Science (S1-3)

1. Introduction

Science is the study of the natural world, and of the way that humans interact with it. It is traditionally separated into three strands, biology, chemistry and physics. At HKUGAC, the science curriculum reflects these domains. We require students to actively learn about innovations and how science can be used responsibly in this constantly changing world. Science is a practical subject, and we place a strong influence on developing students' practical skills through a hands-on course, while fostering learning skills for independent study that will lead to more effective life-long learning.

1.1 Method of Delivery

1.1.1 Secondary One and Two

During the Science Programme, students will acquire core knowledge, skills and attitudes that will equip them to study more effectively in the senior years. The strand of Scientific Investigation is infused into the curriculum; facilitating students' understanding of the nature of science and acquisition of science process skills. The nature of science includes the belief and attitudes towards the knowledge about the natural world, the methods and processes through which scientific knowledge is acquired, and the socio-cultural and historical influences involved.

1.1.2 Secondary Three

Science is taught as a single subject with elements of biology, chemistry and physics. This enables students to acquire core knowledge, skills and attitudes that will equip them to study the separate sciences more effectively in S3 to S6. The students become aware of the major steps of scientific method by personally experiencing different laboratory investigations. They will also begin to develop awareness of the impact of science on individuals, society and environment. Students in S3 to S6 are taught the three separate disciplines of biology, chemistry and physics. This approach ensures that an in-depth study of each discipline is achieved. Continuing the foundations laid down in S1 and S2, the course emphasizes investigative practical skills alongside an appreciation of the effects of science on wider society.

1.2 Teaching methods

1.2.1 Secondary One and Two

The curriculum adopts a thematic approach to provide broad and balanced learning experiences for students to extend their learning of the science elements in General Studies at primary level. The approach is student-led, through modules of topic-based projects and end-of-unit assessments. Students work interactively through experimental work and collaborate through project feedback sessions to gain the required skills and knowledge from the topics studied. Students will enquire beyond the confines of "curriculum prescriptions" and textbooks, developing note-writing skills in order to enhance their knowledge-building capacity. Students will be assessed based on rubrics, gaining a clear understanding of assessments, and learning from giving and receiving constructive comments through peer feedback. Work will be differentiated to cater for different learning styles, through the use of audio, visual, pictorial, graphic representations, texts and e-learning. Students and teachers will give formative feedback which focuses on goal-setting in order for students to better achieve learning objectives.

1.2.2 Secondary Three

Teachers will provide students with an appropriate level of curriculum and reasonable expectations to suit individual capabilities and to engage students in the process of learning. Students will be encouraged to enquire beyond the confines of "curriculum prescriptions" and textbooks, and to process information and make their own judgments in order to enhance their knowledge-building capacity. Different modes of grouping will be used to facilitate the learning process, as well as to provide enough challenging tasks to students with different abilities. To address the needs of students with different learning styles, teachers will make diversified use of learning materials, such as audio, visual, pictorial, graphic representations, and texts, etc. To promote effective learning, teachers will give informal feedback during learning and teaching processes or more formal feedback in assessment events. The feedback will focus on what students could do to achieve the learning objectives or improve learning further. Community resources will also be drawn upon to contribute to school-based programmes.

1.3 Assessment

A variety of approaches and styles will be used for assessing what students are capable of. In Secondary One and Two, they will be required to run scientific investigations through experimentation, present their project work during exhibitions, and complete a series of concepts check exercises, experimental-skills tests, end-of-module tests and a year-end examination. Self-assessment and peer feedback will be used to report students' achievement and teacher feedback, written or verbal, will help students understand their strengths and areas for development to enhance student learning in everyday lessons and beyond.

From Secondary Three onwards, model-making, essay writing and laboratory reports will also be included in assessment. The focus of the formative assessments is to gauge how students can improve rather than just determining what has been learned: this knowledge reveals the best ways that individuals learn so that teachers can help students progress more effectively.

2. The Aims and Objectives of Science, S1 – S3

HKUGAC science aims to provide a worthwhile educational experience for all students, and participation in science enables students to

- Actively develop skills that are relevant and useful to the study and practice of science in everyday situations
- Acquire understanding and knowledge of concepts, principles and applications through rigorous investigation and research
- Become confident and responsible citizens in a rapidly changing world, able to develop an informed interest in issues on various scales
- Recognize the usefulness and limitations of a scientific approach and appreciate its applicability to other disciplines and everyday life
- Develop an awareness of factors that affect health and innovations in current understanding in order to optimise the health of themselves and others
- Develop a positive attitude toward the conservation of natural resources and the preservation of the environment
- Realise that science does not provide the answers to all problems
- Develop curiosity, interest and enjoyment in science, its methods of enquiry and the innovations it can bring about
- Develop an awareness of science as an increasingly international activity requiring responsible approaches at all levels

Students can also make use of their experience to decide whether or not to go on to study science beyond S3.

3. Curriculum

3.1 Secondary One

3.1.1 Scientific Practices

What practical skills will students use within the laboratory? What methods are used by scientists in the generation of scientific knowledge? How can we conduct a scientific investigation?

3.1.2 Looking at Living Things

What are living things? What are the processes that characterize life? How are these processes carried out? What are the different kinds of living things in nature? Why is the classification of living things necessary? How are living things divided into groups? What is the basic unit of living things? How is a microscope used to observe small objects? What are the basic parts of a cell? How are they related to each other? What are their functions in living organisms? How to use a microscope?

3.1.3 Human Reproduction and Heredity

Why do living things need to reproduce? What are the different kinds of reproduction? What does each part of the reproductive system do? What are the signs of sexual maturity in boys and girls? What is pregnancy? How pregnancy carries out? What is the menstrual cycle? What are the birth control methods? What are sexually transmitted diseases (STDs) and how can they be prevented?

3.1.4 Earth and Space

What is gas pressure? How does air pressure affect our daily life? What is a vacuum? Are all substances categorized into three states easily? What is particles theory? What is Brownian motion? How do we smell? What makes an object float on or sink in water? Why do different substances have different densities? How can we find out the densities of solids and liquids?

3.1.5 Matter and Energy

What are the three states of matter? How does the particle model help explain some physical phenomena in our daily life? How does the change of temperature affect the state of matter? How do the particle models help us understand the behaviour of particles in solid and liquid? What makes an object float on or sink in water? Why do different substances have different densities? How can we find out the densities of

solids and liquids? What is energy? How is energy transferred and stored? How do humans use fuels? How do humans use other energy resources? How can humans make changes to save the environment?

3.2 Secondary Two

3.2.1 Scientific Practices II

A quick recap of the following: What practical skills will students use within the laboratory? What methods are used by scientists in the generation of scientific knowledge? How can we conduct a scientific investigation?

3.2.2 Living Things and Air

Where do we get energy? How do plants get energy for growth? What food do plants make? What are the necessary conditions for plants to make their own food? What is the structure of the human breathing system? How is gaseous exchange in plants different from that in animals? What are the common air pollutants? How does air pollution affect our health?

3.2.3 Sensing the Environment

What are our senses? What are our sense organs? How do we depend on our senses? How do we see? What are the limitations of our eyes? What are the common types of eye defects? What are the causes of eye defects? How do we hear? How is sound produced and transmitted? What are the limitations of our ears? How is the loudness of sound measured? How do we taste and smell? Does smell affect taste? What is our skin sensitive to? How is our brain related to the senses? Is our brain always correct?

3.2.4 Making use of Electricity

What are the common energy sources in daily life? What are open circuit and closed circuit? What is the difference between electrical conductors and insulators? How do we draw a circuit diagram? What is a series circuit? What is a parallel circuit? What is the function of a fuse? Why is 'earthing' of electrical appliances so important? What will happen when there is a short circuit? How is electrical energy related to electrical power? How do we calculate the cost of electricity? What will happen if a current passes through a coiled wire?

3.2.5 Force and Motion

What is the relationship between average speed, distance and time? How to represent and interpret a motion using a distance–time graph? What is force? What are the effects of force on the motion of an object? How is force measured? What is the unit of force? What is friction? How can friction be reduced? What is the force of gravity? What is the relationship between mass and weight? Is the weight of an object on the Earth different from those on other planets? What is the principle behind the launching of a rocket into space? How does the spacecraft move in space? How can the spacecraft land on the Earth safely?

3.2.6 Common Acids and Alkalis

What are some common examples of acids and alkalis in daily life? How do we distinguish acids from alkalis by natural indicators? What are some commonly used acids and alkalis in the lab? How do we distinguish acids from alkalis in the lab? Why is it important to keep the right pH? How does the corrosive effect of acids affect us? What is neutralization? What is the potential danger when handling acids and alkalis? What happens when concentrated acids and alkalis are diluted?

3.3 Secondary Three

3.3.1 Physics

3.3.1.1 General Physics

What is Physics? How do we measure different physical quantities? What are SI units? How do we notate a very large or a very small quantity?

3.3.1.2 Temperature and Heat

What is Temperature? How to measure it? What is Celsius Scale? What is heat? What is thermal equilibrium? What is internal energy? How does heat transfer from one body to another? What is the definition of power? How to increase the internal energy of a body? What is heat capacity? What is specific heat capacity? What is the importance of the high specific heat capacity of water?

3.3.1.3 Optics

How is light reflected by a plane mirror? How does light behave when it passes through a boundary? How can we find out the speed of light in different media? What is Snell's Law? What is Refractive Index? What is Total Internal Reflection?

3.3.1.4 Motion

What is Time? What are the differences between Scalar Quantities and Vector Quantities? How do we use equations to describe motion? How do we relate displacement, velocity and acceleration?

3.3.2 Chemistry

3.3.2.1 General Chemistry

What is Chemistry? What are Physical properties and Chemical properties?

3.3.2.2 Atomic Structure

What are the chemical symbols for common elements? What is an atom? What are the meanings of atomic number and mass number of an atom? What information can be provided from the atomic symbol like "$^{23}_{11}Na$"? What do 'isotopes' mean? What are the relationships between isotopic masses and relative atomic masses? How can we represent the electronic arrangements of atoms using electron diagrams?

3.3.2.3 Periodic Table

How are the elements in the Periodic Table arranged? How are the electronic arrangements of Group I, II, VII and VIII / 0 related to their chemical properties?

3.3.2.4 Bonding and structures of chemical compounds

What are anions / cations? What are the colours of ions in aqueous solution? What is chemical bonding? What is ionic bonding? How can we draw electronic diagrams of simple ionic compounds? What is covalent bonding? What is the meaning of formulae mass? How do we detect the presence of different cations and anions? What is dative covalent bonding? What are the four types of chemical structure in general? What are the properties of different chemical structures? How to identify the structures of a chemical based on their physical properties?

3.3.2.5 Planet Earth

What is the composition of air? What is the separation method of separating oxygen and nitrogen from liquid air? What is the composition of seawater? How to extract common salt and isolate pure water from sea water? How does electrolysis of seawater work? How are metals extracted from their ores? What are the different forms of calcium carbonate and what are its reactions? How to show the presence of calcium and carbonate in a sample of limestone/chalk/marble? What are mixtures and compounds? How can crude oil be converted to different useful fractions? What are the uses of each fraction? What are the environmental problems related to crude oil and its fractions?

3.3.2.5 Metals and Alloys (extension)

What is the relationship between metals and their ease of extraction and availability? What are some metals that occur in elemental form and in compound form in nature? What are some common properties and uses of metals? What are alloys and their uses?

3.3.3 Biology

3.3.3.1 Molecules of Life

What are the organic and inorganic constituents of organisms? What are carbohydrates, lipids, proteins and nucleic acids? What are their functions?

3.3.3.2 Cells – the basic units of life

What are cells? How were cells discovered? What is a microscope? How did technological developments of microscopes contribute to the discovery and understanding of cells and organelles? How are cells organized to perform functions? How are cells organized in multicellular organisms? Why is this organization important?

3.3.3.3 Movement of substances across membranes

How do different substances move across the membranes of a cell? What are diffusion, osmosis, active transport and phagocytosis? Why are these processes important?

3.3.3.4 Metabolism and enzymes

What is metabolism? What are enzymes? What is their role in metabolism? What are the properties of enzymes? How does an enzyme work? What factors affect the rate of enzymatic reactions? What are the applications of enzymes in everyday life? What are the functions of enzymes in the human body?

3.4 Delivery schedule

3.4.1 S.1 – S.2 Delivery Schedule

<table>
<tr><th>Term</th><th>Subject / Cycle</th><th>S1 Science</th><th>S2 Science</th></tr>
<tr><td rowspan="10">1</td><td>1</td><td rowspan="2">Scientific Practice</td><td rowspan="2">Scientific Practice II</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="4">Looking at Living Things</td><td rowspan="4">Living Things and Air</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td rowspan="4">Human Reproduction and Heredity</td></tr>
<tr><td>8</td><td rowspan="3">Sensing the Environment</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
<tr><td rowspan="9">2</td><td>1</td><td rowspan="3">Earth and Space</td><td rowspan="2">Making Use of Electricity</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="3">Force and Motion</td></tr>
<tr><td>4</td><td rowspan="4">Matter and Energy</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td rowspan="2">Acids and Alkalis</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td>Consolidation</td><td>Consolidation</td></tr>
</table>

3.4.2 S.3 Delivery Schedule

<table>
<tr><th>Term</th><th>Subject Cycle</th><th>Physics</th><th>Chemistry</th><th>Biology</th></tr>
<tr><td rowspan="11">1</td><td>1</td><td>Introduction</td><td>Introduction</td><td>Introduction</td></tr>
<tr><td>2</td><td rowspan="6">Temperature and Heat</td><td rowspan="3">Atomic Structure,
Periodic Table</td><td rowspan="2">Molecules of life</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="5">Cells – the basic unit of life</td></tr>
<tr><td>5</td><td rowspan="8">Bonding and Structure of chemical compounds</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="6">Optics</td></tr>
<tr><td>9</td><td rowspan="3">Movement of substances across membranes</td></tr>
<tr><td>10</td></tr>
<tr><td rowspan="10">2</td><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="5">Metabolism and enzymes</td></tr>
<tr><td>4</td><td rowspan="5">Planet Earth
+ Metals & Alloys</td></tr>
<tr><td>5</td><td rowspan="3">Motion</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td>Consolidation</td><td>Consolidation</td><td>Consolidation</td></tr>
</table>

4. Assessment

4.1 Assessment Criteria

4.1.1 Assessment of Knowledge and Understanding

Students should be able to demonstrate knowledge and understanding in relation to

1. phenomena, facts and concepts in science;
2. scientific vocabulary and terminology;
3. application of concepts to familiar and unfamiliar situations;
4. application of science in society and students' everyday life.

Oral questioning, class assignments, module tests and examination can be used to allow students to demonstrate their understanding and creative ideas.

4.1.2 Application of Scientific Processes

Students should be able to

1. ask relevant questions, identify problems and formulate hypotheses for investigations;
2. select and apply facts and concepts learnt to solve problems;
3. plan scientific investigations individually and collaboratively with appropriate instruments and methods;
4. collect and analyse data, make further predictions, draw conclusions and present scientific information effectively.

Project work provides excellent opportunities for students to apply what they have learnt. Investigative projects, in particular, are suitable for assessing enquiry skills such as identifying problems, formulating hypotheses and designing strategies to solve problems scientifically and creatively.

4.1.3 Assessment of Experimental Skills

Students should be able to

1. handle apparatus and chemicals safely and properly;

2. carry out instructions for experiments;

3. observe and describe objects and experimental results accurately;

4. select appropriate apparatus and suggest experimental procedures.

The most suitable method for assessing science skills is practical assessment. Students are required to perform a number of practical tasks. They are expected to make use of their knowledge and understanding of science in performing these tasks. Through these practical tasks, students' practical, process and generic skills will be developed and assessed.

4.1.4 Assessment of Attitudes

Students should

1. develop curiosity and interest in science;
2. be aware of the importance of the safety of oneself and others in the laboratory and be committed to safe practices in daily life;
3. develop personal integrity through honest recording of experimental data;
4. develop an awareness of scientific advancement and its social, economic, environmental and technological implications;
5. be willing to communicate and comment on issues related to science and respect the decisions of others;
6. develop a positive attitude in enhancing personal and community health;
7. show concern for the care of the environment and a willingness to contribute to it.

Attitudes such as curiosity, perseverance, care and concern for living things, and cooperation with others are important in science learning. As these attitudes take time to develop, their assessment should take place over a period of time to show the progress that students have made. Some common means of assessing attitudes include, observing behaviour, asking students to write essays, and using questionnaires.

4.2 Weighting of component parts

- S1 to S2

Component	Weighting
Continuous assessment ● Knowledge and understanding ● Communication in science ● Scientific inquiry ● Practical skills	60%
Examination	40%

- S3

Component	Weighting
Continuous assessment ● Science experiments ● Quizzes and tests ● Assignments and projects ● Preparation task before lesson ● Uniform tests	60%
Examination	40%

4.3 The role of parents at home and homework

In S1 and S2 science, students are assessed through continuous assessment. Projects, laboratory reports and note writing are given to students for learning and for assessment purposes. Class time may be given for designated tasks to be completed and students' participation in tasks during lessons will be assessed. To achieve effective learning, the Science Department suggests students conduct research through the internet or reading of books, watching documentaries and writing down questions to be raised in lessons. Self-motivation is generally very difficult for students of this age and parents may need to assist them in structuring their time. They should aim for approximately 20 mins after each lesson to consolidate their notes based on the activities conducted that day.

In S3 science, students will be learning Physics, Chemistry and Biology as three different subjects at different times of the year. Assignments will be given. Efficient time management is essential for students to be successful in these subjects. Lesson preparation is essential for S3 science curriculum. Quizzes or lesson preparation tasks will be given as a means to promote effective learning. Students are encouraged to come to each lesson with full preparation and questions to be asked. Parents may review tasks assigned to your child in order to obtain a better understanding of his / her learning situation in the subject. Zero marks will be awarded in cases of late submission of homework.

4.4 E-learning

E-learning has long been implemented in the curriculum of Junior Science. It is broadly inclusive of all forms of educational technology in learning and teaching, such as multimedia learning, computer-aided instruction, internet-based training, web-based training, online education, virtual education, etc. E-learning is a valuable way to boost engagement through interactive learning which complements strategies for learning both inside and outside the classroom.

Through computer animations or simulations, students can visualize abstract concepts and processes. They also allow students to work at their own pace and according to their individual needs, and give them more time to pursue creative activities. In addition, e-learning may extend students' learning through the internet, which is an extremely valuable source of scientific information and resources. The internet may also provide opportunities for students to learn, often collaboratively, with students in another part

of the world. Through the use of electronic media, we aim to provide students with an enriched and more efficient learning environment; enhanced self-directed learning that meets their varied learning needs. These innovations should help students to gradually develop into lifelong learners.

5. Guideline on AI-assisted Learning

Guideline on AI-assisted Learning

Artificial intelligence (AI), including Generative AI, could serve as an effective tool for assisting science learning. This section provides examples of using AI to assist learning in science and general reminders.

Examples of AI-assisted learning in science

1. **Research and organization of information**
   Information such as scientific concepts, real-life examples, and data, could be obtained from generative AI. AI could also be used to organize large amounts of information for clear presentation.

2. **Feedback**
   Generative AI could provide feedback on student work based on given criteria to improve the quality of work and assess the accuracy.

3. **Language support**
   By inputting the work in generative AI, the grammar and clarity of the work could be checked

4. **Exploration and brainstorming**
   Exploration of topics and generation of ideas for project work could be achieved using generative AI.

General reminders for using AI in science

1. **Verification of information**
   Students should assess the accuracy of scientific concepts and the reliability of examples/data with their judgment and other sources. Information obtained from generative AI may not always be correct.

2. **Learning effectiveness**
   There are multiple ways of learning. AI is not the only way for students to learn. Students should consider different learning styles and make good use of different learning strategies, instead of solely relying on AI. Moreover, information obtained from AI should be processed cognitively by students, instead of simply performing "copy and paste".

3. **Quality of prompts**
   Prompts inputted into generative AI should be specific. More details and conditions allow responses that better suit your needs to be generated.

Guideline on ethical use of AI (Important)

General guideline

Respect Intellectual Property
Students must observe copyright laws and understand the importance of giving proper credit to the original creators of any content they use or modify. When using AI-generated text or other content, students must properly **cite the source** and **acknowledge the use of the AI tool**.

Avoid Misinformation
Students should recognize the potential dangers of AI-generated content, including the spread of **misinformation**. Students should **cross-reference** AI-generated content with reliable sources and think critically about the information's validity.

Privacy and Security
Students must be aware of **privacy** and **security** concerns when using AI tools. Students need to protect their **personal information** and use secure platforms when accessing these tools. Students should be informed about the data collection and use practices of AI tool providers and be mindful of the potential risks associated with sharing personal data.

AI policy in science
Penalty will be given to students with inappropriate use of AI in their work including assignments, projects, etc.

- Students are suggested to keep the original work before being modified by AI. The original work may be requested to be submitted to verify the originality of the submitted work.
- Mark penalty could be given for work with content generated by AI without proper citation and acknowledgment. A zero mark could be given in serious cases. Follow-ups and further disciplinary actions could be taken.
- Students may be asked to redo and resubmit their work if the AI policy is violated.

Other Reminders

- Students should consult their subject teachers for anything uncertain about the use of AI in science subjects.