Physics (S5 - S6)

1. Introduction

Physics is one of the fundamental natural sciences. It involves the study of universal laws, and of the behaviours and relationships among a wide range of physical phenomena. Through the learning of physics, students will develop scientific literacy and the essential scientific knowledge and skills for lifelong learning in science and technology. At HKUGAC, the physics course will provide a platform for acquiring conceptual and procedural knowledge relevant to daily life. With a solid foundation in physics, students should be able to appreciate both the intrinsic beauty and quantitative nature of physical phenomena, and the role of physics in many important developments in engineering, medicine, economics and other fields of science and technology. In addition, students are being prepared to sit for the International Advanced Subsidiary/ Advanced Level examination in physics in S5 and S6.

Teaching methods

The key knowledge, understanding, skills, values and attitudes that students are to develop at senior secondary level are embodied in the appropriate level of curriculum.

1.1 Knowledge, understanding, and skills

Students will be given opportunities to demonstrate and apply the knowledge, understanding and skills described in the content. They are also expected to analyse, interpret and evaluate a range of scientific information, ideas and evidence using their knowledge, understanding and skills. To demonstrate their knowledge, students will undertake a range of activities, including the ability to recall, describe and define, as appropriate. To demonstrate their understanding, students will learn how to explain ideas and use their knowledge to apply, analyse, interpret and evaluate, as appropriate. Throughout the course, students will develop their ability to apply mathematical skills to physics.

1.2 Problem-based learning

A series of lessons will be provided to train students in appropriate strategies to deal with issues that may arise. Students will be expected to clarify and analyze problems related to physics. During which, they will apply knowledge and principles of physics to solve problems or suggest creative ideas or solutions to problems.

1.3 Issue-based learning

Inquiry activities will be provided that will help students make decisions based on the examination of evidence and arguments. Students will be challenged to support judgments using appropriate scientific principles and put forward suitable reasoning to choose between alternatives.

1.4 Embedding of learning in real-life issues

By reading the latest research and industry products, students will be expected to appreciate the relationship between physics and other disciplines, and to be aware of the interconnections among science, technology, society and the environment in contemporary issues, thereby becoming responsible citizens.

2. Aims and objectives

Physics education is to provide physics-related learning experiences for students to develop scientific literacy, so that they can participate actively in our rapidly changing knowledge-based society, prepare for further studies or careers in fields related to physics, and become lifelong learners in science and technology. The aims and objectives of the curriculum are to enable students to develop:

1. essential knowledge and understanding of different areas of the subject and how they relate to each other;
2. a deep appreciation of the skills, knowledge and understanding of scientific methods;
3. competence and confidence in a variety of practical, mathematical and problem-solving skills;
4. their interest in and enthusiasm for the subject, including developing an interest in further study and careers associated with the subject.

3. Curriculum

The curriculum is based on the International Advanced Subsidiary (IAS)/ International Advanced Level (IAL). The assessment objectives are listed below:

1. Demonstrate knowledge and understanding of physics;
2. Application of knowledge and understanding of science in familiar and unfamiliar contexts;
3. Analysis and evaluation of scientific information to make judgements and reach conclusions; and
4. Experimental skills in science, including analysis and evaluation of data and methods.

3.1 Curriculum framework

	Topics
S5	Revision of topics learned in S4: • Force and Motion • Energy and Momentum • Wave Motion • Nature of Light
	Electric Circuits Students should be able to: • define electric current, voltage, and resistance • determine the electrical resistivity of a material experimentally • explain the large range of resistivities of different materials • sketch, recognise and interpret current-potential difference graphs for components, including ohmic conductors, filament bulbs, thermistors and diodes • understand how changes of resistance may be modelled in terms of lattice vibrations and number of conduction electrons • understand the principles of a potential divider circuit • derive and use the equations for combining resistances in series and parallel using the principles of charge and energy conservation • understand e.m.f. and internal resistance, and determine them experimentally • derive and use the equations for electrical power
	Further Mechanics Students should be able to: • understand the relationship between the force exerted on an object and its change of momentum • apply conservation of linear momentum to problems in two dimensions • determine whether a collision is elastic or inelastic • express angular displacement in radians and in degrees • understand and use the equations for angular velocity • derive and use the equations for centripetal acceleration • understand that a resultant force (centripetal force) is required to produce and maintain circular motion, and use the equations for centripetal force
	Electric Fields Students should be able to: • understand that an electric field is defined as a region where a charged particle experiences a force • define and use the equations for electric field strength • understand the relationship between electric field and electric potential

	• draw and interpret diagrams using field lines and equipotentials to describe radial and uniform electric fields • use Coulomb's law to calculate the force between two charges
	<u>Capacitors and Electromagnetism</u> Students should be able to: • define and use the equations for capacitance • derive and use the equations for the energy stored by a capacitor • draw and interpret charge and discharge curves for resistor capacitor circuits • understand the significance of the time constant • derive and use related equations for exponential discharge in a resistor-capacitor circuit and the corresponding log equations • understand and use the terms magnetic flux density, flux, and flux linkage • use the equations and apply Fleming's left-hand rule to charged particles and current carrying conductors in a magnetic field • understand the factors affecting the e.m.f. induced in a coil • use Faraday's law and Lenz's law
	<u>Nuclear and Particle Physics</u> Students should be able to: • understand nuclear models of atom • understand the role of electric and magnetic fields in particle accelerators (linac and cyclotron) and detectors (general principles of ionisation and deflection only) • derive and use the equation for a charged particle in a magnetic field • apply conservation of charge, energy and momentum to interactions between particles and interpret particle tracks • classify standard quark-lepton model particles • use the properties of a particle to deduce the properties of its antiparticle and vice versa • use laws of conservation of charge, baryon number and lepton number to determine whether a particle interaction is possible
S6	<u>Thermodynamics</u> Students should be able to: • use the equations for specific heat capacity and specific latent heat • understand the concepts of internal energy and absolute zero • use the ideal gas equation • use the kinetic theory equation
	<u>Nuclear Decay</u> Students should be able to: • understand the relationships between the nature, penetration, ionising ability and range in different materials of nuclear radiations (alpha, beta and gamma) • write and interpret nuclear equations given the relevant particle symbols • understand the spontaneous and random nature of nuclear decay

	• determine the half-lives of radioactive isotopes graphically • use the equations for radioactive decay and derive the corresponding log equations • understand the processes of nuclear fusion and fission with reference to the binding energy per nucleon curve • use the equation for mass-energy equivalence in calculations of nuclear mass (including mass deficit) and energy
	<u>Oscillations</u> Students should be able to: • understand the condition for simple harmonic motion and identify situations in which simple harmonic motion will occur • use equations for a simple harmonic oscillator and a simple pendulum • draw and interpret displacement-time graph and velocity-time graph for an object oscillating • understand resonance • apply conservation of energy to damped and undamped oscillating systems
	<u>Astrophysics and Cosmology</u> Students should be able to: • understand that a gravitational field is defined as a region where a mass experiences a force • define and use the equations for gravitational field strength • use Newton's law of universal gravitation • understand black body radiator and interpret radiation curves • use Stefan-Boltzmann law equation • use Wien's law equation • relate intensity, luminosity, and distance from the source • understand how astronomical distances can be determined using trigonometric parallax and measurements of intensity received from standard candles • sketch and interpret a simple Hertzsprung-Russell diagram and relate it to the life cycle of stars • understand Doppler effect

3.2 Delivery schedule

	S5	S6
1st term	Electric Circuits Further Mechanics Electric Fields	Nuclear and Particle Physics Thermodynamics Nuclear Decay Oscillations Astrophysics and Cosmology
2nd term	Capacitors Electromagnetism Nuclear and Particle Physics	

4. Assessment

4.1 Internal assessment

4.1.1 Assessment criteria

4.1.1.1 Assessment of knowledge and understanding

Students are expected to:

1. understand phenomena, facts and patterns, principles, concepts, laws, theories and models in physics;
2. learn the vocabulary, terminology and conventions used in physics;
3. acquire knowledge of techniques and skills specific to the study of physics; and
4. develop an understanding of technological applications of physics and of their social implications.

Preparation exercises, presentations, oral questioning, class assignments, module tests and an examination will be used to enable students to demonstrate their understanding and creative ideas.

4.1.1.2 Assessment of skills and processes

Students are expected to:

1. identify attributes of objects or natural phenomena;
2. examine evidence and apply logical reasoning to draw valid conclusions;
3. integrate concepts within a framework of knowledge, and apply this to new situations;
4. select appropriate methods and apparatus to carry out investigations;
5. evaluate experimental methods and suggest possible improvements;
6. support judgments using appropriate scientific principles;
7. use information technology to manage and present information, and to develop habits of self-directed learning; and
8. organize, present and communicate physics ideas in a vivid and logical manner.

Project work and practical exercises provide excellent opportunities for students to apply what they have learnt. Investigative projects, in particular, are suitable for assessing enquiry skills such as problem-solving, decision-making, information handling and communication and collaboration skills.

4.1.1.3 Assessment of values and attitudes

Students are expected to:

1. possess and develop positive values and attitudes such as curiosity, honesty, respect for evidence, perseverance and tolerance of uncertainty through the study of physics;
2. develop a habit of self-reflection and the ability to think critically;
3. develop open-mindedness and be able to show tolerance and respect towards the opinions and decisions of others even in disagreement;
4. be aware of the social, economic, environmental and technological implications of the achievements in physics;
5. recognize the consequences of the evolutionary nature of scientific knowledge and understand that constant updating of knowledge is important in the world of science and technology; and
6. recognize the importance of lifelong learning in our rapidly changing knowledge-based society.

4.1.2 Weighting of component parts

Component	Weighting	
	S5	S6
Continuous assessment ➢ Scientific investigations ➢ Experimental skills ➢ Quizzes and tests ➢ Assignments ➢ Preparation tasks before lessons	40%	
Examination	60%	

4.1.3 Grading system

The International Advanced Subsidiary in Physics will be graded on a five-grade scale from A to E. The International Advanced Level in Physics will be graded on a six-point scale A* to E.

4.2 E-learning

E-learning has been implemented in the curriculum of physics, including 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. It also provides an interactive channel for sharing between groups of students and the teacher, which complements strategies for learning both inside and outside the classroom.

E-learning also allows students to work at their own progress, and gives 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 the most updated scientific information and resources. Through the use of electronic media, we aim to provide students with an enriched and efficient learning experience, to enhance self-directed learning, and meet their varied learning needs.

4.3.1 Practical related tasks

Students are required to carry out a variety of practical work to develop their practical skills. This should help them to gain an understanding and knowledge of the practical techniques that are used in experimental work. In order to prepare students for the assessment, students will be given opportunities to plan experiments, implement their plans, collect data, analyse their data and draw conclusions. Experiments will cover a range of different topic areas and require the use of a variety of practical techniques. Students will be expected to apply their knowledge and understanding of practical skills to familiar and unfamiliar situations in assessments and examinations.

4.3.2 Non-practical related tasks (Optional)

Students are required to perform a number of non-practical related tasks. The inclusion of non-practical related tasks is to enhance the integration of the curriculum, teaching and assessment. To this end, the assignment tasks adopted should cover one or more of the curriculum content areas and one or more of the generic skills such as creativity, critical thinking, communication skills and problem-solving skills. Examples of such tasks include: reading critically; evaluating and reporting on the work of some physicists; designing posters/pamphlets/webpages on physics-related issues; reporting on physics knowledge and concepts acquired after a visit to a power station or the Science Museum; and building models or using IT tools to illustrate concepts of physics. Teachers can employ different means of assessing their students as appropriate. Such assignments will also be an integral part of the investigative study.

5. Role of parents at home and homework

Interest and effective learning are the key to success in the subject. To ensure effective learning in class time, students are encouraged to come fully prepared to each lesson. A preparation and reflection book system are used as a means to promote effective learning. Homework and module quizzes consolidate, reinforce and strengthen concepts learnt in class and help teachers assess the performance of students. Self-motivation for learning an interesting subject generally gives a better outcome. Zero marks will be awarded in cases of late submission of homework. Parents are encouraged to talk to their son or daughter about the work done in class and the current learning topics in order to have a better understanding of their child’s learning progress in the subject and to provide an opportunity for students to revisit topics after class.

6. Guidelines for using Artificial Intelligence (AI)

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.