PHYSICS

INTRODUCTION

The CE Physics syllabus builds upon the CDC Syllabus for Science (Secondary 1-3), in which some basic physics concepts on Force and motion, Energy, Electricity and Light have been introduced. Based on students' prior knowledge and their everyday experiences, some fundamental principles of physics in the above areas are further developed in this syllabus. Other topics are also introduced to provide a coherent and comprehensive view of the world of physics. Apart from knowledge and understanding, the syllabus also calls for an increasing emphasis on skills and processes, values and attitudes. The syllabus has been developed in conjunction with the CDC Curriculum Guide for Physics (Secondary 4-5). Reference should be made to the Curriculum Guide and other supporting resource materials developed by the Science Section of the Education and Manpower Bureau for the learning and teaching of this course.

Scientific investigation and practical work are essential to the study of Physics. Through hands-on practical activities, students should acquire the relevant skills identified in the objectives and in the contents of individual sections of the syllabus. Upon completion of this course, candidates, in addition to demonstrating the acquisition of a certain amount of knowledge and principles in physics, are expected to display skills in carrying out scientific investigation and practical work. In the examination, the questions set will be based on the assumption that candidates have had appropriate hands-on experience of investigation and practical work relevant to the syllabus.

Self-learning skills are essential for students to become active life-long learners in science. Students should independently read scientific articles of appropriate depth so that they can develop the ability to read, interpret, analyse and communicate scientific information. Students' exposure to a wide variety of articles will also serve the purpose of broadening and enriching the curriculum. The factual knowledge acquired is of relatively minor importance and rote-memorisation should not be encouraged. In the examination, emphasis will be placed on assessment of information-handling and communication skills.

Physics is closely related to our society and environment. Students need to develop an awareness of the impact and role of physics in society and the environment and the interconnections between science, technology and society.

Acknowledging the fact that candidates may have a wide range of abilities, the syllabus has been designed to allow flexibility in teaching and learning. The content of this syllabus is divided into two parts: the ***Core*** and the ***Extension***. The Core represents the basic and fundamental components of knowledge of physics that all candidates should strive to learn. The Extension includes additional topics that may require candidates to exercise higher order skills in order to master the knowledge involved. For some candidates, it will be beneficial, less stressful and more effective to concentrate on the Core so that more time is available to master the basic knowledge while for high-achievers, the challenges provided by the Extension may provide a fuller sense of achievement.

AIMS

The broad aims of the course are to enable students to

1. develop interest, motivation and a sense of achievement in the study of physics;
2. develop an appreciation of the nature of physics, the historical and current development in physics;
3. understand the fundamental principles and concepts of physics and its methodology;
4. develop an awareness of the relevance of physics to their daily life;
5. acquire the basic scientific knowledge and concepts for living in and contributing to a scientific and technological world;
6. recognize the usefulness and limitations of science and the interactions between science, technology and society;
7. develop an attitude of responsible citizenship, including respect for the environment and commitment to the wise use of resources;
8. develop the ability to describe and explain concepts, principles, systems, processes and applications related to physics using appropriate terminologies;
9. develop skills relevant to the study of physics such as scientific investigation, problem solving, experimental technique, collaboration, communication, mathematical analysis, information searching and processing, analytical and critical thinking and self-learning;
10. develop positive values and attitudes towards physics, themselves and others through the study of physics;
11. carry out further studies and embark upon careers in fields related to physics; and
12. recognize the role of the applications of physics in the fields of science, engineering and technology.

Most of the above aims are reflected in the assessment objectives, while some are not because they cannot be translated readily into measurable objectives. All, however, are essential aims for the course.

ASSESSMENT OBJECTIVES

The objectives of the examination are to assess candidates' abilities

1. to recall and understand the knowledge and principles of physics set out in the syllabus;
2. to apply the knowledge and principles of physics set out in the syllabus to solve problems involving familiar or unfamiliar situations;
3. to understand the applications of physics in different contexts and their social, economic and environmental implications;
4. to observe, describe and present explanations for phenomena, patterns and relationships;
5. to apply scientific thinking and logical reasoning skills to examine theories and concepts, make predictions and hypotheses, and draw valid conclusions;
6. to understand the use of scientific instruments and apparatus, including techniques of operation, essential precautions and safety aspects;
7. to devise plans and procedures for scientific investigation and practical work, including the selection of techniques, apparatus, measuring devices and materials;
8. to analyse and interpret information and results obtained in scientific investigation and practical work, identify patterns or trends, and draw valid conclusions;
9. to evaluate and suggest possible improvements on methods used in scientific investigation and practical work;
10. to read, understand, select and interpret scientific information from a variety of sources, including everyday experience;
11. to organize, present and communicate scientific information in appropriate forms (including written, symbolic, diagrammatic, graphical and numerical);
12. to evaluate scientific information and make informed decisions or judgements, based on social, economic, environmental and technological considerations.

THE EXAMINATION

The examination will consist of two papers : Papers 1 and 2. Each paper will consist of two sections : Section A will comprise questions set on the Core of the syllabus, while Section B will comprise questions set on the whole syllabus. In each paper, all questions are compulsory. Details of the two papers are as follows:

		Paper 1	**Paper 2**
Weighting		60%	40%
Duration		1 hour 45 minutes	1 hour
Question format		All are conventional questions.	All are multiple-choice questions.
Paper format	Section A (60% of paper mark)	Consists of 8 to 10 questions set on the Core of the syllabus.	Consists of questions set on the Core of the syllabus.
	Section B (40% of paper mark)	Consists of 3 to 5 questions set on the whole syllabus.	Consists of questions set on the whole syllabus.

Note :
1. In general, questions in Section B of both papers will be at a higher level of difficulty than those in Section A.
2. Candidates will be expected to have acquired knowledge of the physics components of the Core part of the CDC Secondary 1-3 science curriculum.
3. Questions involving unfamiliar contexts or daily-life experiences may be set to assess candidates' problem-solving and higher-order processing skills. In answering such questions, sufficient information will be given for candidates to understand the situation or context. Candidates are expected to apply their knowledge and skills included in the syllabus to solve the problems.
4. Questions involving apparatus not mentioned in the syllabus, e.g. data-loggers, may be set; however, the operating principles and procedures for those apparatus will not be assessed.
5. In general, SI units and terminology will be used.
6. Appendix 1 shows the common circuit symbols to be used in the examination papers.

THE SYLLABUS

The syllabus content is divided into five sections. It must be emphasized that the concepts and principles of physics are inter-related and should not be confined by an artificial boundaries of sections. In the syllabus, the Extension topics are underlined.

Section 1 Heat

This section introduces the concept of internal energy and energy transfer processes related to heat. Candidates should possess experimental skills in temperature and energy measurement. The precautions essential for accurate measurements in heat experiments should be understood in terms of the concepts learnt in this section. Candidates should be expected to suggest methods for improving the accuracy of these experiments.

1.1 Temperature, heat and internal energy

temperature and thermometers	• temperature as the degree of hotness of an object • interpretation of temperature as a quantity associated with average kinetic energy due to the random motion of the molecules in a system • use of temperature-dependent properties to measure temperature • degree Celsius as a unit of temperature • fixed points on the Celsius scale
heat and internal energy	• heat as the energy transferred resulting from the temperature difference between two objects.

		internal energy as the energy stored in a system interpretation of internal energy as the sum of the kinetic energy of random motion and the potential energy of the molecules in a system
	heat capacity and specific heat capacity	definitions of heat capacity and specific heat capacity application of the formula $Q = mc(T_2–T_1)$ to solve problems practical importance of the high specific heat capacity of water
1.2	**Transfer processes**	
	conduction, convection and radiation	conduction, convection and radiation as means of energy transfer interpretation, in terms of molecular motion, of energy transfer by conduction in solids and by convection in fluids emission of infra-red radiation by hot objects factors affecting the emission and absorption of radiation
1.3	**Change of state**	
	melting and freezing, boiling and condensing	melting point and boiling point

latent heat	latent heat as the energy transferred during a change of state at constant temperature interpretation of latent heat in terms of the change of potential energy of the molecules during a change of state definitions of specific latent heat of fusion and specific latent heat of vaporization application of the formula $Q = mL$ to solve problems
evaporation	occurrence of evaporation below boiling point cooling effect of evaporation factors affecting rate of evaporation interpretation of evaporation in terms of molecular motion

Section 2 Mechanics

In this section, some fundamental knowledge of mechanics are introduced. Candidates are expected to possess experimental skills in time measurement and in the recording of displacement, velocities and acceleration of objects using suitable measuring instruments. Skills in the measurement of masses, weights and forces are also required. Data handling skills such as the conversion of displacement data into information on velocity or acceleration are expected. Candidates should be able to display experimental results in an appropriate form, interpret and analyse motion and draw valid conclusions. In particular, candidates should be able to plot graphs with an appropriate scale and interpret the significance of slopes, intercepts and areas in certain graphs.

2.1 Position and movement

position, distance and displacement	description of the change of position of objects in terms of distance and displacement displacement-time graphs for moving objects
scalars and vectors	distinction between scalar and vector quantities use of scalars and vectors in different contexts
speed and velocity	average speed and average velocity distinction between instantaneous and average speed/velocity description of motion of objects in terms of speed and velocity

uniform motion	definition of uniform motion application of the formula $s = vt$ for uniform motion velocity-time graphs of objects in uniform motion
acceleration	velocity-time graphs of objects in uniformly accelerated motion in one direction and with a change in direction (including the interpretation of slope and area) definition of acceleration as the rate of change of velocity formula $a = \frac{v-u}{t}$ for uniformly accelerated motion along a straight line acceleration-time graphs of objects in uniformly accelerated motion in one direction and with a change in direction
equations of uniformly accelerated motion	equations of uniformly accelerated motion $v = u + at$ $s = \frac{1}{2}(u+v)t$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ problem solving of uniformly accelerated motion for journeys in one direction and with a change in direction

	vertical motion under gravity	free-falling objects have the same acceleration (g) description and graphical representation of motion of free-falling objects in one direction and with a change in direction problem solving of vertical motions in one direction and with a change in direction using the equations of uniformly accelerated motion. qualitative treatment of the effect of air resistance on the motion of objects falling under gravity
2.2	**Force and motion**	
	Newton's First Law of motion	meaning of inertia and mass Newton's First Law of motion application of the First Law to explain situations in which objects are at rest or in uniform motion friction as a force opposing relative motion between two surfaces
	addition of forces	addition of forces graphically and algebraically in one dimension addition of forces graphically and algebraically in two dimensions
	resolution of forces	resolution of a force graphically and algebraically in two mutually perpendicular directions

	Newton's Second Law of motion	effect of a net force on the speed and direction of motion of an object Newton's Second Law of motion and the equation $F = ma$ definition of a unit of force, Newton use of free-body diagrams to show the forces acting on objects and to identify the net force in a system consisting of one or two objects application to solve problems involving rectilinear motion in one direction and with a change in direction
	Newton's Third Law of motion	forces act in pairs Newton's Third Law of motion identification of the action and reaction pair of forces
	mass and weight	distinction between mass and weight relationship between mass and weight $W = mg$
2.3	**Work, energy and power**	
	mechanical work	mechanical work done as a measure of energy transfer definition of mechanical work done $W = Fs$ definition of a unit of energy, joule, with reference to the equation $W = Fs$ application of the formula $W = Fs$ to solve problems

gravitational potential energy (P.E.)	gravitational potential energy of an object due to its position under the action of gravity derivation of the formula $E_P = mgh$ application of the formula $E_P = mgh$ to solve problems
kinetic energy (K.E.)	kinetic energy of a moving object derivation of the formula $E_K = \frac{1}{2}mv^2$ application of the formula $E_K = \frac{1}{2}mv^2$ to solve problems
law of conservation of energy	interpretation of the law of conservation of energy inter-conversion of P.E. and K.E., taking into account of energy loss application of the law of the conservation of energy to solve problems
power	definition of power in terms of the rate of energy transfer definition of a unit of power, watt application of the formula $P = \frac{W}{t}$ to solve problems

2.4 Momentum

linear momentum	definition of momentum as a quantity of motion of an object $p = mv$
change in momentum and net force	change in momentum resulted when a net force acts on an object for a period of time interpretation of force as the rate of change of momentum (Newton's Second Law of motion)
law of conservation of momentum	interpretation of the law of conservation of momentum
elastic and inelastic collisions	distinction between elastic and inelastic collisions application of the law of conservation of momentum to solve problems involving collisions in one dimension energy changes in collisions

Section 3 Waves

This section examines the basic nature and properties of waves. Light and sound waves, in particular, are studied in detail. Candidates should possess practical skills in the study of vibrations and waves through various physical models. They need to develop the skills for interpreting indirect measurements and demonstrations of wave motions from the displays on a cathode ray oscilloscope. They should be aware that various models are used in the study of physics, e.g. the ray model is used in geometric optics for image formation and the wave model is used to explain phenomena such as diffraction and interference.

3.1 Nature and properties of waves

nature of waves	oscillations in a wave motion waves transmitting energy without transferring matter
wave motion and propagation	distinction between transverse and longitudinal travelling waves description of wave motions in terms of: waveform, crest, trough, compression, rarefaction, wavefront, displacement, amplitude, period (T), frequency (f), wavelength (λ), wave speed (v) displacement-time and displacement-distance graphs for travelling waves application of $f = 1/T$ and $v = f\lambda$ to solve problems

	reflection, refraction and diffraction	reflection of waves at a plane barrier/reflector refraction of waves across a straight boundary refraction of waves due to a change in speed diffraction of waves through a narrow gap and around a corner <u>relationship between the degree of diffraction and size of the gap compared to the wavelength</u> illustration of reflection, refraction and diffraction of waves using wavefront diagrams
	interference of waves	interference of waves as a property of waves occurrence of constructive and destructive interferences <u>interference of waves from two coherent sources</u> <u>conditions for constructive and destructive interference in terms of path difference</u> illustration of interference of waves using wavefront diagrams
3.2	**Light**	
	wave nature of light	light as an example of transverse waves light as a part of the electromagnetic spectrum range of the wavelength for visible light

	relative positions of visible light and the other parts of the electromagnetic spectrum speed of light and electromagnetic waves in vacuum
reflection of light	laws of reflection graphical constructions of image formation by a plane mirror
refraction of light	laws of refraction path of a ray being refracted at a boundary definition of refractive index of a medium $n = \sin i / \sin r$ application of Snell's law to solve problems involving refraction at a boundary between vacuum(or air) and another medium
<u>total internal reflection</u>	<u>conditions for total internal reflection</u> <u>problem solving involving total internal reflection and critical angle at a boundary between vacuum(or air) and another medium</u>
formation of images by lenses	graphical constructions of image formation by converging and diverging lenses distinction between real and virtual images
evidence for the wave nature of light	diffraction and interference as evidences for the wave nature of light

3.3 Sound

wave nature of sound	sound as an example of longitudinal waves requirement of a medium for the transmission of sound waves comparison of the general properties of sound waves and light waves
audible sound	range of frequency for audible sound waves
ultrasound	frequencies of ultrasound
musical notes	comparison of musical notes using the terms pitch, loudness and quality association of the frequency and amplitude with the pitch and loudness of a note respectively
noise	representation of the sound intensity level using the unit decibel effects of noise pollution and the importance of acoustic protection

Section 4 Electricity and Magnetism

This section examines basic knowledge of electricity and magnetism. Candidates should possess practical skills in circuit connections. They should be able to perform electrical measurements using various equipment such as ammeters, voltmeters, multimeters, joulemeters and cathode ray oscilloscopes. Candidates should also possess skills of conducting experiments to study, demonstrate and explore concepts such as electric fields, magnetic fields and electromagnetic induction. Candidates should gain practical experience related to design processes through the construction of physical models such as motors and generators.

4.1 Electrostatics

electric charges	experimental evidences for two kinds of charges in nature attraction and repulsion between charges representation of a quantity of charge using the unit coulomb charging in terms of electron transfer
electric field	existence of an electric field in the region around a charged body representation of an electric field using field lines

4.2 Circuits and domestic electricity

electric current	electric current as a flow of electric charges definition of a unit of current, ampere, as one coulomb per second convention for the direction of an electric current

electrical energy and voltage	energy transformations in electric circuits definition of voltage as the energy transferred per unit charge passed volt as a unit of voltage
resistance and Ohm's law	Ohm's law definition of resistance $R = V/I$ ohm as a unit of resistance application of the formula $V = IR$ to solve problems factors affecting the resistance of a wire
series and parallel circuits	comparison of series and parallel circuits in terms of the voltages across the components of each circuit and the currents through them relationships $R = R_1 + R_2 + \ldots..$ for resistors connected in series $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots..$ for resistors connected in parallel
simple circuits	determination of I, V and R in simple circuits effects of resistance of ammeters, voltmeters and cells in simple circuits
electrical power	heating effect when a current passes through a conductor application of the formula $P = VI$ to solve problems

	domestic electricity	power rating of electrical appliances kilowatt-hour (kWh) as a unit of electrical energy calculation of the costs of running various electrical appliances household wiring and the safety aspects of domestic electricity operating current for an electrical appliance and the selection of power cable and fuse
4.3	**Electromagnetism**	
	magnetic force and magnetic field	attraction and repulsion between magnetic poles existence of a magnetic field in the region around a magnet representation of a magnetic field using field lines behaviour of a compass in a magnetic field
	magnetic effect of an electric current	existence of a magnetic field due to moving charges and electric currents magnetic field patterns associated with currents through a long straight wire, a circular coil and a long solenoid factors affecting the strength of an electromagnet
	current-carrying conductor in a magnetic field	existence of a force on a current-carrying conductor in a magnetic field and determination of its direction factors affecting the force on a current-carrying conductor in a magnetic field

	turning effect on a current-carrying coil in a magnetic field operating principle of a simple d.c. motor
electromagnetic induction	induction of voltage when a conductor cuts magnetic field lines and when the magnetic field through a coil changes application of Lenz's law to identify the direction of an induced current in a closed circuit operating principles of simple d.c. and a.c. generators
transformer	operating principle of a simple transformer relationship between the voltage ratio and turns ratio $\frac{V_P}{V_S} = \frac{N_P}{N_S}$ and its application to solve problems efficiency of a transformer methods for improving the efficiency of a transformer
high voltage transmission of electrical energy	advantage of the transmission of electrical energy with a.c. at high voltages various stages of stepping up and down of the voltage in a grid system for power transmission

Section 5 Atomic Physics

In this section, the atomic model and radioactivity are introduced. Candidates should possess the analytic skills to draw valid conclusions from the result of experiments involving radioactivity. They should be aware of the potential danger of radioactive sources and the applications of radioactivity in different disciplines. Candidates should be able to evaluate scientific information and appreciate the importance of making informed decisions when facing controversial issues such as the debate on the use of nuclear energy.

5.1 Radiation and Radioactivity

X-ray	X-ray as an ionizing electromagnetic radiation of short wavelength with high penetrating power emission of X-rays when fast electrons hit a heavy metal target
α, β and γ radiation	origin and nature of the α, β and γ radiation comparisons of the α, β and γ radiation in terms of penetrating power, range, ionizing power, deflection in electric and magnetic fields, and cloud chamber tracks
radioactive decay	occurrence of radioactive decay in unstable nuclides random nature of radioactive decay proportional relationship between the activity of a sample and the number of undecayed nuclei

	definition of half-life determination of the half-life of a radioisotope from its decay graph or from numerical data problem solving involving the half-life
detection of radiation	detection of radiation using a photographic film and G-M counter measurement of radiation in terms of the count rate using a G-M counter
radiation safety	major sources of the background radiation representation of a radiation dose using the unit sievert potential hazard of ionizing radiation and the ways to minimize the radiation dose absorbed safety precautions in handling radioactive sources

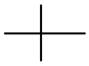
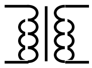
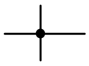
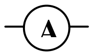
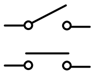
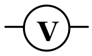
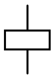
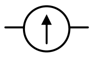
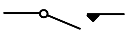
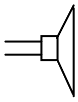
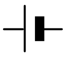
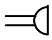
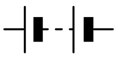
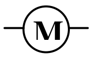
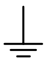
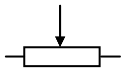
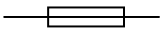
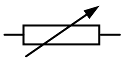
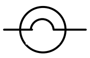
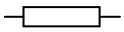
5.2 Atomic model

atomic structure	structure of a typical atom definitions of atomic number and mass number use of symbolic notations to represent nuclides
isotopes and radioactive transmutation	definition of isotope existence of radioactive isotopes in some elements representation of radioactive transmutations in α, and γ decays in terms of equations

5.3 Nuclear energy

nuclear fission	release of energy in a nuclear fission nuclear chain reaction
nuclear fusion	release of energy in a nuclear fusion nuclear fusion as the source of solar energy

TABLE OF COMMON CIRCUIT SYMBOLS

	connecting wires crossing with no connection		transformer
	junction of connecting wires		ammeter
	switch		voltmeter
	relay coil		galvanometer
	relay contact		loudspeaker
	cell		buzzer
	battery		motor
	earth		potential
	fuse		variable
	filament lamp		a.c. power supply
	fixed resistor		