Science (Secondary 1-3) Curriculum Framework

(Supplement to the Science Education Key Learning Area Curriculum Guide)

(Consultation Draft)

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Contents

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 document 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).

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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 continuous promoting STEAM education in primary and secondary schools through measures such as optimising curriculum, enhancing teacher training, and providing resource support implementing various measures and strategies, including optimising school curricula, with a view to facilitating schools in creating an atmosphere conducive to the learning of science and Innovation & Technology (I&T), inspiring students' creativity and potential in science from an early age, as well as facilitating students to recognise on the contributions and major achievements made by our country on scientific development. The Education Bureau, in line with the announced Primary Science Curriculum, is now updating the Junior Secondary Science Curriculum to strengthen the implementation of a coherent science education foundation spanning nine years. To further strengthen the interface between the primary and secondary levels for enhancing students' scientific thinking and fostering innovation, an Ad Hoc Committee was set up in May 2023 by the

Curriculum Development Council Committee on Science Education to review and revise the Science (S1-3) curriculum. The Ad Hoc Committee members include academics from tertiary institutions, experienced school principals and teachers as well as officers from the Bureau. It is expected that a holistic review of the science curriculum could be conducted to align with students' need and societal development.

1.2 Direction for Curriculum Revision

During the curriculum revision process, the Ad Hoc Committee reviewed the implementation of science education at the junior secondary level, considered views from various stakeholders on the Junior Secondary Science Curriculum, and referred to international trends in science education to establish directions for the curriculum revision. The committee considered that the development of the Junior Secondary Science Curriculum should focus on fostering students' scientific literacy and enhancing their ability to integrate and apply cross-disciplinary knowledge and skills, fostering their interest in science, and deepening their understanding of I&T applications, with a view to preparing them for future studies and career development as well as equipping them to respond to diverse opportunities and challenges in personal, societal, and global contexts. The proposed directions for curriculum revision are as follows:

1. Enhancing students' scientific literacy

   With the rapid advancement of I&T and artificial intelligence (AI), accessing information has become increasingly convenient, bringing significant changes to science education. The curriculum revision should focus on enhancing students' scientific literacy, enabling them to understand scientific knowledge while also fostering scientific thinking and strengthening their ability to conduct inquiry, as well as cultivating students' proper scientific attitudes. The revised curriculum will provide diverse science learning experiences, develop in students scientific literacy through scientific inquiry, thereby facilitating students adapt to senior secondary levels and meet the needs of personal development in the future.

2. Deepening students' understanding of I&T applications

   Diversified and engaging I&T learning activities can stimulate students' interests and curiosity in science and technology, and encourage them to actively explore science and the applications of I&T. The revised curriculum will incorporate more diversified and daily-life related learning activities to deepen students' understanding of science and I&T through inquiry and application so as to equip

them to adapt to the rapid changes in future societies and technological advancements.

3. Strengthening cross-disciplinary connections, fostering in students the spirit of innovation

   To prepare students for the uncertainties of a rapidly changing world, it is increasingly important to cultivate their spirit of innovation. The revised curriculum will emphasise on developing in students the ability to integrate and apply knowledge and skills from science and relevant disciplines, via providing different cross-disciplinary learning activities. These activities will provide students with opportunities to develop diverse and original solutions for creative problem solving, thereby establishing in them proper values and attitudes and fostering the spirit of innovation.

4. Ensuring a smooth transition for science education between primary and secondary levels

   The Junior Secondary Science Curriculum builds upon the learning foundation established in the Primary Science Curriculum and provides the necessary knowledge base and learning experiences for senior secondary education, addressing students' diverse learning needs. The revised curriculum will reduce certain learning content overlap in the primary science curriculum while taking into account the articulation with senior secondary science subjects. The curriculum content and the sequence of learning and teaching will be streamlined to facilitate teachers to conduct curriculum planning effectively and organise scientific investigations and cross-disciplinary learning activities for students.

1.3 Curriculum Rationale

The curriculum rationale of Science (S1-3) Curriculum is "Enhancing Scientific Literacy, Fostering the Spirit of Innovation". The curriculum emphasises cultivating students' scientific literacy by equipping them with essential scientific knowledge, fostering creativity, collaboration, problem-solving and encouraging critical thinking. These will enable students to become a life-long learner amid the rapid development of science and technology in the society.

Enhancing Scientific Literacy

Cultivating students' scientific literacy aims to strengthen their ability to understand and apply scientific methods 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 scientific knowledge to help them understand the nature of science, and acquire scientific inquiry skills, thereby enhancing their scientific literacy. This enhance students' scientific literacy which enable them to participate in the community to discuss in the context involving science, technology, society and environmental sustainability. Students with scientific literacy can utilise scientific knowledge and inquiry skills, along with a proper scientific attitude, to analyse issues related to daily life and the natural world. They are able to verify and address problems rationally using scientific thinking. The curriculum forces on cultivating students' scientific literacy through the following four dimensions:

	Example
Scientific Thinking	Scientific concepts, nature of science, modelling, scientific explanation
Inquiry Practices	Verifying theory, scientific observation and measurement, engineering design, data processing
Scientific Attitudes	Searching for truth, honest reporting, skepticism, encouragement of innovation, commitment to the society
Scientific Community	Scientific discussion, scientific argumentation, scientific communication

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 fostering in students the spirit of innovation

through various cross-disciplinary learning and teaching activities, such as "Engineering Design" and "Discussion on Socio-scientific Issues", in which students could integrate and apply science and knowledge and skills from other relevant disciplines for proposing diverse and original ideas as well as solving problem creatively. These science-related learning opportunities not only could facilitate students to adapt to a dynamic and uncertain global environment, but also foster the development of proper values and attitudes and the spirit of innovation.

1.4 Curriculum Aims

The aims of the Science (S1-3) Curriculum is to provide junior secondary students with diverse and engaging science learning experiences, sustain and extend the learning of science from primary level, thereby fostering their curiosity and interests in science, and building a solid foundation of scientific knowledge, enabling students to become lifelong learners of science. Moreover, the curriculum aims to consolidate students with scientific inquiry skills, equipping them to pursue further studies in science and I&T related subjects at senior secondary levels. The curriculum encourages students to participate in scientific inquiry and cross-disciplinary learning activities, nurturing in them scientific literacy and the 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 on issues relating to individual, societal and global contexts with a view to foster positive values and scientific attitudes, as well as take 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 conduct 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 lifelong learners in science for personal development and prepared for further studies or future careers 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 enable students to 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 is structured into thirteen 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;

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) for a scientific investigation;
- 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 decision 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;
- recognise the usefulness and limitations of science and the evolutionary nature of scientific knowledge;
- 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, understand the reasons behind, 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, involving procedures such as identifying science questions, formulating hypotheses, conducting experiments, and analysing data. Through scientific inquiry, scientists infer and interpret scientific phenomena, propose evidence-based arguments to communicate scientific reasoning, and construct scientific models for prediction. Scientific inquiry may not follow a fixed approach; instead, scientists explore scientific phenomena through various methods, such as conducting controlled experiments, classifying and pattern seeking.

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 developing interests in exploring science in their daily life and nurturing in them the scientific inquiry skills systematically. The curriculum emphasises three aspects of scientific inquiry skills: Scientific Reasoning, Experimenting and Data Processing.

Scientific Reasoning

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

Experimenting

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 Estimating accuracy and precision in a scientific measurement
E5 Setting up a control experiment to avoid confounding factors and identify causation
E6 Choosing appropriate design for a scientific investigation and assessing its reliability

Data Processing

D1 Using scientific notation, significant figures, ratio and rate for presenting 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, practicing experimental skills, verifying scientific theory and making scientific inference. Below are some examples 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 accuracy of experimental results
- repeating the experiment under different environmental conditions or with the use of different apparatuses to examine the reproducibility of the experiment

(d) Pattern seeking

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

- using scatter plots to illustrate relationships between variables and fitting the data to draw 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 should 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	• Prepare slides of plant and animal tissues and examine these slides under a microscope • Identify the vascular tissues by observing the uptake of dye solution in vegetables
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 and make a fresh water collector (e.g. fog collector, rain water collector)
Living Things and the Environment	• Investigate the necessary conditions for photosynthesis • Perform practical work to find out the change in carbon dioxide content in a boiling tube with organisms (e.g. aquatic plant, brine shrimp)
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 before and after burning different substances (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 / indicator) when an acid is mixed with an alkali
Force and Motion	• Study the free-falling motion of an object using a motion sensor • Measure the friction 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 and the polarity 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	• Investigate the effect of physical exercise on breathing rate and heart rate • *Perform practical work to identify food substances (e.g. glucose, starch, lipids, proteins and vitamin C) in food samples* • *Compare the amount of vitamin C in different fruits* • *Investigate the chemical digestion by enzymes (e.g. amylase, protease, lipase)*
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 about light refraction (e.g. prepare a "refractive index matching fluid") • 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 sea water using microscale electrolytic cell • Distinguish oxygen, hydrogen and carbon dioxide from unknown gaseous samples through chemical tests • Examine whether water is present in unknown samples • *Investigate factors (e.g. surface area) 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, 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

The curriculum focuses on cross-disciplinary learning, emphasising on cultivating students to connect different subject knowledge and skills to understand and solve real-world problems from multiple perspectives. In junior secondary science, cross-disciplinary learning involves different domains, such as science, innovation & technology, environment, society and engineering. Students are encouraged to step beyond the limitations of subjects, integrate and apply cross-disciplinary knowledge and skills, and engage in solving problem creatively and inquiry on scientific issues.

Connecting science learning to different subject domains facilitates students to understand the interaction and complementarity between different fields. It also allows students to learn to appreciate the benefits of science and innovation technologies in improving human life, and to understand the applications and the limitation of science. Through cross-disciplinary learning,

students can think critically about contemporary scientific issues and understand and solve problems using scientific methods, thereby cultivating their creativity, collaboration skills and the spirit of innovation.

The curriculum incorporates various cross-disciplinary learning activities, such as **constructing scientific model**, **engineering design**, and **Socio-scientific Issues (SSI)**. To enable students actively participating in scientific discussions, scientific 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.

(a) Constructing scientific model

Scientific modelling activities allow students to use science, mathematics and information technology to learn about knowledge building, as well as explore and understand scientific phenomena. It can help students recognise the complementary relationship between knowledge in different disciplines. 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 education technology, such as online platform or AI tools, to facilitate students in constructing, testing, revising and evaluating their models. For instance, 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 questions. 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 fostering their problem-solving skills. Students can apply their scientific inquiry skills in authentic situations, thereby arising their motivation and interests in learning science.

Considerations on planning a "Constructing scientific model" activity
Activity focuses (examples): • providing opportunties for students to ask scientific questions from phenomena • facilitate students to construct initial models based on existing knowledge and use them to explain scientific phenomena • facilitating students to conduct experiments to collect data and use models to predict experimental results • facilitating 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: Earth and Space) • construct a model to simulate the blood flow in a cholesterol-clogged vessel (Unit: Healthy Body) 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 construct revised models for analysis and comparison • able to use evidence for justifying the choice of the selection of models

(b) Engineering Design

The learning process that students to experience engineering design can help them understand the connection between science, engineering and other disciplines, thereby cultivating students' ability to integrate and apply knowledge and skills to solve problems in real life situations. Engineering design is a systematic process to solve daily life problems while considering a set of practical constraints. The main components of engineering design share many similarities with scientific inquiry, such as conducting investigations, analysing data and constructing explanations; there are also differences between engineering design and scientific inquiry in some other aspects. For example, engineering design involves identifying an engineering problem, creating prototypes, and conducting tests, while scientific inquiry involves the formulation of hypothesis and examining it through conducting experiments.

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 criteria to achieve the expected outcome in solving the problem
	• Consider the needs of users and the expectation from the community
Developing Prototypes	• Propose different design solutions
	• Recognise the strengths and limitations of the prototypes
Conducting Investigations	• Conduct scientific tests and summarise data about the performance of the prototypes under a range of conditions
Analysing Data	• Analyse data for the optimal setting of the prototypes
	• Conduct budget calculation
Constructing Designing Solutions	• Analyse and select the best design with reference to different criteria
	• Present the advantages and the limitations of the finalised design
Evaluation	• Analyse the feedbacks received and propose further enhancement to the design

Providing opportunities for students to conduct learning and teaching activities related engineering design would facilitate them to apply the knowledge and skills in science, mathematics and technology in solving engineering problem creatively. In the course of science learning at the junior secondary level, students can organise students into groups for activities, allowing time for students to propose diverse designs, develop their own solutions to tackle the engineering problems, build prototypes and conduct scientific tests.

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 • fostering students' creativity in an engineering design while considering the practical constraints Activity themes (examples): • design and make a device to harvest solar energy at day time (Unit: Earth and Space) • design and make a water-saving device to be fixed on water tap for daily use (Unit: Earth and Space) • design and make a heat insulating house model (Unit: Matter and Energy) • design and make a "water rocket" or a "balloon car" (Unit: Force and Motion) 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 best design solution

(c) Socio-scientific Issue

One of the learning focuses of the 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.

Socio-scientific Issue (SSI)	
Socio-scientific Issue (SSI) refer to scientific issues related to human life and involving different disciplines (such as I&T, environment, society). SSI usually does not have clear solutions, and different stakeholders may have different point of views.	
Scientific Argumentation	
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 supports a claim Reasoning: A justification curated based on scientific knowledge or principles to describe why the evidence supports the claim	
Major Component of SSI-based Learning Activity	
Selecting SSI	• Selected SSI related to students' daily experience / curriculum content
Exploring SSI	• Propose the related cross disciplinary knowledge, facts, concerns and myths of the SSI
	• Consider different stakholders' views
	• Select suitable approaches to investigate the SSIs (e.g. literature review, experimentation, debate, role playing)
	• Apply scientific reasoning and knowledge to explore the SSI
	• Analyse the evidence and make informed suggestions and recommendations based on evidence
Scientific Reporting and Evaluation	• Select suitable format for presenting their work (e.g. oral presentation, poster design or report writing)
	• Presenting their work and conducting evaluation

Arranging SSI-related learning and teaching activities for students can help students understand the application of scientific knowledge in society and its importance to society, ethics, economy and the environment, and understand the impact of the development of science and technology on our lives and society. interaction with the environment. Teachers can choose different learning and teaching activities, such as group discussions, mock debates, role plays and project studies, to arrange SSI-based learning activities. Students may come up with different opinions during the discussion and support or oppose certain points of view. Teachers can guide students to conduct experiments or find reliable data, allowing students to construct evidence-based arguments and conduct scientific discussions. SSI learning activities allow students to

reflect on their own arguments and revise their claims based on the opinions of their peers, 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 students with the opportunities to have scientific discussion Activity themes (examples): • investigate the importance of biodiversity to the sustainable development of the natural environment and its benefits to humans (Unit: Looking at Living Things) • discuss on the needs of using fossil fuels and its impact on the society (Unit: Earth and Space) • discuss on the pros and cons of the ways of the conservation of species (e.g. artificial fertilisation and cloning) (Unit: Living Things and the Environment) • discuss on the social, economic and environmental consequences of using different ways to generate electricity (Unit: Making Use of Electricity) Skills involved in the activity (examples): • able to distinguish fact from myth • able to identify what scientific evidence is • able to explain why scientific literature is reliable information (e.g., scientists conduct peer review on research results) • able to question the views of different stakeholders (e.g. checking for over-interpretation of data) • able to extract evidence from information to support or refute arguments • able to put forward scientific arguments (claim-evidence-reasoning)

Curriculum resources – Cross-disciplinary connections

When arranging cross-disciplinary science learning activities, teachers can 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, etc. 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 application 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 is structured with 13 units, designed in the form of cross-disciplinary themes that encompass various scientific domains, including biology, chemistry, physics, and earth science, as well as elements of scientific inquiry. Through learning these units, students will acquire scientific knowledge and gain an understanding of the four overarching concepts: "systems and organisation," "evidence and models", "change and constancy," and "form and function". 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.

S1 and S2	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
S3	Unit 11: Healthy Body
	Unit 12: Light and Sound
	Unit 13: Our Planet Earth

The four overarching concepts – "Systems and Organisation", "Evidence and Models", "Change and Constancy" and "Form and Function", which span general scientific domains and transcend disciplinary boundaries, are briefly outlined as follows:

	Note
Systems and organisation	These are ways of observing and describing phenomena that are related to each other and/or work together as a whole. • A system is an organised group of related objects or components that form a whole. • Organisation is the act or process of putting things into a structural framework according to a particular hierarchy.
Evidence and models	Scientists use evidence and models to understand, explain and/or predict scientific phenomena. • Evidence consists of observations and data on which scientific explanations can be constructed and predictions can be made. • Models are representations that are taken to illustrate real systems, objects, concepts or events. They can be used to explain, predict and study how real objects work. Models can be physical, conceptual, or mathematical.
Change and constancy	Change and constancy describe states of being of a scientific phenomenon. • Change is a process resulting in alteration. • Constancy is the state of being unchanged or some aspects of systems that have the remarkable property of always being conserved.
Form and function	Form and function are usually interrelated. Form can be used to explain its function and function can be used to explain its form. • Form is the shape and structure of an object. • Function is the role that an object, activity or job has, or the purpose for which it is used.

2.3.1 Organisation of each Unit

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

Overview
This part outlines the context and the focuses of each Unit.

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.

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. During the teaching of related topics, teachers should systematically arrange these KPTs, 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 list includes a wide range of activities, such as discussion, practical work, investigations, information search and projects. They 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 the interests and abilities of their students. 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 around them. It is hoped that students will then be equipped with scientific concepts, theories and process skills to investigate and solve everyday 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). Schools should deploy the school lesson time flexibly for arranging different learning and teaching activities, such as scientific investigations, cross-disciplinary project learning, design and make activities, and other opportunities for students to integrate and apply knowledge and skills in different disciplines. Shown below is the estimated lesson time for each Unit of Science (S1-3) Curriculum as reference. Teachers may adjust the lesson time having regard to students' learning progress.

S1 and S2 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	
S3 Units	**Core Part**	**Extension Part**
Unit 11: Healthy Body	16 – 23	15 – 23
Unit 12: Light and Sound	16 – 23	15 – 23
Unit 13: Our Planet Earth	16 – 23	15 – 23

2.3.4 Suggested Learning and Teaching Sequence

The Suggested Learning and Teaching Sequence is a possible sequence suitable for the majority of junior secondary students (Suggested learning and teaching sequence of Science (S1-3) Curriculum is shown in the next page). This sequence allows learning starts with scientific concepts that are related to macroscopic patterns (such as those in "Looking at Living Things" and "Earth and Space"), and progresses onto scientific concepts that are microscopic or atomic-level in nature (such as those in "Matter and Energy" and "Atomic World"), and finally progresses on S3 curriculum units. The 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 adopt alternative sequence so as to facilitate the learning of the students.

Other Possible Options of Learning and Teaching Sequences

Example A

"Science Practice I" and "Science Practice II" include different domains of scientific inquiries. The Suggested Learning and Teaching Sequences could avoid loading students with different scientific inquiry concepts and scientific reasoning method in a short period of time. If teachers, after considering the scientific foundation of the students, believe that it is more beneficial for the students to learn "Science Practice I" and "Science Practice II" in one go, they can make reference to the Example A of Other Learning and Teaching Sequences which is shown in next page.

Example B

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, after considering the abilities and interests of the students, believe that learning 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 Example B of Other Learning and Teaching Sequences which is shown in next page.

<table>
<tr><th></th><th rowspan="2">Suggested Learning and Teaching Sequence</th><th colspan="2">Other possible options of Learning and Teaching Sequences</th></tr>
<tr><th></th><th>Example A</th><th>Example B</th></tr>
<tr><td rowspan="2">S1</td><td rowspan="3">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
⇩</td><td rowspan="3">Unit 1: Scientific Practices I
⇩
Unit 4: Scientific Practices II
⇩
Unit 2: Looking at Living Things
⇩
Unit 3: Human Reproduction and Heredity
⇩
Unit 5: Earth and Space
⇩
Unit 6: Living Things and the Environment
⇩</td><td rowspan="3">Unit 1: Scientific Practices I
⇩
Unit 2: Looking at Living Things
⇩
Unit 3: Human Reproduction and Heredity
⇩
Unit 5: Earth and Space
⇩
Unit 7: Matter and Energy
⇩
Unit 4: Scientific Practices II
⇩</td></tr>
<tr><td>S2</td></tr>
<tr><td>S3</td><td colspan="3">S3 Units</td></tr>
</table>

Suggested Learning and Teaching Sequences of Science (S1-3) Curriculum

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 *"Science (Primary 1 – 6) Curriculum Framework"* (CDC). 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 reasoning as to facilitate them to understand and connect different scientific concepts for exploring new scientific knowledge. Teachers are expected to exercise professional judgment in accordance with the needs of their students and provide learning support such as scaffolding and learning cues.

2.4.2. Teaching Arrangement of S3 Units

Scientific inquiry skills, knowledge and understanding of science developed through the three-year Junior Secondary Science Curriculum are laying down solid foundation for the learning of senior secondary subjects. The core parts of the curriculum cover essential scientific concepts that all students should 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 may refer to the suggested curriculum arrangements as shown in the diagram below, and plan the curriculum tailored to school contexts to foster students' interests and motivation of science learning, thereby preparing students for further studies and personal development. For the teaching arrangement, teachers should note the following:

- Teachers need to complete the teaching of the Core Part of the Science (Secondary 1 - 3) curriculum in the first place. Besides the Core Part, teachers may select materials from the Extension Part to cater for the needs, interests and abilities of their students.

- Apart from selecting topics in the Extension Part and where appropriate, teachers might include some enrichment topics in the school science curriculum to extend students' learning experiences to different science disciplines, such as physics, chemistry and biology, to provide opportunities to students with strong interest in science for further developing their potential.

Mode I	Mode II	Mode III
S1 and S2 Units	S1 and S2 Units	S1 and S2 Units
↓	↓	↓
S3 Units (Core Part)	S3 Units (Core Part)	S3 Units (Core Part)
↓	↓	↓
S3 Units (Extension Part)	Science enrichment topics	Assorted arrangement (Selected topics in Extension Part and Science enrichment topics)

2.5 e-Learning

With appropriate uses of e-learning tools, science teachers can design deep learning tasks to help students construct scientific knowledge, and connect science learning with the real world. Therefore, teachers may develop educational applications of e-tools in school contexts, through which teachers, students and artificial intelligence can form a synergistic learning environment to help enhancing teaching effectiveness and students' learning motivation. The following are examples of the applications of e-learning tools for teachers' reference:

e-Learning Tools	Applications
Animation	• watching animations to help visualise natural phenomena and processes, and grasp abstract concepts (e.g. the motion of particles in a liquid as temperature changes).
Virtual experiment	• using interactive simulations which students could manipulate different simulated objects through 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 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. • using a VR and AR technology to create immersive learning experiences that can make abstract scientific concepts more tangible (e.g. exploring human system or ecological system).
Artificial intelligence (AI)	• using visual recognition technology for pattern seeking. • using machine learning system to make scientific predictions. • Using AI chatbot in adaptive science learning.

While the use of e-learning could offer space for developing students' scientific thinking, creativity and problem solving skills, and fosters the development of self-directed learning, teachers need to exercise their professional judgement on the appropriate use of IT and ensure that the students are provided with sufficient opportunities for hands-on experiments to develop their scientific inquiry skills. Efforts should also be devoted to nurture students to be ethical and responsible users of IT.

Some relevant curriculum resources are listed below for teachers' use :

Science (S1-3) 'Hong Kong Wetland Park Self-directed Outdoor Learning' Resource Package	The Use of Mobile Devices for Conducting Science (S1-3) Practical Activities Resource Package	Junior Secondary Science Video-based Self-learning Pack

Unit 1: Scientific Practices I

Overview

This Unit will introduce the scope and applications of science and the concepts about scientific observation, such as scientific measurements and error. Besides, students will learn about the apparatus, equipment for conducting experiments and the safety equipment in the science laboratory, and understand the importance of laboratory safety.

Scientific Literacy

Through different learning activities, such as heating substances and mixing solutions, students can learn scientific observation, measurement and verifying theories. Reading articles about hazards and risks can cultivate students' awareness of pursuing truthiness towards information. In addition, students can enhance understanding of the scientific community by learning the contributions and the process of conducting scientific research of scientists. Besides, teachers can design appropriate learning and teaching activities to facilitate students to develop and master the following skills:

- operating simple experimental apparatus
- making qualitative observations and quantitative measurements (E3)
- estimating accuracy and precision in a scientific measurement (E4)
- 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 • give examples of daily life applications of science, innovation and technology • be aware of the responsibility towards promoting science ethics, animal welfare and environmental sustainability

Students should learn	Students should be able to
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)
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 ofI&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 will introduce how living things can be classified according to their key features. Students will also learn about other relevant science concepts, such as life cycles of animals, cells, as well as level of organisation of organisms. Learning about the grouping of living things helps students realise the concept "systems and organisation", while learning about the structural characteristics of animals and plants helps students recognise the concept "form and function".

Scientific Literacy

Through different learning activities, such as preparing slides and examining cells under a microscope, students can learn scientific observation and measurement. Observing the uptake of dye solution in vegetables can help them understand the function of vascular tissue and develop their scientific verifying skills. By identifying the key features of animals and making identification key, students can acquire relevant scientific knowledge and enhance data processing skills. Besides, teachers can design appropriate learning and teaching activities to facilitate students to 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 (R2)
- identifying similarities and differences of organisms
- classifying organisms according to their external features
- using tables and graphs for data analysis (D2)
- 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 grouping living things • 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 cells under a microscope and identify structures of the observed cells (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) and the components of systems (e.g. breathing system, digestive system) in human body* • *recognise the role of major organs and systems in human body (e.g. organs involved in breathing)*

Key Practical Tasks

- Prepare slides of plant and animal tissues and examine these slides under a microscope
- Identify the vascular tissues by observing the uptake of dye solution in vegetables

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 human reproduction and heredity. Within every cell, there are genetic materials, DNA, which carry the instructions for defining the different traits of a living thing. Reproduction is an essential life process that leads to the formation of a new life. Through reproduction, new individuals with some traits looking very alike to their parents will be formed. The passing of traits from generation to generation is called heredity. The concept "change and constancy" can be exemplified in the process involved in heredity. At the same time, 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.

Scientific Literacy

Through different learning activities, such as constructing DNA models to show the double helix structure as well as base pairing of DNA, students can enhance their understanding of constructing scientific models. By conducting survey on continuous variation and discontinuous variation in class and presenting the data in tables and charts, students' data processing skills can be enhanced. Besides, teachers can design appropriate learning and teaching activities to facilitate students to develop and master the following skills:

- using tables and graphs for data analysis (D2)
- 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 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 on 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 appeared 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 oviduct when a sperm fuses with an ovum to form a zygote • state that the development of the embryo begins before the implantation in 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 encodes 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 the complete set of chromosomes in a cell* (S) • *state that there exists four kinds of bases, A, T, C and G of 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 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 (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

- Watch video clips to identify the structural features of sperm and ovum
- Examine photomicrographs of the set of chromosomes found in a cell
- 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 passing of a trait in a family
- Discuss on 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 will introduce concepts about scientific investigation, such as types of investigation and control experiment. Students will also learn about various ways of scientific reasoning that scientists commonly used to establish scientific knowledge and make inference. Through learning about how scientists develop scientific models for describing and explaining scientific phenomena, students will realise the concept "evidence and models".

Scientific Literacy

Through different learning activities, such as designing fair tests and comparing the accuracy and precision of results obtained from two experimental groups, students can learn the skills of scientific verification and data processing. Students can develop their scientific reasoning skills by conducting practical work to find out the relationship between the temperature and the thermal expansion of liquid. In addition, reading story about experiments conducted by scientists to investigate photosynthesis can facilitate students understand the nature of Science. Besides, teachers can design 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 (R1)
- using a set of general observations, trend or model to deduce a specific result (R2)
- making inference to the best possible explanation to the observed phenomenon (R3)
- making informed decision based on the probability of phenomenon to be occurred (R4)
- formulating a hypothesis based on observed phenomenon (E1)
- identifying independent variables, dependent variables and control variables (E2)
- setting up a control experiment to avoid confounding factors and identify causation (E5)
- choosing appropriate design for a scientific investigation and assessing its reliability (E6)

Students should learn	Students should be able to
4.1 Scientific investigation • hypothesis • types of investigation • types of variable • control experiment	• recognise that a hypothesis is a statement to describe, predict or explain some phenomenon 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 control experiment in ensuring the scientific investigation is valid for establishing causality (S) • be aware that the conclusion drawn from the experiments is used to support or refute the hypothesis set in the scientific investigation (S) • recognise some ways for testing 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, explaining or making predictions on scientific phenomenon (S) • give examples of different types of scientific models • be aware of different ways of scientific reasoning for establishing scientific knowledge and making inference: (S) ➢ using specific data to induce conclusions, predict trends or develop scientific models ➢ using scientific models or trends to deduce a specific result ➢ *making inference of the most possible explanation to the observed phenomena* ➢ *making informed decision based on the likelihood of phenomena to be occurred* • *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 the temperature and the thermal expansion of liquid
- 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 story about 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 some astronomical discoveries of the Solar System, including the physical features of the Earth, the Moon and other planets in the Solar System. Through learning about the space exploration programmes in our country, students will understand and appreciate the contributions and achievements made by our country on the development of space science. Besides, students will learn about the basic structure of the Earth, the existence of precious natural resource and the sources of energy essential to our living. Students will have a preliminary understanding about the concept of sustainability by learning different ways of resource conservation and the needs for developing renewable energy sources. Recognising about the concept of water cycle helps students realise the concept "change and constancy", while learning about solar system helps students recognise another concept "systems and organisation".

Scientific Literacy

Through different learning activities, such as observing the effects of bleach on microorganisms in water under a microscope, students can learn scientific observation and measurement. Students can acquire the skills of engineering design and data processing through design and make fresh water collector and a water-saving device to be fixed on water tap. Activities involve design and make water purifiers and a device to harvest solar energy can foster students' spirit of innovation and strengthen their scientific verifying skills. In addition, by understanding the contribution and achievements made by our country on the development of space science, students will appreciate the spirit of commitment to the society from 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 (R2)
- making inference to the best possible explanation to the observed phenomenon (R3)
- using tables and graphs for data analysis (D2)
- choosing appropriate design for a scientific investigation and assessing its reliability (E6)
- inferring abstract concept through observing macroscopic phenomena (e.g. inferring the concept of particles from observing the formation of cloud and rain)
- checking the validity of explanation against new findings from experiment
- 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 The Earth	
• structure of the Earth • the atmosphere • water cycle	• 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 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)
5.2 Earth's resources	
• water conservation • methods of purification and separation • water pollution and air pollution • fossil fuels and renewable energy sources	• construct a table or diagram to show the distribution of fresh water and salt water in different regions on the Earth's surface (S) • 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 need for developing renewable energy sources (e.g. solar energy, biomass energy, wind power and hydroelectric power)

Students should learn	Students should be able to
5.3 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)

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 and make a fresh water collector (e.g. fog collector, rain water collector)*

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 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 day time
- 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

In this Unit, students will learn about essential life processes of living things. The importance of the balance of oxygen and carbon dioxide in Nature will also be introduced. Through the study of biodiversity and conservation, the interrelationships in ecosystem, as well as climate change, students will learn about the concept "change and constancy".

Scientific Literacy

Through different learning and teaching activities, such as investigating the necessary conditions for photosynthesis, students can learn scientific reasoning, scientific explanation and scientific observation and measurement. By design and make micro-ecosystems and using food webs to demonstrate the feeding relationships among organisms, students can understand the construction of scientific models. In addition, arranging learning activities such as visiting to the Hong Kong Museum of Biodiversity for students can cultivate students the pursuit of truth. 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 (R2)
- making inference to the best possible explanation to the observed phenomenon (R3)
- formulating a hypothesis based on observed phenomenon (E1)
- identifying independent variables, dependent variables and control variables (E2)
- setting up a control experiment to avoid confounding factors and identify causation (E5)
- choosing appropriate design for a scientific investigation and assessing its reliability (E6)
- using tables and graphs for data analysis (D2)
- 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 factors 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)

Students should learn	Students should be able to
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) • state that some human activities (e.g. deforestation, destruction of habitat) 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 wild life
6.4 Climate change	
• balance of carbon dioxide and oxygen in Nature • greenhouse gases emission • alleviating climate change	• recognise that there is a natural balance of carbon dioxide and oxygen in Nature • recognise that carbon dioxide is one of the greenhouse gases which absorb and re-emit heat back to the Earth's surface • recognise 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 • state the advantages of planting that benefit the environment and its role in alleviating the climate change

Key Practical Tasks

- Investigate the necessary conditions for photosynthesis
- Perform practical work to find out the change in carbon dioxide content in a boiling tube with organisms (e.g. aquatic plant and brine shrimp)

Suggested Learning and Teaching Activities

- 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

In this Unit, students will learn about the basic ideas of particle theory and the use of this scientific model to explain some daily life phenomena, such as the thermal expansion and contraction, and the changing of physical states of substances. Students will also learn about the energy transformation in common processes in everyday life. Learning about the concept of particle theory helps students recognise the concept "evidence and models", while learning about the concepts of energy transfer and the conservation of energy helps students recognise the concept "change and constancy".

Scientific Literacy

Through different learning activities, such as investigating the properties of substances in different states, students can learn scientific observation and measurement, as well as verifying theories. By design and make a heat insulating house model and a container that can minimise temperature change, students are encouraged to apply scientific principles and be creative. It can also strengthen their ability of engineering design. In addition, conducting practical work to demonstrate the phenomenon of thermal expansion and contraction can cultivate students' abilities in scientific reasoning and scientific explanation. Besides, teachers can design 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 (R1)
- formulating a hypothesis based on observed phenomenon (E1)
- seeking evidence to support or refute claims
- estimating accuracy and precision in a scientific measurement (E4)
- using scientific formula for scientific inference (D3)
- identifying outliers and handling data from repeated measurements to assess the uncertainty incurred (D4)

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 differences in relative speed and distance between particles in solids, liquids, and gases • 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 life 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 and predict the final temperature of the two objects (S) • identify the evidence for heat transfer processes: conduction, convection and radiation (S) • give examples of daily life 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 will introduce science concepts relevant to microscopic world, such as structure of atoms, classifying compounds and mixtures, distinguishing chemical changes and physical changes of matter. Learning content relating to "solution", "acids and alkalis" and "chemical reaction" will also be covered. Learning the structure of atoms helps students realise the concept "evidence and models", while learning about conservation of matter in a chemical reaction helps students recognise the concepts "change and constancy".

Scientific Literacy

Through different learning activities, such as investigating the factors affecting the rate of dissolving of substances, students can learn scientific observation and measurement as well as scientific reasoning. By conducting fair tests to find out the solubility of substances at different temperatures, students can learn the skills of scientific verification and data processing. In addition, constructing molecular models and calculating the number of atoms according to chemical formula can help students understand the construction of scientific models. At the same time, teachers can design 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 (R1)
- making inference to the best possible explanation to the observed phenomenon (R3)
- identifying independent variables, dependent variables and control variables (E2)
- making qualitative observations and quantitative measurements (E3)
- estimating accuracy and precision in a scientific measurement (E4)
- setting up a control experiment to avoid confounding factors and identify causation (E5)
- using scientific notation, significant figures, ratio and rate for presenting scientific data (D1)
- using tables and graphs for data analysis (D2)

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 (e.g. CO_2 is a compound constituted of one carbon atom and two oxygen atoms) • classify substances as elements or compounds based on their chemical formula (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, stirring and the surface area of solute in contact with the solvent (S) • use the solubility curve of a solute to explain observations about dissolving (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 common cleansing products may be hazardous • describe 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 salts)*

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 distinguish different ink samples (e.g. oil-based ink and water-based ink)
- Construct molecular models and calculate the number of different types of atoms from the chemical formula of molecules (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

In this Unit, students will learn about some examples of contact force and non-contact force, the concept of balanced force and unbalanced force, as well as the calculation of net force acting on an object. Through learning the relationship between force and pressure, students will recognise the concept "change and constancy", while learning about the use of scientific models to explain the daily-life phenomena relating to the existence of gas pressure help students realise the concept "evidence and models".

Scientific Literacy

Through different learning activities, such as using motion sensors to study the free-fall motion of objects, students can learn scientific observation and measurement. By proposing an original method to compare the friction of different surfaces, students are encouraged to develop new solutions to conduct scientific investigation creatively. In addition, investigating the action and reaction forces exerted on objects can cultivate students' abilities in scientific reasoning and scientific explanation. Besides, teachers can design 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 (R1)
- making inference to the best possible explanation to the observed phenomenon (R3)
- formulating a hypothesis based on observed phenomenon (E1)
- identifying independent variables, dependent variables and control variables (E2)
- setting up a control experiment to avoid confounding factors and identify causation (E5)
- choosing appropriate design for a scientific investigation and assessing its reliability (E6)
- Using scientific formula for scientific inference (D3)
- Identifying outliers and handling data from repeated measurements to assess the uncertainty incurred (D4)

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) • recognise that the speed of an object will change over time when it is accelerating or decelerating • investigate the motion of an object (e.g. free-falling) (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)

Students should learn	Students should be able to
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 life applications of pressure
9.4 Pressure and particle movement	
• *gas pressure*	• *use diagram to explain the existence of gas pressure is due to gas particles hitting against the walls of a container* (S) • *use evidence to examine the relationship between temperature, volume of gas and gas pressure :* (S) ➢ *the gas pressure in a fixed container increases when the temperature in the container is increasing* ➢ *the volume of a balloon will vary when temperature inside the balloon changes* ➢ *balloon expands when inflated*

Key Practical Tasks

- Study the free-falling motion of an object using a motion sensor
- Propose original methods and conduct practical work to compare the friction 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

In this Unit, students will learn about connecting circuits, drawing and interpreting circuit diagrams. Students will also learn about the concepts of current, voltage and resistance. They will also understand the practical use of electricity in households and the importance of safety aspects of domestic electricity. Students will also learn about the properties of magnets, the factors affecting the strength of magnets, as well as the uses of electromagnets in everyday life. The study of the patterns of changes in currents and voltages in series and parallel circuits helps students recognise the concept "change and constancy".

Scientific Literacy

Through different learning activities, such as measuring the current and voltage in series and parallel circuits, students can learn scientific observation and measurement and scientific explanation. By conducting practical work to compare and contrast the power, light output, and efficacy of different types of light bulbs, students can develop the data processing skills and cultivate them the pursuit of truth. In addition, by calculating household electricity usage and discussing ways of reducing electrical energy consumption, students can exchange ideas on scientific issues. Besides, teachers can design appropriate learning and teaching activities to facilitate students develop and master the following skills:

- Making inference to the best possible explanation to the observed phenomenon (R3)
- Selecting appropriate apparatus for conducting experiment
- reading scales of different apparatuses
- Formulating a hypothesis based on observed phenomenon (E1)
- Identifying independent variables, dependent variables and control variables (E2)
- Estimating accuracy and precision in a scientific measurement (E4)
- Setting up a control experiment to avoid confounding factors and identify causation (E5)
- Using tables and graphs for data analysis (D2)
- Using scientific formula for scientific inference (D3)
- Identifying outliers and handling data from repeated measurements to assess the uncertainty incurred (D4)

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) • 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) • explain briefly the daily life applications of electromagnets (e.g. doorbell, metal recycling factory) • recognise the magnetic effect of current

Students should learn	Students should be able to
10.3 Household electricity	
• household electrical appliances	• be aware that household electrical appliances are energy convertors making use of heating effect and magnetic effect of current
• mains voltages and domestic circuits	• state the mains voltage in Hong Kong
• potential hazards in using electricity	• recognise fuses and circuit breakers as devices in protecting circuits
• safety precautions in using electricity	• explain why parallel circuits are preferred to series circuits in domestic circuits
• *power and efficiency of an electrical appliance*	• recognise the danger of overloading in the use of universal adaptors
• *cost of electricity*	• recognise the condition leading to short circuits and its danger
	• state safety precautions in using electricity
	• *use formula (power = energy / time) to calculate the power 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)

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 electricity

Unit 11: Healthy Body

Overview

This Unit will introduce 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 idea of a balanced diet. Students will realise the importance of building healthy lifestyles, as well as how maintaining personal hygiene, vaccination and herd immunity could bring about importance on reducing the risk of infecting non-infectious (non-communicable) diseases and infectious (communicable) diseases. Students will also 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 decision 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 concept "change and constancy". In addition, students will also realise the concept "systems and organisation" from the study of the digestive system.

Scientific Literacy

Through different learning activities, such as investigating the effects of physical exercise on breathing rate and heart rate, students can learn scientific observation and measurement and scientific explanation. Constructing model to simulate the blood flow in a cholesterol-clogged vessel can faciliate students' understanding of constructing scientific models. In addition, examining food labels to identify the nutritional value and energy content of food can help students develop data processing skills. Besides, teachers can design appropriate learning and teaching activities to facilitate students to develop and master the following skills:

- making inference to the best possible explanation to the observed phenomenon (R3)
- making informed decision based on the probability of phenomenon to be occurred (R4)
- setting up a control experiment to avoid confounding factors and identify causation (E5)
- conducting a fair test
- constructing and using models to explain phenomena
- using scientific notation, significant figures, ratio and rate for presenting scientific data (D1)
- using tables and graphs for data analysis (D2)
- 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 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)
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 on our judgements, responses and our health
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)

Students should learn	Students should be able to
11.5 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 related applications of biotechnology

Extension Part

Students should learn	Students should be able to
11.6 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*
11.7 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*

Students should learn	Students should be able to
11.8 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*

Key Practical Tasks

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

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 vessel
- Use 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
- 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 properties of light and some common phenomena such as reflection, refraction and total internal reflection of light. Students will also aware that visible light is part of the electromagnetic spectrum consisting of lights of different colours. Besides visible light, there are also other radiations in the electromagnetic spectrum that are widely used in the modern world. This Unit will also introduce the properties of sound and the relationship between sound and the environment. Through investigating the angle of refraction when light travels through different media, students will realise how scientists generate scientific models for describing scientific phenomena. This will help students realise the concept "evidence and models" while the study of the structures of eye and ear will help them realise the concept "form and function".

Scientific Literacy

Through different learning activities, such as conducting practical work to find out how the loudness of a note changes with distance from the source, students can learn scientific observation and measurement. By using simulation experiments to interpret different waveforms of notes, students can enhance their skills of constructing scientific models and data processing skills. In addition, students can understand the structure of eye by dissecting an ox eye. Searching information on eye diseases and various ways of protecting our eyes can cultivate students' awareness of pursuing truthiness towards information. Besides, teachers can design appropriate learning and teaching activities to facilitate students develop and master the following skills:

- using a set of general observations, trend or model to deduce a specific result (R2)
- making inference to the best possible explanation to the observed phenomenon (R3)
- using scientific formula for scientific inference (D3)
- formulating a hypothesis based on observed phenomenon (E1)
- identifying independent variables, dependent variables and control variables (E2)
- estimating accuracy and precision in a scientific measurement (E4)
- 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	• identify the main parts of an eye through experiment (S) • 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 • 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 life applications of electromagnetic spectrum* • *recognise potential hazards of using electromagnetic radiations and the associated risk*

Students should learn	Students should be able to
12.6 Sound and the environment • *audible frequency range* • *noise pollution*	• *state the range of frequencies audible to humans* • *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 to find out how the loudness of a note changes with distance from the source
- Perform practical work about light refraction (e.g. prepare a "refractive index matching fluid")
- 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 will introduce different extraction and isolation methods to obtain chemicals. Students will recognise that many useful chemicals can be obtained from the atmosphere, the ocean and the Earth's crust. Students will learn some simple chemical testing and extraction methods, and will learn about using word equations or chemical equations to represent chemical changes that occur during the extraction processes. Besides, students will recognise that the chemicals extracted from the Earth can be used to produce useful materials which are widely used in the modern world to improve our quality of life. However, students should also be aware of the environmental problems associated with the improper use and disposal of these materials. Through the learning of the development of the Periodic Table of elements, students will realise the concept "systems and organisation", while learning the processes in the carbon cycle will help students realise the concept "change and constancy"

Scientific Literacy

Through various learning activities, such as conducting flame tests, students can learn scientific observation, measurement and inference. By designing experiments to separate mixed plastic samples by type, students can develop skills in verifiying theory and providing scientific explanations. In addition, by searching information on the invention of the advancement in new plastics invention, students can cultivate the awareness of pursuing truthiness towards information. Besides, teachers can design appropriate learning and teaching activities to facilitate students develop and master the following skills:

- using specific data to induce a general trend, conclusion or model (R1)
- using a set of general observations, trend or model to deduce a specific result (R2)
- making inference to the best possible explanation to the observed phenomenon (R3)
- formulating a hypothesis based on observed phenomenon (E1)
- identifying independent variables, dependent variables and control variables (E2)
- making qualitative observations and quantitative measurements (E3)
- identifying causation (E5)
- choosing appropriate design for a scientific investigation and assessing its reliability (E6)
- using tables and graphs for data analysis (D2)
- 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 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 sea 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 sea 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 attack 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) • recognise that flame tests can be conducted to show the presence of metals in ore 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 problems of using materials*	• *describe some environmental problems associated with the use of materials (e.g. plastics, metals)* • *state some solutions to the problems of using materials (e.g. plastics, metals)*

Key Practical Tasks

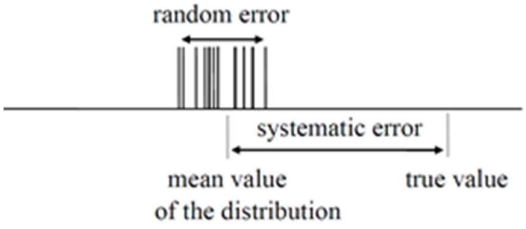
- Investigate the electrolysis of sea water using microscale electrolytic cell
- Distinguish oxygen, hydrogen and carbon dioxide from unknown gaseous samples through chemical tests
- Perform practical work to examine whether water is present in unknown samples
- *Investigate factors (e.g. surface area) 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

Part I : Scientific Investigation

Term	Description
Control experiment	An experiment which compares two setups (i.e., experimental setup and control setup) that have all the influencing factors identical except one.
Control variable	Variable to be kept constant between the experimental and control groups.
Dependent variable	Variable which is being measured or observed in an experiment.
Hypothesis	A statement testable by scientific investigation that describes or explains an observed phenomenon.
Independent variable	Variable which is being changed in an experiment.
Significant figure	For representing the accuracy of a measurement.
Source of error	Some examples include: (i.e. systematic error / random error) (a) Reading error – Taking measurements with quantities smaller than half of the limit of reading (b) Zero error – The measurement error incurred when adjusting of zero reading is not performed (c) Human error – Caused by flaws or mistakes in the investigation (e.g. parallax error) 
Validity	Referring to whether an investigation (e.g. fair testing) is designed to eliminate the influence caused by confounding factors.

Part II : Scientific Measurement

Term	Description
Accuracy	The closeness of agreement between a measured value to the true value or the reference value.
Error / Uncertainty	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.
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.
Random error	Random error result from unknown and unpredicted variations in experimental situations. The effect of random error can be reduced by improving experimental techniques and repeating measurement a sufficient number of times.
Reliability	The degree of consistency in scientific measurements.
Repeatability	Precision obtained when measurement results are produced by the same student group using the same sets of equipment.
Reproducibility	Precision obtained when measurement results are produced by a different student group or different sets of equipment.
Systematic error	Systematic error cause all measurements to be shifted systematically in one direction. They cannot be reduced by taking repeated measurements.
True value	Value that would be obtained in an ideal measurement.

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

(From May 2023)

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