proactively promote environmentally sustainable practices
- providing opportunities for students to engage in scientific discussion

Activity themes (examples):

- investigate the importance of biodiversity to the sustainable development of the natural environment and its benefits to humans (Unit 2)
- discuss on the needs of using fossil fuels and its impact on the society (Unit 5)
- discuss on the pros and cons of the ways of the conservation of species (e.g. artificial fertilisation and cloning) (Unit 6)
- discuss on the social, economic and environmental consequences of using different ways to generate electricity (Unit 10)

Skills involved in the activity (examples):

- able to distinguish between facts and myths
- able to identify what scientific evidence is
- able to explain why scientific literature is considered a reliable information
- able to critically evaluate the views of different stakeholders
- able to extract evidence from information to support or refute claims
- able to put forward scientific arguments (claim-evidence-reasoning)

Curriculum resources – Cross-disciplinary connections

When arranging cross-disciplinary science learning activities, teachers may refer to the curriculum resources of the "Science (S1-3) STEAM Learning Module". The STEAM learning module includes a series of learning activities, such as I&T investigative activities, engineering design, problem-solving activities and data processing exercises. to encourage students to integrate and apply knowledge and skills in mathematics, science and technology, understand the basic concepts of engineering design, and recognise the applications of science and innovative technology in daily life. Teachers can adapt relevant materials and activities according to students' interests and abilities.

2.3 The Units for the Curriculum

The curriculum comprises 13 units, designed in the form of cross-disciplinary themes that encompass various scientific domains, including biology, chemistry, physics, and earth science, with strong emphasis on scientific inquiry and the development of scientific thinking. Through learning these units, students will acquire scientific knowledge across different fields and gain an understanding of the five overarching concepts: “systems and organisation”, “evidence and models”, “change and constancy”, “form and function” and “matter and energy”. These concepts span across general scientific domains and transcend the boundaries of individual disciplines. Learning these concepts will help students recognise the interconnections between scientific knowledge and deepen their understanding of the nature of science.

Unit 1: Scientific Practices I
Unit 2: Looking at Living Things
Unit 3: Human Reproduction and Heredity
Unit 4: Scientific Practices II
Unit 5: Earth and Space
Unit 6: Living Things and the Environment
Unit 7: Matter and Energy
Unit 8: Atomic World
Unit 9: Force and Motion
Unit 10: Making Use of Electricity
Unit 11: Healthy Body
Unit 12: Light and Sound
Unit 13: Our Planet Earth

2.3.1 Organisation of each Unit

The content of each Unit in this curriculum is organised into the following parts:

Overview

This part outlines the context and the focuses of each Unit, including examples of relevant elements of scientific literacy.

Student should learn

This column lists the major content areas of each Unit. It indicates the knowledge and concepts that students should learn.

Students should be able to

This column lists the learning outcomes that students should achieve in each Unit. These learning outcomes depict the cognitive level of the curriculum content that students should grasp. Whenever learning outcomes which draw on higher cognitive ability (e.g. relate) are applicable, other learning outcomes drawing on lower cognitive ability (e.g. state, describe) are not listed. Moreover, learning outcomes that involve students to apply scientific skills are denoted as (S). Teachers can use these learning outcomes to set appropriate assessment tasks for reviewing the progress of learning and teaching. In addition, students can achieve learning outcomes in curriculum units through different learning modes, such as reading-to-learn, video-based learning, visits, outdoor learning, online interactive learning and cross-subject collaborative learning. Having regard to students' learning needs, teachers can arrange learning activities or tasks for learning outside the science classroom to replace lecturing for completing the teaching of the learning outcomes.

Key Practical Tasks

The curriculum specifies a series of Key Practical Tasks (KPTs) to be conducted by students within each learning unit, linking scientific learning with hands-on scientific practice. Teachers should systematically arrange these KPTs when teaching relevant topics, enabling students to solve scientific problems through experimentation, practice manipulative skills, verify scientific theories, and develop scientific argumentation. These activities could help students to develop scientific inquiry skills effectively.

Suggested learning and teaching activities

This column suggests activities through which students may achieve the learning outcomes. The range of learning activities listed are for teachers' reference only and are by no means an exhaustive or mandatory list. Teachers should exercise their professional judgment in

selecting activities to cater for students' interests and abilities. Where possible, the learning and teaching activities should be designed with students' daily relevancy, allowing them to relate scientific knowledge to society and the environment. It is hoped that students will then be equipped with scientific concepts, theories and process skills to investigate and solve daily life problems, and develop proper values and attitudes.

2.3.2 Core and Extension Part

The curriculum content of each Unit is designed with *Core* Part and *Extension* Part to cater for students of different abilities and needs. The *Core* Part covers the basic science ideas that all students should learn. The *Extension* Part constitutes learning of science knowledge in wider or deeper scope. The learning outcomes and related learning and teaching activities in the Extension Part of the curriculum are indicated in blue italics.

2.3.3 Time Allocation

The total lesson time for the junior secondary level should be around 918 hours per school year. The suggested time allocation for Science Education KLA should be 10 – 15% of the total lesson time, that is, about 92 – 138 hours per school year (e.g. assuming 40 minutes per lesson and adopting 5-days per teaching cycle comprising of 40 lessons, schools should allocate 4-6 science lessons per teaching cycle at each junior secondary levels respectively). Shown below is the suggested lesson time for each Unit of Science (S1-3) Curriculum as reference. Teachers may adjust the lesson time having regard to students' learning progress.

Curriculum Units	Suggested lesson time (hours)	
Unit 1: Scientific Practices I	12 – 18	
Unit 2: Looking at Living Things	12 – 18	
Unit 3: Human Reproduction and Heredity	12 – 18	
Unit 4: Scientific Practices II	12 – 18	
Unit 5: Earth and Space	20 – 27	
Unit 6: Living Things and the Environment	24 – 36	
Unit 7: Matter and Energy	24 – 36	
Unit 8: Atomic World	24 – 36	
Unit 9: Force and Motion	24 – 36	
Unit 10: Making Use of Electricity	20 – 27	
Unit 11: Healthy Body	16 – 23 (Core)	16 – 23 (Extension)
Unit 12: Light and Sound	16 – 23 (Core)	16 – 23 (Extension)
Unit 13: Our Planet Earth	16 – 23 (Core)	16 – 23 (Extension)

2.3.4 Suggested Learning and Teaching Sequence

The following shows a suggested Learning and Teaching Sequence, prepared in regard to the feasibility and suitability for the majority of secondary students.

This sequence allows learning starts with scientific concepts that are related to macroscopic patterns (e.g. "Looking at Living Things" and "Earth and Space"), and gradually progresses to scientific concepts at the microscopic or atomic-level in nature (e.g. "Matter and Energy" and "Atomic World"). However, this suggested learning sequence mentioned above is not intended to be the only one suitable for all schools. With reference to students' learning needs, prior knowledge and science knowledge foundation, teachers may consider the following options and exercise their discretion to feasibly adopt alternative learning and teaching sequence so as to facilitate the learning of the students.

<u>Other Possible Options of Learning and Teaching Sequences</u>

① "Scientific Practice I" and "Scientific Practice II" include different aspects of scientific inquiries. If teachers consider that it is more beneficial for the students to learn "Scientific Practice I" and "Scientific Practice II" in one go, they can make reference to the following example.

② Under the suggested learning and teaching sequences, the units in S1 are mainly related to Biology and Earth Science while the units in S2 are mainly related to Physics and Chemistry. If teachers consider that teaching different science disciplines (Biology, Chemistry, Physics, Earth Science) evenly in each school year can facilitate the students to have cross-disciplinary connections in a more effectively manner, they can make reference to the following example.

2.4 Vertical Continuity of Curriculum

2.4.1 Interface with Primary Science Curriculum

The Science (S1-3) Curriculum is built on the learning outcomes of the one at the primary level. It continues the development of the learning of primary science and equips students with the prerequisite knowledge and skills for their further learning at the senior secondary level.

Science teachers should note the following concerning the transition between primary and junior secondary:

- Although some of the topics in the science curricula for primary level and junior secondary level maybe similar, teachers should note the difference in the students learning experience and the contents of the topics. To facilitate a smooth transition between primary and junior secondary science education, teachers should plan for effective progression from the one to the other with reference to the learning contents in primary science. Teachers may refer to the QR code shown on the right for more information about the curriculum link between the science curricula for primary and junior secondary levels.

- At the primary level, students learn several areas of basic science knowledge and the applications of the knowledge in daily life; while for Science (S1-3), focuses should be put on facilitating students to work towards making evidence-based scientific explanation and strengthening in students the capability on scientific problem solving. Therefore, teachers at the junior secondary level may progressively introduce tasks that require the integrated application of scientific knowledge for problem-solving.

- For the arrangement of assignments, teachers should design suitable learning and teaching activities to train students' scientific thinking as to facilitate them to understand and connect different scientific concepts for exploring new scientific knowledge. Teachers are expected to exercise professional judgment and design learning tasks flexibly in accordance with the needs of their students and provide different learning support such as scaffolding and prompts.

2.4.2. Teaching Arrangement

The scientific knowledge, inquiry skills, and understanding developed throughout the three-year junior secondary science curriculum lay a solid foundation for students' learning of senior secondary subjects. The core parts of the curriculum cover essential scientific concepts that all students are expected to master for learning of different senior secondary subjects, and to facilitate students' smooth progression towards senior secondary levels. The extension parts of the curriculum provide broader and deeper scientific knowledge; in particular, some of the topics are more challenging which are suitable for students planning to pursue elective science subjects at senior secondary levels.

Schools should plan the curriculum tailored to school contexts to foster students' interest in and motivation for science learning, thereby preparing students for further studies and personal development. For the teaching arrangement, teachers should take note of the following **curriculum requirements**:

- **Teachers should complete the teaching of the Core Part of the Junior Secondary Science Curriculum and arrange the respective Key Practical Tasks (KPTs) for students in the first place.**

- With regard to students' needs, interests and abilities, teachers might adopt suitable teaching arrangements to extend students' learning experiences across different science disciplines. Examples are:
  - selecting appropriate materials from the *Extension Part* for teaching
  - including science enrichment topics (chemistry, biology, physics)
  - arranging in-school science competitions / problem-based project learning
  - arranging cross-disciplinary learning activities (e.g. scientific modelling, engineering practices, investigating socio-scientific issues)
  - using digital platform or digital educational tools to facilitate interactive learning / self-regulated learning

2.5 The Use of Digital Educational Tools and Artificial Intelligence

Digital educational tools and artificial intelligence (AI) technologies provide support for learning and teaching in junior secondary science, and promote pedagogical innovation in science education. By utilising digital educational tools and AI-assisted teaching strategies, teachers can better design interactive learning and teaching materials, understand students' learning progress and needs, and enhance teaching effectiveness by adopting innovative teaching strategies.

With the assistance of AI technologies, such as generative AI, personalised learning platforms, and learning analytics tools, teachers can design learning activities and assessment methods that are better tailored to students' needs. AI can assist teachers to analyse students' performance, identify learning difficulties, and provide suggestions and support for revising learning resources, thereby facilitating students' science learning.

Teachers can ultilise AI and digital educational tools appropriately, including the use of simulation experiments, animations, virtual reality (VR), and augmented reality (AR) tools. These tools help students develop a deeper understanding of complex or abstract scientific concepts. Moreover, teachers can make good use of online science learning platforms to provide students with diverse learning experiences, and apply AI to analyse students' learning data, offering personalised feedback and guidance. This can effectively promote self-directed learning and enhance learning effectiveness.

The following are examples of the applications of digital educational tools for teachers' reference:

Digital Educational Tools	Pedagogical Use
Simulation	● using interactive simulation experiments in which students could manipulate different simulated objects, thereby promoting self-directed learning.
Science Online Platform	● using online platform to provide students with different learning experiences, such as online science seminars, e-quizzes, and online reading activities.
Data-logger	● using a data-logger to conduct experiments, e.g. a data-logger with a position sensor can be used to investigate the motion of a ball falling under the action of gravity.
Mobile Device	● using VR and AR APPs to create immersive learning experiences to make abstract scientific concepts more tangible (e.g. exploring human system or ecological system). ● using mobile devices installed with apps for interactive learning inside and outside the classroom, e.g. using "location-based" applications to extend science learning beyond the classroom.
Artificial Intelligence (AI)	● using generative AI in science journal reading activity. ● using AI chatbot in adaptive science learning. ● using AI tools (e.g. machine learning system) to construct, revise, and evaluate predictive models. ● using visual recognition technology for pattern seeking. ● using AI to assist in assessing open-ended scientific questions.

Pedagogical Considerations of Using AI in Junior Secondary Science

When applying AI (including generative AI (GenAI)) to assist teaching, teachers should strike a balance between AI-assisted learning and hands-on scientific investigations. Teachers need to exercise their professional judgement on the appropriate use of AI and ensure that the students are provided with sufficient opportunities for students to engage in hands-on experiments and authentic learning experiences, both inside and outside the classroom, so as to fully develop their scientific inquiry skills.

For the learning and teaching materials designed with the assistance of GenAI, teachers should indicate clearly the content generated by GenAI, and avoid using such content in ways that

compromise academic integrity. When using GenAI tools during teaching, teachers must verify the authenticity, accuracy, and consistency of the generated content. For example, if GenAI is used for marking assignments or assessments, teachers should perform manual reviews to ensure assessment quality and uphold academic integrity. Teachers should also foster students' awareness of ethical AI usage, and nurture students to be ethical and responsible users of AI tools.

AI enables both teachers and students to conveniently access scientific information and has also brought changes to the mode of learning and teaching. When designing science lessons, teachers should consider students' learning needs and use AI appropriately as an assistive tool to plan and conduct suitable scientific inquiry activities, with a view to foster students' inquiry skills, scientific thinking, and scientific attitudes. By engaging in diverse science learning activities with the use of digital educational tools (including AI), students can perform advanced data analysis and reflect on the inquiry process. The learning process could nurtures students' scientific thinking, creative thinking, critical thinking, and computational thinking skills. Below are some learning and teaching examples of the use of AI in Science (S1-3) for teachers' reference:

The Use of Generative AI in Science Journal Reading

Using AI to Construct, Revise, and Evaluate Scientific Models

Using AI to Assess Open-ended Scientific Questions

<u>The Use of AI in Science Lesson Setting</u>

When planning science lessons, teachers should clearly define the learning objectives of the science lessons, and consider how AI can be used to support students in carrying out scientific practices that align with those teaching objectives, and thereby facilitating students' effective science learning. Teachers may make reference to the following materials when planning science lessons:

Learning Modes of Scientific Practices

Modes of Application of GenAI in Science Lessons

Example of Using AI in Classroom Design

The following example shows how AI can be used as an assistive tool to facilitate students' learning in scientific modeling activities. Teachers design learning activities according to relevant curriculum unit to allow students to conduct scientific investigation with the use AI.

Topic: Unit 6 Living Things and the Environment (6.4 Climate Change)

Learning Outcomes:

- recognise that carbon dioxide is one of the greenhouse gases
- recognise that some human activities can disrupt the balance of carbon dioxide in Nature
- state the advantages of planting that benefit the environment and its role in alleviating the climate change

Learning Activities	The Use of AI	Time
View videos about climate change and recognise related scientific problems (Asking Scientific Question)	No **AI**	5 min
Sketch a concept map to illustrate the relationship between factors affecting climate change according to instruction (Communicating and evaluating science)	No **AI**	10 min
Generate original ideas to revise the concept map by incorporating new factors affecting climate change (Scientific modelling). ● If teachers allow GenAI to be used by students for assisting ideation, students should be guided to explain the selection of AI-generated ideas	**AI** Assisted Ideation	15 min
According to the information from the concept map, construct a scientific model using an online platform (Scientific modelling)	No **AI**	20 min
Use the model to make predictions and explain climate change-related phenomena (Constructing scientific explanation)	No **AI**	10 min

Unit 1: Scientific Practices I

Overview

This Unit aims to develop in students understanding of basic concepts of scientific experiments and measurement, while also strengthening their safety awareness and scientific attitude. Students will conduct experiments such as heating solids and liquids or mixing solutions, using common laboratory apparatus such as stopwatches, measuring cylinders, thermometers, and electronic balances. Through these activities, students will learn the importance of measurement errors and the concepts of "accuracy" and "precision". For example, teachers can have students compare multiple measurement data and discuss the impact of parallax on the readings to develop students' ability to observe carefully and think logically.

Safety in the laboratory is another learning focus of this unit. Students will learn to identify common hazards (factors that can potentially cause harm) and risks (possibility of causing harm), and recognise the meaning of hazard warning symbols. While learning about the concept of the "Fire Triangle", students will understand the necessary conditions for combustion and learn ways to reduce or control accidents. These learning contents will help students become familiar with the proper use of laboratory apparatus and chemicals, learn to deal with common laboratory accidents, and establish positive values on responsibility and safety during experiments.

Teachers can also organise different learning activities, such as using candles to conduct fair tests to find out the necessary conditions for fire. Students can record and analyse experimental data, and present their data using tables or simple charts. Through this process, students will learn about control variables, analyse cause-and-effect relationships, and come up with ways to improve experimental design. These activities can help students develop collaborative skills in problem-solving. Teachers can also design other appropriate learning and teaching activities to help students develop and master the following skills:

- operating simple experimental apparatus
- making qualitative observations and quantitative measurements
- commenting accuracy and precision in a scientific measurement
- reporting data honestly

Students should learn	Students should be able to
1.1 Scientific knowledge	
• science communication • steps of scientific investigation • applications of science, innovation and technology	• be aware that scientific knowledge is built from experimentation, analysis of data and scientific reasoning based on evidence • state the major steps of a scientific investigation • be aware that scientists will assess new discoveries by peer-review • recognise the daily applications of science, innovation and technology • be aware of the responsibility towards promoting science ethics, animal welfare and environmental sustainability
1.2 Scientific observation and data	
• the use of apparatus for measurement • accuracy and precision • measurement error • sources of error	• use appropriate apparatus for heating, mixing and transferring solution properly and safely (S) • use appropriate apparatus for conducting proper measurement (e.g. stop watch, metre rule, measuring cylinder, electronic balance and thermometer) (S) • be aware that error is the difference between the true value and the measured value in an experiment (S) • be aware that the measurement is considered to be accurate if the error is small (S) • be aware that precision refers to the spread between measured values and can be found by repeated measurements (S) • recognise some sources of error in measurement (zero error, parallax and reading error) (S)

Students should learn	Students should be able to
1.3 Safety in the laboratory	
• laboratory safety rules • hazard and risk • hazard warning symbols • ways to minimise the risk of accidents in laboratory • fire triangle	• be aware that a laboratory is a suitable place for conducting scientific investigation • recognise the laboratory safety rules • identify some safety equipment in school laboratories • be aware that hazard is the factor causing potential harm (S) • be aware that risk is the likelihood of a hazard causing harm in practice (S) • identify some common hazard warning symbols • recognise some measures to minimise and control the risk of laboratory accidents • describe how to handle some common laboratory accidents • recognise the fire triangle and the various ways of putting out a fire

Suggested Learning and Teaching Activities

- Perform practical work on heating solid and liquid
- Perform practical work to transfer and mix different solutions
- Perform fair test with the use of candles to demonstrate the necessary conditions for fire
- Find out the volume of some objects in irregular shapes
- Perform practical work to measure the mass of an object and the temperature of a solution
- Read articles about the hazard and risk and understand the relationship between them
- Search information on the impact of scientific knowledge on natural resource management and the development of I&T
- Identify potential hazards shown in pictures of laboratories and suggest appropriate precautions
- Discuss the proper ways to cope with some laboratory accidents (e.g. a fire or acid spills)
- Watch video about the proper use of fire-fighting equipment (e.g. fire extinguishers)
- Read about the contribution of famous scientists (e.g. Louis Pasteur, Marie Curie, Youyou Tu, Charles Kao, Daniel Tsui and Lap-chee Tsui)

Unit 2: Looking at Living Things

Overview

This Unit engages students in observing different organisms and cultivates students' ability to make scientific observation and in identifying and summarising key biological features. Students will learn to classify fish, amphibians, reptiles, birds, and mammals based on their external features, and recognise the key features of non-vascular and vascular plants, seed and seedless plants, flowering and non-flowering plants. These learning activities help students understand the overarching concept of "form and function". Through activities such as examining photos and conducting a biodiversity survey on the school campus, students can learn about the concepts of biodiversity, and develop the proper values of respecting nature and cherishing life.

Learning about the life cycles of animals through observing the changes in the growth process of birds or frogs, can help students understand more about the patterns of growth and reproduction of organisms. This Unit also introduces cells as the basic unit of living things, teachers may teach the relevant concepts via the use of practical activities, such as providing opportunities for students to prepare slides and examine plant and animal tissues under a microscope, which students could experience the process of scientific inquiry and master relevant experimental skills. Besides, teachers can design appropriate learning and teaching activities to help students develop and master the following skills:

- observing an organism over a period of time, noticing relevant details
- using a set of general observations, trend or model to deduce a specific result
- identifying similarities and differences of organisms
- classifying organisms according to their external features
- using tables and graphs for data analysis
- referring information from reliable sources

Students should learn	Students should be able to
2.1 Grouping of living things	
• key features of different groups of living things • grouping of living things and identification key	• recognise the need of classifying living things into groups • state that scientists put living things into different groups according to their key features • identify the key feature for distinguishing between invertebrates and vertebrates (S) • identify the key features for distinguishing between fish, amphibians, reptiles, birds and mammals (S) • identify the key features for distinguishing between non-vascular plants and vascular plants, seedless plants and seed plants, non-flowering plants and flowering plants (S) • construct a simple key for identification of living things (S) • give examples to illustrate the structural and behavioural characteristics possessed by organisms that facilitate them in surviving and passing on their characteristics to their offspring • be aware that some mammals possess structural characteristics different from others (e.g. echidna, dolphin and bat)
2.2 Life cycles	
• life cycles of animals	• compare the life cycles of animals as exemplified by birds, frogs and butterflies
2.3 Cells	
• basic unit of living things • major cell structures and their primary functions • plant cells and animal cells	• recognise cells as the basic unit of living things • recognise that cells can divide, grow and differentiate into different types of cells • recognise the major cell structures and their primary functions (e.g. cell wall, cell membrane, nucleus, cytoplasm, chloroplast, mitochondrion and vacuole) • examine plant and animal tissues and identify cells structures under a microscope (S) • compare the structural similarities and differences between plant cells and animal cells

Students should learn	Students should be able to
2.4 Level of organisation of organisms	
• *major organs and the components of systems in human body* • *role of major organs and systems in sustaining life*	• *recognise that tissues is formed from groups of cells with specialised structures and functions (e.g. nerve, muscle and bone)* • *recognise the major organs (e.g. lungs, stomach, brain, heart) and the components of systems (e.g. breathing system, digestive system, nervous system, transport system) in human body* • *recognise the role of major organs and systems in human body (e.g. organs involved in breathing)*

Key Practical Tasks

- Examine plant and animal tissues under a microscope
- Identify whether vascular tissues are present in different plant samples

Suggested Learning and Teaching Activities

- Examine photos to identify the key features of different groups of animals (e.g. fish, frog, tortoise, bird and rabbit)
- Construct a simple identification key for a variety of plants, terrestrial animals and marine animals
- Identify flowering or non-flowering plants in school campus or a park
- Conduct a biodiversity survey in school campus or a park using mobile devices
- Visit Fung Yuen Butterfly Reserve to learn about the life cycle of butterflies and their relationship with host plants

Unit 3: Human Reproduction and Heredity

Overview

This Unit will introduce the basic concepts of human reproduction and heredity. The genetic material, DNA, within the body cells carries the instructions for defining the different traits of a living organism. Reproduction is an essential life process that leads to the formation of a new life. Through reproduction, new individuals with traits similar to their parents are formed. The passing of traits from generation to generation is called heredity. The overarching concept "change and constancy" can be exemplified in the process involved in heredity. In tandem, through learning about the formation of life and its related processes, students can gain an understanding of the mysteries of life, thereby developing proper values of cherishing and respecting life.

Through different learning activities, such as constructing a DNA model to demonstrate the double helix structure as well as base pairing of DNA and performing practical work to extract DNA from fruit and vegetable samples, students can develop practical manipulative skills and enhance their understanding of constructing scientific models. By conducting a class survey on continuous and discontinuous variation and presenting the data in tables and charts, students can strengthen their data processing skills. Besides, teachers can design appropriate learning and teaching activities to facilitate students' development and mastery of the following skills:

- using tables and graphs for data analysis
- observing carefully to discern the order in which events take place
- extracting and suitably organising relevant information from reliable sources
- organising the claim, evidence and reasoning clearly in scientific discussions
- reflecting on and consolidating scientific concepts through scientific discussions to enhance understanding of the concepts
- distinguishing between fact, myth and belief, and making informed decisions based on evidence
- evaluating the impact of various application of scientific discoveries on society
- thinking critically about the scientific information obtained from the media from scientific, ethical and social perspectives

Students should learn	Students should be able to
3.1 Human reproduction	
• reproduction • sexual maturity and secondary sexual characteristics • reproductive systems • sex cells: sperm and ovum • fertilisation and implantation	• recognise that reproduction is an essential life process to ensure the continuity of humans • describe the signs of maturation of the reproductive system and the secondary sexual characteristics that appear during puberty • identify the structures and functions of the male and female reproductive systems • state that sperm and ovum are the sex cells • recognise that fertilisation occurs in the oviduct when a sperm fuses with an ovum to form a zygote • state that the development of the embryo begins before the implantation into the uterine lining • recognise the development of the embryo into foetus inside the mother's body and the birth of a baby
3.2 Chromosomes and DNA	
• *DNA as the genetic materials*	• *recognise that the chromosomes found in the nucleus of each cell contain the genetic materials, DNA* • *state that DNA carries the instructions that determine different traits in organisms* • *state that sex cells carry one set of chromosomes (23 chromosomes) in humans* • *state the zygote formed from fertilisation carries two sets of chromosomes (46 chromosomes)* • *be aware that the sex of the zygote is determined by the sex chromosomes* • *identify sex chromosome by examining the photomicrographs of a complete set of chromosomes in a cell* (S) • *state that there are four kinds of bases, A, T, C and G in DNA* • *state that the double helix structure of DNA depends on the base pairing of A with T and C with G* • *recognise that the instructions encoded in DNA depends on the base sequence of the DNA, which determines the production of proteins* • *construct a model of DNA to demonstrate the double helix structures as well as the base pairing* (S)

Students should learn	Students should be able to
3.3 Pregnancy and family planning	
• pregnancy and parenting • family planning and birth control	• state the signs and the length of pregnancy • be aware that parenting is essential for the growth of infants • recognise the need of family planning • state that the prevention of the fusion of ovum and sperm is one of the basic principles of birth control • recognise various methods of birth control • recognise the importance of preventing the transmission of sexually transmitted diseases
3.4 Heredity and variation	
• heredity • variation	• state that heredity is the passing of traits from one generation to the next as a result of the transmission of genetic information • recognise that variations are determined by both heredity and the environment • give examples of continuous variation and discontinuous variation in humans • give examples of inherited traits and acquired traits • construct and interpret bar charts and histograms showing the distribution of variations in a group of individuals (S)

Key Practical Tasks

- *Construct a model of DNA to demonstrate the double helix structure as well as the base pairing*

Suggested Learning and Teaching Activities

- Perform practical work to extract DNA from fruit and vegetable samples
- Use computer simulation or virtual laboratory to learn about the concept of heredity and variation
- Watch video clips to identify the structural features of sperm and ovum
- Examine photomicrographs of an individual's complete set of chromosomes
- Conduct a survey about a continuous variation in the class and present the data in a table and in a histogram
- Conduct a survey about a discontinuous variation in the class and present the data in a table and in a bar chart
- Construct a "genetic traits tree" to analyse the inheritance of a trait in a family
- Discuss the consequences and issues relating to abortion and pre-marital sex so as to develop students' proper value and attitude
- Watch a video clip on the development of an embryo from the fertilisation of sperm and ovum
- Watch a video clip on foetal development and the birth giving process

Unit 4: Scientific Practices II

Overview

This Unit is a continuation of "Scientific Practices I" with a focus on deepening students' understanding of scientific inquiry and scientific reasoning, and further developing their data analysis capabilities. Students will learn how to construct hypotheses and verify them through different scientific inquiry methods. Students will master the concepts of independent variables, dependent variables and control variables as well as design controlled experiments to identify casual relationships. By comparing the accuracy and precision of experimental results, students will learn how to evaluate the reliability of the conclusions.

For the learning of scientific reasoning, this Unit introduces how to use data to infer general trends and construct models or theories for explaining phenomena scientifically. For example, in the activity of "perform practical work to find out the relationship between temperature and thermal expansion of liquids", students will observe and compare the changes in liquid volume at different temperatures, organise the data using charts, and construct different models to explain their observations. This process will help students understand the concept of "evidence and models".

In addition, reading historical stories about famous scientists conducting scientific investigations could facilitate students to understand the key role of scientific inquiry in building scientific knowledge. Teachers can also arrange problem-solving exercises in scientific reasoning and design fair tests and other activities to cultivate students' scientific attitudes, laying a solid knowledge foundation for future scientific learning. Teachers can also design other appropriate learning and teaching activities to enable students to develop and master the following skills:

- using specific data to induce a general trend, conclusion or model
- using a set of general observations, trend or model to deduce a specific result
- making inference to the best possible explanation to the observed phenomenon
- making informed decisions based on the probability of phenomenon occurring
- formulating a hypothesis based on the observed phenomenon
- identifying independent variables, dependent variables and control variables
- setting up a controlled experiment that minimises the effect of confounding factors to identify causation
- choosing from alternative experimental methods or improving the method for a scientific investigation
- **c**ommenting the reliability of a scientific measurement or a scientific investigation

Students should learn	Students should be able to
4.1 Scientific investigation • hypothesis • types of investigation • types of variables • control experiment	• recognise that a hypothesis is a statement to describe, predict or explain some phenomena in nature, and could be tested by scientific investigation (S) • recognise different types of scientific investigations: (S) ➢ fair testing ➢ classifying ➢ pattern seeking • identify different types of variables in a scientific investigation (S) • recognise the role of a controlled experiment in ensuring the scientific investigation is valid for establishing causality (S) • be aware that the conclusion drawn from an experiment is used to support or refute the hypothesis set in the scientific investigation (S) • recognise some ways for assessing the reliability of the conclusion drawn in a scientific investigation (e.g. repeating the experiment with the same set of apparatus, reproducing the experiment in a different environment or with a different set of apparatus) (S)
4.2 Scientific reasoning • scientific models • ways of scientific reasoning • uses and limitations of scientific reasoning	• be aware that modelling is a process by which scientists generate scientific models for describing, making predictions on and explaining scientific phenomena (S) • give examples of different types of scientific models • be aware of different ways of scientific reasoning for establishing scientific knowledge and making inferences: (S) ➢ using specific data to induce conclusions, predict trends or develop scientific models ➢ using scientific models or trends to deduce a specific result ➢ *making inferences about the most possible explanation for the observed phenomena* ➢ *making informed decision based on the likelihood of phenomena occuring* • *be aware of the limitations of the scientific reasoning for establishing scientific knowledge and making inference* (S)

Suggested Learning and Teaching Activities

- Perform practical work to find out the relationship between temperature and thermal expansion of liquids
- Design a fair test for a scientific investigation
- Comment on the validity of a control experiment in a scientific investigation
- Compare the accuracy and precision for the results obtained from two experimental groups
- Do problem-solving exercises on scientific reasoning
- Read historical stories of experiments conducted by scientists to investigate photosynthesis (e.g. Jan Baptista van Helmont, Joseph Priestley, Jan Ingenhousz)

Unit 5: Earth and Space

Overview

This Unit will introduce scientific concepts related to the structure of the earth, earth resources and space exploration. Students will begin by learning the physical characteristics of the planets in the solar system and compare them with the surface temperature, atmospheric composition and water distribution of the Earth, through which to explore planets which may have potential conditions to support life. Students will further develop their understanding of the relationships between different phenomena and processes on Earth, such as the sun provides energy to the earth through radiation, the growth of plants and animals, the movement of clouds, and the water cycle, and discuss how these processes interact with each other to make life sustainable, thereby deepening their understanding of the overarching concepts of "change and constancy".

In addition, teachers can arrange appropriate learning activities to allow students to conduct scientific discussions comparing the advantages and limitations of fossil fuels and renewable energy sources, and inspiring them to reflect on the responsibilities towards the environment and sustainable development. Moreover, concepts learnt from geography topics of "Energy" and "Ocean" provide background knowledge for students to understand the scientific concepts in this Unit. Teachers are encouraged to guide students to carry out cross-disciplinary projects so that they can have a more holistic view in investigating issues relating to these topics.

This Unit also facilitates students to appreciate the country's achievements in the development of space science (e.g. the Tiangong Space Station and China manned space program) and understand the contributions made by local and national aerospace scientists in research fields on lunar surface sampling and deep space exploration. By studying the national space research project, students can understand and appreciate the country's important achievements and contributions in the development of space science and appreciate the dedication of scientists. Besides, teachers can design appropriate learning and teaching activities to facilitate students to develop and master the following skills:

- using a set of general observations, trend or model to deduce a specific result
- making inference to the best possible explanation to the observed phenomenon
- using tables and graphs for data analysis
- choosing from alternative experimental methods or improving the method for a scientific investigation
- commenting the reliability of a scientific measurement or a scientific investigation
- organising the claim, evidence and reasoning clearly in scientific discussions
- evaluating the balance between the development of science and technology as well as environmental cost

Students should learn	Students should be able to
5.1 Space exploration	
• physical features of planets in the solar system • space exploration programmes by our country	• state that the Sun is a star providing light energy and thermal energy to members of the Solar System • compare physical features of the Earth, the Moon and other planets (e.g. the composition of atmosphere, average surface temperature, presence of water, mass, gravity, distance from the Sun, the period of revolution and rotation, and the potential conditions to support life) • appreciate the contributions and major achievements in space exploration programmes by our country (e.g. Tiangong Space Station, China Manned Space Program) • be aware of the contribution of local scientists in national space research project (e.g. Space Agriculture Research, Deep Space Exploration, Lunar Surface Sampling)
5.2 The Earth	
• structure of the Earth • the atmosphere • forms and distribution of water	• construct a diagram to show the structure of the Earth: Crust, mantle, inner core, and outer core (S) • state that the atmosphere is a layer of gases surrounding the Earth • state the percentage of main gases in air • recognise the forms of freshwater existing on Earth (ice glaciers, streams and wetlands) • construct a table or diagram to show the distribution of fresh water and salt water in different regions on the Earth's surface (S) • propose diverse and original solutions to distinguish between freshwater and salt water (S)
5.3 Water circulation on Earth**	
• water cycle	• construct a diagram to show the major processes in water cycle: evaporation, condensation and precipitation (S) • be aware of the role of plants in water cycle (e.g. transpiration) • recognise that the Sun provides the source of energy to drive water cycle on the Earth • *recognise the role of cloud movement and water circulation on the renewal of freshwater on the Earth's surface* • *propose diverse and original solutions to collect and conserve freshwater* (S)

Students should learn	Students should be able to
5.4 Earth's resources**	
• water conservation • water pollution and air pollution • fossil fuels and alternative energy sources	• investigate different methods of purification and separation (e.g. filtration, distillation, use of magnets, use of water purification tablets and sedimentation) (S) • recognise that fresh water is a precious natural resource and the importance of water conservation • state different ways to conserve water • construct a concept map to show the relationship of the following : the causes of water pollution, the harmful effects of water pollution on humans and the environment, the methods to control water pollution (S) • be aware of our responsibility to minimise water pollution • be aware of the concerns about using fossil fuels (e.g. limited supply and pollution problem) and nuclear power • recognise the needs and considerations for developing renewable energy sources (e.g. solar energy, biomass energy, wind power and hydroelectric power) and nuclear power

**Note: The learning content in this part is related to the topics of "Energy" and "Ocean" in junior secondary geography.

Key Practical Tasks

- Observe the effect of chlorine bleach or water purification tablets on microorganisms in water under a microscope
- Separate substances from mixtures with apparatus provided (e.g. filter funnel and filter paper, sieve and bar magnet)
- Design an experiment to distinguish between freshwater and sea water samples

Suggested Learning and Teaching Activities

- Search information about the achievement made by our country on the development of clean energy
- Watch video clips on "Tiangong classroom" to learn about the life of astronauts of our country in Tiangong Space Station
- Search information about local scientists' work on Space Agriculture Research, Lunar Surface Sampling and Deep Space Explorations
- Search information about the working principle of geothermal power plant
- Do problem-solving exercise to analyse the efficiency of different water purification methods
- Design and make a fresh water collector (e.g. fog collector, rain water collector)
- Design and make a water treatment device

- Watch video clip about how ocean regulates climate of the Earth
- Do problem-solving exercise to analyse the engineering considerations on installing solar power systems
- Design and make a device to harvest solar energy at daytime
- Evaluate the environmental effect caused by coal-burning power plants with reference to relevant data (e.g. CO_2 and SO_2 emission)
- Discuss the advantages and the disadvantages of using solar and wind energy in urban city
- Design and make a water-saving device to be fixed on water tap
- Compare the relative sizes of the planets in solar system with the use of 3D model or Augmented Reality (AR) technology
- Visit Hong Kong Base for Aerospace Science Education to learn about the contributions and achievements in space exploration programmes by our country
- Visit H_2OPE Centre and the CLP Power Low Carbon Energy Education Centre to learn about the achievement of water and energy resources management in Hong Kong

Unit 6: Living Things and the Environment

Overview

This Unit aims to develop in students the basic understanding of the interrelationship between living things and the environment. Students will conduct different practical activities, such as by investigating the necessary conditions for photosynthesis to occur. Students will learn how plants use light energy, carbon dioxide and water to make food and release oxygen as a by-product. In the activities, students will perform data processing to analyse the changing trends of oxygen consumption or oxygen production, thereby cultivating scientific thinking to propose explanations based on observed phenomena. This Unit also explains the importance of respiration in releasing energy within cells, and explains the complementary roles that photosynthesis and respiration play in carbon and oxygen balance in Nature.

Learning the concepts of "ecosystem" and "biodiversity", such as distinguishing between producers, consumers and decomposers, and analysing food webs to understand relationships such as predation, competition, and symbiosis, help students understand how life could sustain on the earth. Teachers may arrange activities to design micro-ecosystems, facilitating students to observe how the entire system is affected when the number of certain organisms changes, thereby understanding the importance of biodiversity. Students will also understand the impact of human activities on habitats and species survival, thereby cultivating a sense of responsibility and proper values in protecting the ecosystem.

"Climate change" is an important issue encompassing science, technology, the environment, and society. To facilitate students to gain a deeper understanding of the interconnections among its various factors, teachers should actively consider collaborating with other subjects (e.g. junior secondary geography) when planning the learning and teaching on this topic. Interdisciplinary project learning could facilitate students to objectively evaluate the impact of the greenhouse effect on the natural environment, explore the interrelationships among photosynthesis, respiration, ecosystems, and climate change, thereby assisting them appreciate the concept of "change and constancy". Teacher can also design other appropriate learning and teaching activities to enable students to develop and master the following skills:

- using a set of general observations, trend or models to deduce a specific result
- making inferences to the best possible explanation to the observed phenomenon
- identifying independent variables, dependent variables and control variables
- setting up a controlled experiment to minimise confounding factors to identify causation
- choosing from alternative experimental methods or improving the method for a scientific investigation
- **c**ommenting the reliability of a scientific measurement or a scientific investigation
- using tables and graphs for data analysis
- organising the claim, evidence and reasoning clearly in scientific discussions

Students should learn	Students should be able to
6.1 Photosynthesis and respiration	
• photosynthesis • respiration	• recognise that photosynthesis is the process that plants make their own food during which light energy is converted to chemical energy • collect evidence to show that light, chlorophyll, carbon dioxide and water are the necessary requirements for photosynthesis (S) • recognise that the carbohydrates produced in plants can be used immediately or stored as starch for later use • recognise that respiration is a process in which food is broken down to release energy for use in cells • write word equations of photosynthesis and respiration (S)
6.2 Ecosystems	
• habitats and ecosystems • producers, consumers and decomposers • food web • interrelationships among organisms	• state that a habitat is the environment in which organisms live • state that an ecosystem is the interactions between organisms and their environment • identify and give examples of producers, consumers and decomposers (S) • construct and interpret food webs to represent the feeding relationships of organisms (S) • recognise the predation, competition and symbiosis relationship between organisms • identify different interactions (e.g. predation, competition and symbiosis) between organisms (S)
6.3 Biodiversity and conservation	
• effects of human activities on biodiversity and conservation	• recognise the importance of biodiversity to the stability of an ecosystem and the sustainable development of the natural environment • give examples of the benefits of biodiversity to humans (e.g. provision of resources such as food, medicine, raw materials) • recognise that some human activities (e.g. deforestation, destruction of habitat and hunting) may threaten the survival of some species and lead to biodiversity loss • give examples of some endangered species • recognise the importance of environmental conservation and the protection of wildlife

Students should learn	Students should be able to
6.4 Climate change**	
• balance of carbon dioxide and oxygen in Nature • greenhouse gases emission • mitigating climate change	• recognise the natural balance of carbon dioxide and oxygen in Nature • recognise that carbon dioxide is one of the greenhouse gases that absorb and re-emit heat back to the Earth's surface • recognise that some human activities can disrupt the balance of carbon dioxide in Nature • recognise the possible impacts (e.g. global warming) of intensified greenhouse gas emissions on the environment and human health • recognise the importance of practising low-carbon living • recognise the advantages of planting for the environment and its role in mitigating the climate change

**Note: The learning content in this part is related to the topic of "Climate Change" in junior secondary geography.

Key Practical Tasks

- Investigate the necessary conditions for photosynthesis
- Investigate how the carbon dioxide content in a container be affected by the presence of living organisms

Suggested Learning and Teaching Activities

- Conduct an urban birdwatching activity in school campus or a park and learn about bird habitats
- Explore marine habitats and organisms with the use of VR tools
- Search information on the achievement of mangrove conservation and restoration in our country
- Perform practical work to mimic the greenhouse effect arisen from carbon dioxide gas
- Design and make a mini-ecosystem to explain the concept of food web
- Perform practical work to investigate how the mass of detached leaves changes over time in air
- Visit Hong Kong Biodiversity Museum, Endangered Species Resources Centre, Woodside Biodiversity Education Centre, country parks and marine parks to learn about the biodiversity in Hong Kong
- Visit Jockey Club Museum of Climate Change to learn about the impacts of climate change to human and the environment
- Search information and discuss the effectiveness of different treatments to control invasive species

outbreaks (e.g. the use of pesticide and introduction of natural predators)

- Use a food web to show the feeding relationship between organisms
- Interpret environmental data of habitats and relate how organisms respond to environmental conditions
- Interpret data about the changes in populations of different species in an ecosystem when a new population is introduced
- Discuss the evidence and causes of climate change based on data provided (e.g. annual global surface temperature, Arctic Sea ice extent in winter and summer, global sea level, measurement of the sun's energy, atmospheric CO_2 concentration)
- Conduct a project on the conservation of marine animals in Hong Kong (e.g. corals, sharks, green turtles and Chinese White Dolphins)
- Search information on the ways of the conservation of species (e.g. artificial fertilisation and cloning)

Unit 7: Matter and Energy

Overview

This Unit facilitates students to understand the properties of matter in different states and the transfer or conversion of energy. Students will use particle theory to explain scientific phenomena in daily life. For example, students may conduct a practical work on observing the length or volume changes of metal rods in cold or hot environments, and use particle models to support their explanations. Through exploring the phenomenon of expansion and contraction due to temperature changes, students will discuss and understand the underlying scientific principles and daily life applications. In addition, students will learn about the concept of density and through scientific measurement and calculation, determine whether different substances float or sink in water. Teachers may also guide students to draw temperature-time graphs to use data in verifying whether the change of physical state processes (e.g. melting, freezing, boiling, condensation) support with hypotheses, while encouraging them to consider sources of error and ways to improve experimental reliability.

In addition, this Unit uses daily examples (e.g. light bulbs converting electrical energy into light energy, regenerative braking system in electric vehicles) to explain the processes of energy conversion. Students will conduct experiments to understand different heat transfer processes and verify the direction of heat transfer based on experimental data. Teachers may guide students to use particle theory and observed data to verify relevant scientific concepts, and further apply the theory to explain other daily phenomena. Through different learning activities, students will understand the concepts of "evidence and models" and "matter and energy", and develop scientific inquiry skills. Moreover, teachers can also arrange "Design and Make" activities to encourage students to propose diverse and original ideas, apply scientific method for creative problem-solving and experience the process of engineering practice. Teachers can also design other appropriate learning and teaching activities to facilitate students to develop and master the following skills:

- using specific data to induce a general trend, conclusion or model
- formulating a hypothesis based on observed phenomenon
- seeking evidence to support or refute claims
- commenting accuracy and precision in a scientific measurement
- using scientific formula for scientific inference
- identifying outliers and handling data from repeated measurements to assess the uncertainty incurred

Students should learn	Students should be able to
7.1 Particle Theory • basic ideas of particle theory • properties of matter in the three states • thermal expansion and contraction	• recognise basic ideas of the particle theory (e.g. All matters are made of particles, empty spaces exist between particles, particles move randomly) • recognise the increase in temperature will cause the particles gain more energy and vibrate more vigorously • recognise the motion and the arrangement of particles in the three states of matter • construct diagrams of particles to explain some common phenomena: (S) ➢ diffusion of liquids or gases ➢ the physical properties of solids, liquids, and gases (e.g. compressibility) ➢ thermal expansion and contraction • examine that only the volume but not the mass of the substances will change in thermal expansion or contraction (S) • give examples of daily applications of thermal expansion and contraction
7.2 Density • float and sink	• perform calculation with the formula : Density = Mass / Volume (S) • infer the floating and sinking of an object by comparing its density with that of its surrounding medium (S) • explain the effect of temperature change on the density of a substance
7.3 Physical states of matter • change of physical states	• examine that mass remains unchanged when a substance is melted or frozen (S) • recognise that the thermal energy will be absorbed or released during the change of physical states of substances while the temperature remained constant • interpret a temperature-time graph about the change of physical states of substances (e.g. melting, freezing, boiling and condensation) (S)

Students should learn	Students should be able to
7.4 Energy Transformation	
• energy transformation in common processes	• state the energy transformations that take place in common processes (e.g. photosynthesis in plants, the relative changes in potential energy and kinetic energy of a ball throwing in air vertically) • recognise that energy is conserved in an energy transformation process
7.5 Heat Transfer	
• heat transfer processes	• infer the direction of transfer of thermal energy between substances at different temperatures based on the results of scientific measurement (S) • identify the evidence for heat transfer processes: conduction, convection and radiation (S) • give examples of daily applications of heat transfer processes

Key Practical Tasks

- Perform practical work to heat a substance and plot a temperature-time graph to show the temperature change during the process
- Investigate the properties of substances under different phases (e.g. compressibility)
- Investigate the physical properties of substances (e.g. thermal conductivity of metal rods)
- Find out the density of some objects (e.g. make a density column using different liquids)

Suggested Learning and Teaching Activities

- Perform practical work to show thermal expansion and contraction
- Perform practical work to investigate the change in volume when water is mixed with alcohol
- Perform practical work to investigate the regenerative braking system in electric vehicles
- Perform practical work to test the effectiveness of Sun Control Films
- Design and make a heat insulating house model
- Perform practical work to investigate the direction of transfer of thermal energy between substances at different temperatures in contact, and analyse the temperature-time graph
- Watch a computer simulation about the effect of temperature change on the movement of particles
- Design and make a container that can minimise temperature change
- Perform practical work to test whether plasticine objects in various shapes float or sink in water

Unit 8: Atomic World

Overview

This Unit is a continuation of "Matter and Energy" which facilitates students to further understand scientific concepts related to the microscopic world such as "matter" and "chemical changes and physical changes" as well as learning contents including "solutions", "acids and alkalis" and "chemical reactions". Students will conduct various practical activities to learn using physical methods to separate different substances. They will also participate in designing experiments involving the mixing of acids and alkalis, and observe the changes in mass for certain substances before and after combustion. Through these activities, students will be able to distinguish between chemical and physical changes based on observations. During the activities, students will learn about the properties of common acids and bases, using indicators to test the pH of different solutions, and guide them to recognise the potential hazards of handling acids and bases, as well as safety precautions during laboratory operations, thereby fostering a considerate and responsible attitude in students.

In addition, students will learn about the relationship between solutes, solvents and solution, and the calculation of concentration of solution, verifying the conservation of mass in the dissolving process through experiments, and investigate the factors that affect the rate of dissolving (e.g. temperature, time of stirring, particle size), which supports students to practice experimenting skills and facilitate them to understand the overarching concept of "change and constancy". Teachers can also design other appropriate learning and teaching activities to enable students to develop and master the following skills:

- using specific data to induce a general trend, conclusion or model
- making inference to the best possible explanation to the observed phenomenon
- identifying independent variables, dependent variables and control variables
- making qualitative observations and quantitative measurements
- commenting accuracy and precision in a scientific measurement
- setting up a control experiment to avoid confounding factors and identify causation
- using scientific notation, significant figures and ratio for presenting scientific data
- using tables and graphs for data analysis

Students should learn	Students should be able to
8.1 Substances • structure of atoms • elements • compounds • pure substances and mixtures	• describe the basic structure of an atom in terms of protons, neutrons and electrons • state some characteristics of protons, neutrons and electrons • state the names and symbols for some common elements from Periodic Table (e.g. H, O, C, Ne, N, Li, Na, Mg, Si, Fe, Cl, S) • recognise that mixtures are formed when two or more substances mix with each other without the formation of new substances • distinguish pure substances and mixtures (S) • be aware that compounds are formed by elements joining together chemically • be aware that molecules consisting of two or more atoms joining together chemically • classify substances as elements or compounds based on their chemical formulae (e.g. H_2O, CO_2, NH_3, CH_4, C, O_2, N_2, Na, Ne) (S)
8.2 Physical changes and chemical changes • physical changes • chemical changes	• recognise that physical change is a process in which changes in chemical composition are not involved • recognise that chemical change is a process of formation of new substances in a reaction • classify different processes as physical changes or chemical changes (e.g. burning, oxidation, rusting, distillation, evaporation, filtration, crushing of stones, melting) (S) • conduct tests to investigate the physical properties of a compound and its constituent elements (S)

Students should learn	Students should be able to
8.3 Solutions	
• solute, solvent and solution • concentration • dissolving • solubility	• recognise that a solution is a mixture formed when a solute is dissolved in a solvent • be aware that solute is a substance lesser by volume or mass in a solution • be aware that solvent is a substance greater by volume or mass in a solution • examine that mass is conserved during dissolving (S) • calculate the concentration (in g/mL) of a solution (S) • investigate factors affecting the rate of dissolving, such as temperature, time of stirring and the surface area of solute in contact with the solvent (S) • beware that solubility refers to the maximum amount of solute dissolving in a volume of solvent at a specific temperature • read solubility curve of a solute to find the relationship between temperature and solubility of solute (S)
8.4 Acids and alkalis	
• common acids and alkalis • acid-alkalis indicator • pH scale • neutralisation • corrosive nature of acids and alkalis • potential hazards related to the use of acids and alkalis	• give examples of common acids and alkalis found at home and in laboratory • state the properties of acids and alkalis • distinguish acidic solutions, alkaline solutions and neutral solutions with the use of natural pigments or acid-alkali indicators (S) • use appropriate instruments to measure precisely the pH of the solution (S) • investigate the observable changes when neutralisation reaction occurs (S) • recognise that acids and alkalis can be irritating or corrosive and may cause injuries to our bodies • recognise that mixing acids or alkali containing household cleansing products may be hazardous • be aware of the emergency treatment for accidents involving acids or alkalis
8.5 Chemical reaction	
• *matter and chemical reaction* • *energy releasing and energy absorbing processes*	• *examine that matter is conserved in a chemical reaction* (S) • *write balanced chemical equations for some reactions between elements which form compounds (hydrogen chloride, water and carbon dioxide)* (S) • *give examples of energy releasing and energy absorbing processes (e.g. combustion, rusting, neutralisation, evaporation, dissolving of table salt)*

Key Practical Tasks

- Investigate the factors affecting the rate of dissolving of substances
- Compare the change in mass of different substances before and after burning (e.g. paper and iron wool)
- Test the physical properties of a compound and its constituent elements (e.g. iron, sulphur and iron(II) sulphide)
- Investigate the observable changes (e.g. temperature, pH value or the colour change of pH paper / acid-alkali indicator) when an acid is mixed with an alkali

Suggested Learning and Teaching Activities

- Watch video clips on "Tiangong classroom" about the effervescence experiment conducted by the astronauts of our country
- Perform fair tests to find out the solubility of a substance at different temperatures
- Perform practical work to classify unknown liquids into acid, alkali, pure water and salt solution
- Perform practical work to investigate the relationship between the concentration of colour dye and the colour intensity of solutions
- Watch video clips about rusting of iron in water
- Perform practical work to investigate effervescence
- Perform practical work on paper chromatography to investigate liquid samples
- Construct molecular models and calculate the number of different types of atoms from the chemical formula of compounds (e.g. H_2O, O_2, C_4H_{10}, NH_3)
- Classify different substances (e.g. sugar, copper, air, crude oil, calcium carbonate, milk) as elements, compounds or mixtures
- Classify elements as metals or non-metals based on their physical properties (e.g. density, appearance, electrical conductivity)

Unit 9: Force and Motion

Overview

This Unit facilitates students to understand the characteristics of object motion and the principles behind it in a systematic manner. Through daily life examples (e.g. a pedestrian's walking speed, a car's speed), students will learn the relationship between speed, distance, and time, and be guided to understand how acceleration or deceleration affects motion. Students will also learn to differentiate between contact forces (e.g. friction, elastic force) and non-contact forces (e.g., gravity, magnetic force), and comprehend that in the physical world, forces and reaction forces occur in pairs, impacting an object's motion.

In addition, teachers can guide students to explore the factors that affect friction through daily examples. Students can conduct experiments to compare the friction of different materials, and present the analysis results through appropriate methods. Students will also learn the relationship between gravity and mass, and predict whether the gravity experienced by objects with the same mass would differ on different planets.

This Unit also facilitates students to learn about the relationship between pressure, force and area. Students will learn how air pressure and water pressure change with height or depth, and give examples of applications of pressure in daily life. Teachers may further guide students to use the concept of particle movement to explore the relationship between air pressure and temperature, propose scientific explanations, and understand the concept of "evidence and models". Through a series of practical activities, students will be able to make scientific inferences, connect theories with daily life phenomena, and explain various observations. Teachers can also design other appropriate learning and teaching activities to allow students to develop and master the following skills:

- using specific data to induce a general trend, conclusion or model
- making inference to the best possible explanation to the observed phenomenon
- formulating a hypothesis based on observed phenomenon
- identifying independent variables, dependent variables and control variables
- setting up a control experiment to avoid confounding factors and identify causation
- choosing from alternative experimental methods or improving the method for a scientific investigation
- commenting the reliability of a scientific measurement or a scientific investigation
- using scientific formula for scientific inference
- identifying outliers and handling data from repeated measurements to assess the uncertainty incurred

Students should learn	Students should be able to
9.1 Characteristics of force and motion	
• speed, distance and time • contact force and non-contact force • force of gravity, mass and weight • action and reaction	• use formula (speed = distance / time) to calculate the average speed of a moving object (S) • investigate the motion of an object under uniform speed, acceleration or deceleration (S) • interpret a distance-time graph (S) • distinguish contact force and non-contact force acting on an object (e.g. normal force, friction, elastic force and force of gravity) (S) • recognise that friction is the contact force that opposes the motion or tendency of motion between contact surfaces • investigate the factors (e.g. texture of surfaces) affecting the frictional force between an object and a surface (S) • recognise that air resistance as the opposing force when an object moves in air • be aware that force of gravity is a non-contact force exerted on an object pulling it towards the centre of the Earth • recognise weight as a measure of force of gravity acting on an object • recognise the relationship between weight and mass • be aware of the difference in weight for an object located on different planets (e.g. Earth and Mars) or moons • use evidence to show that action and reaction pairs are forces equal in magnitude, opposite in direction and acting on different objects (S)
9.2 Effect of force	
• balanced forces and unbalanced forces	• interpret the motion of an object when: (S) ➢ the forces acting on it are balanced ➢ the forces acting on it are unbalanced • perform simple calculation of the net force acting on an object (S)
9.3 Pressure	
• pressure, force and area	• describe pressure in terms of force and area • recognise that atmospheric pressure is the weight exerted by the overhead atmosphere on the surface (in unit area) of an object • use evidence to show that the atmospheric pressure varies with altitude (S) • recognise that water pressure is the weight exerted by water on the surface of a submerged object • give examples of daily applications of pressure

Students should learn	Students should be able to
9.4 Pressure and particle movement • *gas pressure*	• *use diagram to explain the existence of gas pressure due to gas particles hitting against the walls of a container* (S) • *explain the following situation with the concept of particle movement:* (S) ➢ *the gas pressure in a fixed container increases when the temperature in the container is increasing* ➢ *the volume of a balloon varies when temperature inside the balloon changes* ➢ *the volume of a balloon varies when air is injected in it*

Key Practical Tasks

- Investigate the free-falling motion of different objects
- Design an experiment to compare the roughness of different surfaces
- Investigate the action and reaction force exerted on objects
- Investigate the changes in atmospheric pressure at different altitudes using mobile devices

Suggested Learning and Teaching Activities

- Watch video clips on "Tiangong classroom" about the experiment related to the force of gravity conducted by the astronauts of our country
- Search information on the designs of innovative tyre with high durability
- Perform practical work to find out the relationship between the strength of a force acting on a spring and its extension
- Do problem-solving exercise about the use of parachute to slow down skydiver's fall during a dive
- Interpret the speed-time graph and distance-time graph for an object moving at constant speed or accelerated speed
- Perform practical work to show that friction can be reduced by lubricants, air cushions and ball bearings
- Design and make a "water rocket" or a "balloon car"

Unit 10: Making Use of Electricity

Overview

This Unit guides students to learn the basic concepts of electric circuits, draw and analyse simple circuit diagrams, and understand the relationship between current, voltage and resistance. Students will recognise common circuit symbols such as battery, light bulbs, switches, ammeters, voltmeters, and variable resistors. Students will conduct various experiments, such as measure current and voltage in series and parallel circuits, conduct control experiments to explore the relationship between the resistance of a wire and the length and thickness of the wire. During the experiments, teachers can guide students to come up with the best explanation based on the observation, and try to use tables or images to record and analyse the experimental data, thereby cultivating evidence-based scientific reasoning abilities.

In addition, students will conduct experiments to understand the principles of electromagnets as well as how factors, such as the number of coils turns and iron core material, affect the magnetic strength. Students will explore daily life examples of the use of magnets, as well as proposing other creative ideas related to the use of magnets in daily contexts, thereby stimulating creative thinking. This Unit also explores household electricity, including the concepts of power and efficiency in electrical appliances. Students will use formulae to calculate the energy consumption of appliances, investigate the dangers of circuit overloading, and understand the importance of using electricity safely. Teachers can arrange interdisciplinary project learning by providing data on the light output and energy consumption of different light bulbs, facilitating students to evaluate energy efficiency by comparing the data and discuss the relationship between energy conservation and environmental sustainability. Teachers can also design other appropriate learning and teaching activities to enable students to develop and master the following skills:

- making inference to the best possible explanation to the observed phenomenon
- selecting appropriate apparatus for conducting experiment
- reading scales of different apparatuses
- formulating a hypothesis based on observed phenomenon
- identifying independent variables, dependent variables and control variables
- commenting accuracy and precision in a scientific measurement
- setting up a control experiment to avoid confounding factors and identify causation
- using tables and graphs for data analysis
- using scientific formula for scientific inference
- identifying outliers and handling data from repeated measurements to assess the uncertainty incurred

Students should learn	Students should be able to
10.1 Electrical circuits	
• circuit diagrams • current, voltage and resistance • series circuits and parallel circuits • heating effect of current	• recognise the circuit symbols (cell, battery, light bulb, switch, ammeter, voltmeter, resistor and rheostat) • draw and interpret simple circuit diagrams (S) • be aware that there are two kinds of charges in nature • recognise electric current as a flow of charges and voltage as energy of charges • investigate the effect of length, thickness, and the material of the wire on the resistance of a circuit (S) • investigate the effect of varying resistance on the current in the circuit (S) • identify series circuits and parallel circuits • measure the current and voltage in series and parallel circuits (S) • recognise the heating effect of current
10.2 Magnets	
• permanent magnets and electromagnets • magnetic force • magnetic effect of current	• state the properties of permanent magnets (e.g. two opposite poles, attraction and repulsion) • be aware of the variation of strength of the magnetic force with the change in distance • describe the structure of a simple electromagnet • investigate the factors affecting the strength of the electromagnet (S) • recognise the magnetic effect of current • explain briefly the daily applications of electromagnets (e.g. doorbell, metal recycling factory)
10.3 Household electricity	
• mains voltages and domestic circuits • potential hazards in using electricity • safety precautions in using electricity	• state the mains voltage in Hong Kong • recognise fuses and circuit breakers as devices in protecting circuits • explain why parallel circuits are preferred to series circuits in domestic circuits • recognise the danger of overloading in the use of universal adaptors • recognise the condition leading to short circuits and its danger • state safety precautions in using electricity

Students should learn	Students should be able to
*10.4 Energy saving***	
• *power and efficiency of an electrical appliance* • *cost of electricity* • *sustainable use of electricity*	• *use formula (energy = power x time) to calculate the energy consumption of an electrical appliance* (S) • *use formula (efficiency = useful power output / power input x 100%) to calculate the efficiency of an electrical appliance* (S) • *calculate the cost of using electrical appliances using kilowatt-hour (kWh) as a unit of electrical energy* (S) • *propose different ways of using electricity towards low carbon living / the reduction of carbon footprint* (S)

**Note: The learning content in this part is related to the topic of "Energy" in junior secondary geography.

Key Practical Tasks

- Measure the current and voltage in series circuits and parallel circuits
- Investigate the factors affecting the strength of the electromagnet (e.g. number of turns of the coil, length of iron bar)
- Investigate the factors affecting the resistance of a wire
- Investigate the effect of varying resistance on the current in the circuit

Suggested Learning and Teaching Activities

- Perform practical work to compare and contrast the power, light output and the efficiency of different types of light bulbs (e.g. LED, Halogen bulb, CFL bulb)
- Perform practical work to set up a complete circuit (e.g. an alert system) with the use of batteries, switches, light bulbs, resistors, ammeters and voltmeters as shown in a circuit diagram
- Do problem-solving exercises on parallel and series circuits about the brightness of light bulbs
- Study and compare the energy labels of electrical appliances of different models
- Calculate the total annual carbon emission ($kgCO_2e$) from household electricity consumption data
- Discuss ways of reducing electrical energy consumption
- Use data to evaluate the social, economic and environmental consequences of using different ways to generate or use electricity

Unit 11: Healthy Body

Overview

This Unit aims to introduce to students various aspects of nutrition and health, such as different types of food substances, how food can be digested and absorbed by our bodies, and the concepts of a balanced diet. Students will realise the importance of maintaining healthy lifestyles, and recognise that personal hygiene, vaccination and herd immunity are crucial in reducing the risk of infecting non-infectious (non-communicable) diseases and infectious (communicable) diseases. Students will learn about the harmful effects of smoking on our health and the associated risks, and the effects of alcohols, solvents and drugs on our judgements and responses. This can enable them to make informed decisions and refuse to take these substances. Any changes that disturb the internal balance of our body may result in health problems or diseases, and students may then realise the overarching concept "change and constancy". In addition, students will also realise the overarching concept "systems and organisation" from the study of the digestive system.

Through different learning activities, such as investigating the effects of physical exercise on breathing rate and heart rate, students can practice scientific observations and measurements, and develop their ability to propose scientific explanations. In addition, examining food labels to determine the nutritional value and energy content of food can help students develop their data processing skills. Besides, teachers can design other appropriate learning and teaching activities to facilitate students' development and mastery of the following skills:

- making inferences to the best possible explanation to the observed phenomenon
- making informed decisions based on the probability of phenomenon occurring
- setting up a controlled experiment to minimise confounding factors to identify causation
- conducting a fair test
- constructing and using scientific models to explain phenomena
- using scientific notation, significant figures and ratio for presenting scientific data
- using tables and graphs for data analysis
- referencing reliable sources of information
- evaluating the effects of different dietary habits and lifestyles on health

Core Part

Students should learn	Students should be able to
11.1 Nutrition and health	
• food substances	• describe the key functions of the six main types of food substances, including carbohydrates, lipids, proteins, vitamins, minerals (calcium, iron and iodine) and dietary fibre • conduct food tests (S) • compare the amount of vitamin C in different fruits (S) • be aware of the building blocks of carbohydrates, lipids and proteins • state the importance of water to the human body
11.2 Dental care	
• tooth • dental diseases	• recognise the structure of teeth • recognise the types and functions of teeth in humans • explain the causes of tooth decay and periodontal diseases • state the ways of protecting our teeth and gum
11.3 Effects of taking drugs and alcohol	
• cerebrum and cerebellum	• identify the cerebrum and cerebellum and state their functions • recognise the harmful effects of drinking alcohol and taking drugs to our body (including the harm towards making judgements and responses)
11.4 Effects of smoking	
• breathing system in humans • harmful effects of smoking	• identify the main parts of the breathing system in humans • describe the exchange of gases between air sacs and the surrounding blood capillaries • describe how smoking affects gas exchange in humans • recognise the harmful effects of smoking on our health and the associated risk (e.g. causing lung cancer and heart diseases)

Extension Part

Students should learn	Students should be able to
11.5 Digestion and absorption of food	
• *digestive system in humans*	• *identify the main parts of the digestive system in humans and state their functions* • *recognise that food has to be digested into simple and soluble substances before it can be absorbed and used by body cells* • *construct a model using dialysis tubing to simulate the absorption of food in a gut* (S) • *recognise that there are mechanical digestion and chemical digestion* • *recognise that some digestive juices contain enzymes for chemical digestion* • *state that most digested food substances are absorbed in the small intestine and carried to all parts of the body via the transport system*
11.6 Balanced diet and unbalanced diet	
• *balanced diet* • *unbalanced diet*	• *recognise that a balanced diet involves the intake of different food substances in the right proportion and amount* • *explain the energy requirement for people of different age, sex and occupation* • *calculate the energy value of different foods* (S) • *state the effect of insufficient intake of food substances on health, including proteins, dietary fibre, some vitamins (vitamin A, C and D) and minerals (calcium, iron and iodine)* • *recognise that unbalanced diet will increase the risk of certain health problems (e.g. cardiovascular diseases, diabetes and hypertension)* • *describe the effects of under-eating and over-eating on weight and health*
11.7 Keeping our bodies healthy	
• *healthy lifestyles*	• *recognise that healthy lifestyles (e.g. balanced diet, appropriate amount of physical activities, enough rest) and prevention of diseases are required for keeping our bodies healthy* • *investigate the effect of physical exercise on breathing rate and heart rate* (S)

Students should learn	Students should be able to
11.8 Health and diseases • *infectious diseases* • *non-infectious diseases* • *biotechnology and health*	• *recognise that most infectious diseases are caused by infection of microorganisms* • *recognise that some non-infectious diseases are related to unhealthy lifestyles* • *recognise some ways for reducing the risk of infectious diseases (e.g. maintaining personal hygiene, vaccination and herd immunity)* • *be aware that immunity is one's ability to defend against infection (e.g. antibodies and white blood cells in the blood help the body resist infection)* • *be aware that antibiotics work by killing bacteria or inhibiting their growth, and are used to prevent or treat infections caused by bacteria* • *be aware that indiscriminate use of antibiotics can lead to antibiotic resistance* • *recognise some risk factors for cancers (e.g. chemicals, radiations, viral infections, genetic factors)* • *recognise the importance of healthy lifestyles to reduce the risk of certain non-infectious diseases (e.g. cardiovascular diseases, lung cancer, colorectal cancer and diabetes)* • *be aware of the medical applications of biotechnology*

Key Practical Tasks

- Perform practical work to identify food substances (e.g. glucose, starch, lipids, proteins and vitamin C) in food samples
- Investigate the factors affecting the amount of vitamin C in different food samples
- *Investigate the chemical digestion by enzymes (e.g. amylase, protease, lipase)*
- *Investigate the effects of different types of physical exercise on breathing rate and heart rate*

Suggested Learning and Teaching Activities

- Perform practical work to find out one's reaction time
- Perform practical work to measure pulse rate with mobile devices
- Construct a model to simulate the blood flow in a cholesterol-clogged blood vessel
- Use a simulation experiment to learn about the effects of vaccination on the spread of infectious disease in a population
- Analyse the data obtained from an inhibition zone test to compare the effectiveness of various antibiotics
- Analyse the effectiveness of an antibiotic against micro-organisms with reference to a photo of antibiogram
- Search information on the effects of abuse of alcohol and drugs, and smoking on our health

- Dissect pig lungs to observe the structure of the lungs
- Inspect food labels to find out the nutritional value and energy value of the food
- Perform practical work to measure the amount of food colorants in beverages with mobile devices
- Design a one-day menu of balanced diet for people of designated age, sex and occupation
- Search information about the application of biotechnology in the identification of the infectious agents of some common diseases (e.g. influenza)
- Search information on the development of production of drugs (e.g. insulin)
- Compare the food substances (e.g. fat, protein and carbohydrates) contained in different types of milk (e.g. oat milk, soya milk, cow milk)
- Calculate your Body Mass Index (BMI) to see if you are within the healthy weight range
- Search information on the causes and the health effects of obesity and anorexia

Unit 12: Light and Sound

Overview

In this Unit, students will learn about the properties of light and some common phenomena such as reflection, refraction and total internal reflection of light. Teachers can arrange learning activities for students, such as conducting experiments to verify the laws of refraction and the conditions for the occurrence of total internal reflection, so that students can make scientific reasoning and verify scientific formulas based on the observation results. In addition, this Unit also introduces the structure of the eye and the scientific principles of vision formation, along with discussions on the causes of long sight and short sight, as well as their correction methods, thereby cultivating students' awareness of eye protection. Students will also know that visible light is a part of the electromagnetic spectrum and consists of different colours of light. In addition to visible light, there are other radiation in the electromagnetic spectrum. Teachers can guide students to discuss the application and possible risks of electromagnetic radiation in daily life, and cultivate students' probabilistic thinking.

Students can verify the characteristics of sound and understand the relationship between the vibration frequency and amplitude of note through experiments and daily experiences. Students can also use simulated experiments to analyse the waveforms of note, in which students could learn about data processing skills. Teachers can guide students to investigate the issue of noise pollution, which students could explore the impact of noise from shipping or construction industries on the ecosystem from a scientific perspective, encourage students to propose diverse or original solutions, and enhance public concern for environmental sustainability. Teachers can also design other appropriate learning and teaching activities to enable students to develop and master the following skills:

- using a set of general observations, trend or model to deduce a specific result
- making inference to the best possible explanation to the observed phenomenon
- using scientific formula for scientific inference
- formulating a hypothesis based on observed phenomenon
- identifying independent variables, dependent variables and control variables
- commenting accuracy and precision in a scientific measurement
- constructing and using models to explain phenomena

Core Part

Students should learn	Students should be able to
12.1 Light	

• basic properties of light
• reflection of light
• refraction of light
• total internal reflection
	• recognise some basic properties of light
	  ➢ light can travel in vacuum
	  ➢ light travels in straight line
	  ➢ light can exhibit reflection and refraction
	• state the laws of reflection
	• draw ray diagram to construct the image formed by a plane mirror (S)
	• describe the nature of images formed by plane mirror
	• examine the laws of refraction through experimental data (S)
	• use the formula ($n = \frac{\sin i}{\sin r}$) to perform calculation when light travel through different media from the air (S)
	• examine the conditions for total internal reflection through experiments (S)
	• recognise that prism can be used for splitting white light into lights of different colours

12.2 Sight and hearing	
• main parts of an eye • main parts of an ear	• state the functions of the main parts of an eye • describe briefly how an image is formed on the retina • compare the shapes of the lens when seeing near objects and distant objects • be aware that rod cells and cone cells are the light sensitive cells • give examples of defects or diseases of the eye (e.g. colour blindness, astigmatism, cataract) • state the functions of the main parts of an ear • describe briefly how sound travels through the ear • be aware that there are specialised sensory cells in the cochlea for detecting vibrations • state some ways of protecting our eyes and ears

Students should learn	Students should be able to

12.3 Sound
• general properties of sound
• pitch and loudness of a note
	• recognise that sound is produced by vibrations
	• recognise some basic properties of sound
	  ➢ sound requires a medium for transmission
	  ➢ sound transmits at different speed in different medium
	  ➢ sound can exhibit reflection
	• recognise that some animals (e.g. bats) use echoes to navigate and adapt in the environment
	• relate the frequency and amplitude of vibrations with the pitch and loudness of a note (S)
	• find out how the loudness of a note changes with distance from the source (S)

Extension Part

Students should learn	Students should be able to
12.4 Convex lenses and concave lenses	
• *image formed by convex lenses* • *image formed by concave lenses*	• *recognise that light rays converge after passing through a convex lens* • *construct the images formed by convex lenses using ray diagrams* (S) • *describe the nature of images formed by convex lenses* • *find out the magnification of images formed by convex lenses* (S) • *recognise that light rays diverge after passing through a concave lens* • *construct the images formed by concave lenses using ray diagrams* (S) • *describe the nature of images formed by concave lenses* • *find out the magnification of images formed by concave lenses* (S) • *recognise the causes and correction methods of long sight and short sight*
12.5 Electromagnetic spectrum	
• *visible spectrum* • *beyond the visible spectrum*	• *recognise that lights of different colours have different frequencies* • *state that the speed of light in vacuum is* 3×10^8 *m/s* • *recognise that light travel in different speed under different media* • *use the formula* ($v = f\lambda$) *to calculate the speed, wavelength, and frequency of light* (S) • *recognise that some objects will absorb and reflect light of certain wavelength* • *state the relative positions of visible light and other parts of the electromagnetic spectrum* • *describe the invisible parts of the electromagnetic spectrum* • *give examples of the daily applications of electromagnetic spectrum* • *recognise potential hazards of using electromagnetic radiations, the associated risk and safety measures*

Students should learn	Students should be able to
12.6 Sound and the environment	
• *audible frequency range*	• *state the range of frequencies audible to humans*
• *noise pollution*	• *be aware that the range of frequencies audible to humans is different from other animals*
	• *discuss the health and environmental effects of noise pollution and the importance of acoustic protection*
	• *be aware that the noise produced by industry (e.g. maritime industry, construction industry) will affect habitats for animals (e.g. dolphins and whales)*

Key Practical Tasks

- Perform practical work using mobile devices to find out how the loudness of a note changes with distance from the source
- Perform practical work to find out the refractive index of an unknown liquid
- Perform practical work about total internal reflection of light (e.g. investigate a "light bending" water jet)
- *Perform practical work to find out the magnification of images formed by convex lenses*

Suggested Learning and Teaching Activities

- Dissect an ox eye to identify the main parts of the eye
- Perform practical work to find out the refractive index of a medium
- Use simulation experiment to interpret different waveforms of notes
- Draw ray diagram to show the image formed by a plane mirror
- Perform practical work to show the presence of blind spot
- Simulate long sight and short sight, and the corresponding correction methods using an eye model
- Search information about the causes of eye defects (e.g. colour blindness) and some eye diseases
- Search information on various ways of protecting our eyes when using electronic screen products
- Perform practical work to demonstrate the existence of invisible electromagnetic radiations
- Search information on the use of electromagnetic radiations and the related potential hazards
- Find out the range of frequencies audible to the class using a signal generator

Unit 13: Our Planet Earth

Overview

This Unit focuses on how to obtain useful chemicals from the atmosphere, oceans and Earth's crust using various extraction and separation methods. Students will learn about the carbon cycle, and also learn about carbon dioxide removal and storage technologies (e.g. forestation, biochar, direct air capture) to understand the important role of these methods in mitigating the greenhouse effect, and realise the concept of "change and constancy". Students will also learn some simple chemical tests and extraction methods, and practice scientific observation, measurement and inference by conducting different experiments, such as flame tests. Students will practice the use of word equations or chemical equations to express the chemical changes that occur during the metal extraction process of metal ores.

In addition, students will realise that chemicals extracted from the Earth can be used to produce useful materials, which are widely used in the modern world to enhance quality of life. However, students should also be aware that improper use and disposal of these materials will cause environmental pollution and the exhausting of resources. Students can conduct cross-disciplinary project learning to explore scientific issues related to sustainable development, such as discussing how the development of new plastic materials can balance social needs and ecological conservation. These learning activities help students understand sustainable development and cultivate the proper values of protecting the environment. Teachers can also design other appropriate learning and teaching activities to enable students to develop and master the following skills:

- using specific data to induce a general trend, conclusion or model
- using a set of general observations, trend or model to deduce a specific result
- making inference to the best possible explanation to the observed phenomenon
- formulating a hypothesis based on observed phenomenon
- identifying independent variables, dependent variables and control variables
- making qualitative observations and quantitative measurements
- identifying causation
- choosing from alternative experimental methods or improving the method for a scientific investigation
- **c**ommenting the reliability of a scientific measurement or a scientific investigation
- using tables and graphs for data analysis
- referencing reliable sources of information
- evaluating the balance between modernisation and environmental cost
- evaluating the impact of scientific and technological discoveries on the quality of life

Core Part

Students should learn	Students should be able to
13.1 The atmosphere	
• carbon cycle • greenhouse gas removal and storage • fractional distillation of liquid air • air quality	• use diagrams to show the processes involved in carbon cycle (S) • be aware of different methods on carbon dioxide gas removal and storage (e.g. forestation, biochar, direct air capture) • recognise the processes involved in fractional distillation of liquid air • give examples of innovative ways of harvesting fresh water from the atmosphere (e.g. using mesh net to harvest fog in air) • conduct tests to distinguish oxygen, carbon dioxide and hydrogen gases (S) • be aware of the kinds and sources of common air pollutants • be aware that Air Quality Health Index (AQHI) informs the public of the short-term health risk of air pollution
13.2 The Ocean	
• composition of sea water • extraction of pure water and common salt from sea water • electrolysis of water	• describe various kinds of minerals in the sea • conduct chemical tests to show the presence of water and sodium chloride in provided samples (S) • evaluate the appropriateness of using evaporation, distillation, crystallization and filtration for different physical separation situations (S) • investigate the electrolysis of water (S)

Students should learn	Students should be able to
13.3 Rocks and minerals • rocks as a source of minerals • metal extraction • different forms of calcium carbonate in Nature • erosion processes • acid rain and ocean acidification	• recognise that some metals occur in their elemental forms in Nature while most exist as compounds • be aware of the methods for extraction of metals from their ores (e.g. physical method, heating alone and heating with carbon) • write equations of the reactions involved in the extraction of metals from ores : (S) ➢ heating alone ➢ heating with carbon • describe different forms of calcium carbonate in Nature • recognise that dilute acids can react with metals and some building materials (e.g. limestone and marble) • *investigate factors (e.g. surface area) affecting the rate of the reaction between calcium carbonate and dilute acids* (S) • use the results of flame tests as evidence to infer the metals that present in mineral samples • recognise the causes of acid rain and ocean acidification, and its effects on the environment and living things

Extension Part

Students should learn	Students should be able to
13.4 Periodic Table	
• *the development of Periodic Table* • *groups in the Periodic Table*	• *recognise that Periodic Table is a way to organise elements in a systematic order* • *be aware that scientists in the past organise elements according to the mass of atoms and their chemical properties* • *recognise that the modern Periodic Table lists elements in order of increasing atomic number* • *identify the evidence to show that elements in the same group of the Periodic Table exhibit some common properties* (S) • *give examples of elements in different groups and their applications* • *identify evidence to show that the chemical properties among elements in the same group are similar but with different reactivity* (S)
13.5 Useful materials from crude oil	
• *crude oil as a mixture of hydrocarbons* • *fractional distillation* • *plastics*	• *recognise crude oil as a mixture of hydrocarbon molecules of different sizes* • *relate the physical properties of the hydrocarbons to their sizes* (S) • *recognise that fractional distillation is the method for separating crude oil into different fractions* • *state some major uses (e.g. fuels, solvents and raw materials for making plastics) of the different fractions* • *recognise that plastics are macromolecules made by joining up many hydrocarbon molecules* • *give examples of plastics (e.g. PE and PVC) and their usage* • *be aware that new plastics are invented based on the emerging needs in our society* • *propose solutions to separate mixed plastic samples by type* (S)
13.6 Environmental problems associated with the use of materials	
• *solutions to the environmental problems of using materials*	• *describe some environmental problems associated with the use of materials (e.g. plastics, metals)* • *state some solutions to the environmental problems of using materials (e.g. plastics, metals)*

Key Practical Tasks

- Investigate the electrolysis of water using microscale apparatuses
- Design different chemical tests to infer the presence of water in unknown liquid samples
- *Investigate factors affecting the rate of the reaction between calcium carbonate and acids*
- *Design an experiment to separate mixed plastic samples by type*

Suggested Learning and Teaching Activities

- Evaluate the appropriateness of the use of methods (evaporation, distillation, crystallization and filtration) for different situations on separating substances in sea water samples
- Evaluate the pros and cons on different Carbon Capture and Storage (CCS) methods
- Conduct flame test
- Write equations to describe chemical changes of reactions
- Evaluate the pros and cons on different ways to harvest freshwater from the atmosphere
- Search information on the technological applications of Rare-Earth Elements
- Search information on the advancement in new plastics invention
- Propose a feasible plan to reduce the use of plastics or metals in daily life
- Read stories about how scientists developed the Periodic Table
- Compare the physical properties (e.g. strength, malleability, ductility, electrical conductivity and thermal conductivity) of some metals

Glossary
(for teachers' reference)

Term	Description
Accuracy	The closeness of agreement between a measured value to the true value or the reference value.
Control	A set-up identical to the experimental set-up, except that the factor under investigation is absent.
Control variable	Variables that are kept the same in an experiment to ensure that the change in the independent variable is causing the change in the dependent variable.
Dependent variable	Variable which is being measured or observed in an experiment.
Error	The difference between a measured value and the true value for a measurement to be conducted.
Extrapolation	Estimation of the value of one variable on a graph using a line of best fit that is extended beyond the range of the available data.
Hypothesis	A hypothesis is a testable statement that explains a phenomenon or proposes a relationship between variables.
Independent variable	Variable which is being changed in an experiment to see the effect on the dependent variable.
Interpolation	Estimation of the value of one variable on a graph using a line of best fit within the range of the available data.
Limit of reading	The smallest division on the scale of an instrument.
Outlier	A value in a set of results that differ significantly from the observed trends.
Precision	The closeness of agreement between measured values obtained by repeated measurements.
Prediction	A prediction is a statement suggesting the expected outcomes based on the hypothesis set.
Reliability	Reliability depends on whether the measurements or the results of the scientific investigations could be repeated and reproduced.

Term	**Description**
Repeatability	The closeness of agreement between independent results obtained with the same method under the same conditions.
Reproducibility	The closeness of agreement between independent results obtained with the same method but under different conditions (different operators, different apparatus, different laboratories and/or after different intervals of time).
Source of error	(a) Instrumental Limitations All measuring instruments have their limitations. Some instruments may have inaccurate scales and others may not be precise enough for the measurement you wish to make. (b) Systematic Errors Systematic errors cause all measurements to be shifted systematically in one direction either larger or smaller than it should be. They cannot be reduced by taking repeated measurements. Examples include parallax in reading scale (when viewing the scale always from one side), a zero error on any scale and a calibration error. (c) Random Errors Random errors result from unknown factors in experimental situations. Examples include parallax in reading a scale (when viewing the scale in different directions), unpredictable fluctuations in air temperature. The effect of random errors can be reduced by improving experimental techniques and repeating the measurement a sufficient number of times. (d) Plain mistakes These are careless mistakes such as misreading of a scale, spillover of liquid when measuring solution volume.
True value	Value that would be obtained in an ideal measurement.