SEC SYLLABUS (2009)

PHYSICS **SEC 24**

SYLLABUS

Physics SEC 24	Available in September (Paper I and Paper IIB only)
Syllabus	Paper 1 (2 hrs) + Paper 2 (2 hrs) + laboratory reports

Introduction

The syllabus is designed to develop the candidates' understanding of the nature of scientific ideas and activity through the acquisition of a systematic body of scientific knowledge and an appreciation of its power and limitations. The scientific method is to be presented as a method of inquiry in a way that stimulates curiosity and interest. As far as possible, an investigative approach should be followed. Every opportunity should be taken to expose the students to the applications of Physics to technology and environmental issues. Wherever possible the subject content should be presented within a contemporary context relevant to the lives of students and within a historical context which illustrates how the scientific ideas were developed and the scientists who developed them.

Aims

- To emphasize the importance of the process of scientific investigation as a means of solving problems in every day life;
- To contribute to the pupils' general education by helping to make sense of the physical environment through scientific inquiry;
- To provide the basis for further study of the subject;
- To develop experimental and investigative abilities;
- To develop the skills necessary to find solutions to scientific problems;
- To understand that scientific ideas are developed within a contemporary and historical context.
- To develop positive attitudes towards physics, science in general and the environment.

Course objectives

As a result of following the course, candidates should acquire:

Knowledge and understanding	▪ recall facts and ideas; ▪ show an understanding of facts, terminology, principles and concepts; ▪ use units correctly; ▪ demonstrate an understanding of the application of physics in everyday life; ▪ understand that scientific concepts are developed within a contemporary and historical context; ▪ recognise the importance of key scientists in the development of physical theory; ▪ understand the positive and less positive outcomes of the applications of science.
Application of knowledge through problem solving	▪ describe and explain in a clear and logical manner scientific principles and concepts; ▪ interpret data presented in tables, diagrams or graphs; ▪ carry out relevant calculations; ▪ apply principles and concepts to unfamiliar situations;
Experimental skills	▪ plan and carry out investigations; ▪ use safe and accurate practical techniques; ▪ record data accurately; ▪ interpret data and draw conclusions; ▪ communicate the data in a clear and accurate manner;
Positive attitudes	▪ recognise alternative points of views; ▪ evaluate the implications of science and how it affects the quality of life, that of others and the quality of the environment. ▪ use their knowledge and understanding to make informed choices.

Assessment

Content

The examination will consist of two written papers of two hours' duration each and an assessment of practical work. The questions will be set in English and must be answered in English.

Paper I

Consists of a written paper, comprising about 10 compulsory short questions to be answered in the spaces provided in the examination booklet, and a practical component. This paper is to be taken by ALL candidates registered by the examination.

Paper IIA/Paper IIB

There will be two versions of Paper II; Paper IIA or Paper IIB. Questions in Paper IIA will be more difficult than those in Paper I. Questions in Paper IIB will be less difficult than those in Paper I.

Registration

Candidates will be required to indicate on the registration form which option in Paper II (A or B) they wish to sit for. No change in the choice of paper will be allowed after the registration period.

Supplementary

In the September Supplementary session, only Paper I and Paper IIB will be offered.

Test questions

Paper IIA or Paper IIB will consist of five compulsory questions, two of which will test experimental skills.

The papers will cover the whole syllabus and will test the candidates' abilities according to the following scheme:

Ability	Paper I	Paper IIA or Paper IIB	% Mark
Knowledge and Understanding	*	*	40%
Problem Solving	*	*	30%
Design and Planning of experiments		*	15%
Practical Assessment	*		15%
Approximate % of total mark	55%	45%	100%

Questions requiring the application of knowledge will normally refer to common situations and any calculations required will be simple and direct. When reference is made to particular situations or apparata which might be unfamiliar to candidates, sufficient details will be given to explain the context.

Mathematical content

Four figure mathematical tables will be provided by the University on request. The use of electronic calculators with arithmetical (four rules, squares, square root, log) and simple trigonometrical functions (sin, cos, tan, and their inverses in degrees) is recommended.

Units

Standard notation and SI units will be used. When one quantity is divided by another, the solidus will be used, e.g. m/s but the notation ms^{-1} will also be accepted. The acceleration of free fall, g, which will be given in the question paper, will be taken as 10 m/s^2.

Practical Work

Marks

- *15%* of the total marks for this examination are allotted to the practical experience of the candidates. This will be assessed by the schools during the candidates' course of study.
- The mark of the practical work is to be based on the average mark of the best fifteen *(15)* experiments.

Moderation

- Laboratory Report books are to be available at the candidates' schools for moderation by the Markers' Panel.
- When monitoring the candidates' Laboratory Report Books, the Markers' Panel will look for evidence that the candidates have actually carried out practical work and were capable of:
  (a) following verbal and written instructions;
  (b) planning and organizing practical work;
  (c) handling laboratory apparatus;
  (d) carrying out and recording observations and measurements, and
  (e) processing experimental data and drawing conclusions from them.

Private Candidates

- Private candidates who left school before 1994 will not be expected to present their laboratory report books. Their mark will be obtained by pro-rating of the written papers.
- Candidates who studied the subject at school and are re-sitting the subject may carry forward the practical report mark from a previous session.
- Candidates who have never studied the subject at school but have covered the coursework privately will be expected to present their coursework to the MATSEC Board by the date indicated by the board. Candidates will be asked to attend for an oral examination about their practical work.

Notes for teachers on practical work and moderation

Aims of practical work

Through practical work candidates should be able to carry out experimental and investigative work in which they plan procedures, use precise and systematic ways of making measurements and observations, analyze and evaluate evidence and relate this to scientific knowledge and understanding.

Learning outcomes

A candidate must be able to:

- ✓ recall, understand, use and apply the scientific knowledge set out in the syllabus;
- ✓ communicate scientific observations, ideas and arguments using a range of scientific and technical vocabulary and appropriate scientific and mathematical conventions;
- ✓ evaluate relevant scientific information and make informed judgments about it.

Examples of Experiments

In order to ensure that experiments involving a variety of skills are assigned and assessed it is recommended that experiments presented be from different areas such as those listed below. This list consists of suggested topics and is not exhaustive.

- Electricity and Magnetism
- Heat
- Lenses
- Measurement
- Waves
- Energy and Energy Transfer

A number of types of activity may be used such as:

- Skill development [e.g. The use of circuits for measuring current and voltage]
- Open-ended enquiry [e.g. What factors affect the sag of a bridge]
- Testing a given prediction [e.g. Electromagnets with more coils are stronger]
- Verifying a law [e.g. The relationship between force and acceleration could lead to a study of Newton's second law of motion]

It is recommended that experiments in each area include investigations. Simple experiments conducted with the help of data loggers are also recommended.

Examples of experiments that may be carried out include those listed below. This list is intended as a guide and teachers should not feel restricted in their choice of experiments and investigations.

Electricity and Magnetism	
(i)	Measuring current and voltage in series and parallel circuits.
(ii)	Finding out which magnet is the most powerful.
(iii)	Determination of the resistance of a circuit component.
(iv)	Measurement of the efficiency of an electric motor.
Waves	
(i)	Verifying the laws of reflection for a plane mirror.
(ii)	Locating images formed by a plane mirror.
(iii)	Determination of the critical angle for glass.
(iv)	Measuring the speed of water waves.
Energy Resources and Energy Transfer	
(i)	Comparing energy losses by radiation from different surfaces.
(ii)	Measurement of efficiency using an inclined plane.
(iii)	Comparing the potential and kinetic energy changes of falling objects.
Investigations	
(i)	Investigating the effect on lamp brightness or current when varying the number of lamps or batteries in a series circuit.
(ii)	Investigating the factors that affect the strength of an electromagnet.
(iii)	Investigating the factors that affect the size and direction of the current in a coil of wire as a result of electromagnetic induction.
(iv)	Investigating changes in time taken for falling object to reach the ground.
(v)	Investigating the design of a model parachute.
(vi)	Investigating the factors affecting the size of a shadow.
(vii)	Investigating the refraction of light by a glass/Perspex block and triangular prism.
(viii)	Investigating how insulation affects heat loss from a container of hot water.
(ix)	Investigating how temperature affects the speed of evaporation.
(x)	Investigating the factors which affect the bounce height of a ball.

Assessment

In assessing one would look for and award evidence of:

Planning

- A simple safe procedure has been planned.
- A prediction has been made and a fair test planned.
- Appropriate equipment has been selected.
- Scientific knowledge and understanding has been used to plan a procedure.
- A suitable range of measurements has been chosen.
- A detailed strategy has been planned.

Observation

- Equipment has been used safely to obtain measurements.
- Appropriate measurements have been taken.
- The measurements have been recorded clearly and accurately in tables.
- The measurements are sufficient, appear to be accurate and have been repeated.

Analysis

- The student has explained what has been found out.
- A graph has been drawn to present the findings where applicable.
- A trend has been identified.
- Numerical methods have been used to process the evidence.
- A conclusion has been drawn and linked to scientific knowledge and understanding.
- The student has explained how the results match or do not match the original prediction.

Evaluation

- Relevant comment about the procedure and evidence obtained.
- The accuracy of the results and any sources of error are discussed.
- The suitability of procedures are evaluated.

Communicating results

- Report written in an acceptable format.
- Use of technical vocabulary
- Proper format in presentation of results including tabulation, graphs etc.
- Ability to justify conclusions reached verbally and during class discussions

Marking Criteria

Criteria	**Marks**
Actual conduct of experiment including handling of apparatus	5
Format of experiment report to include date, title of experiment, aim and procedure performed.	2
Clear, neat fully-labelled diagram of apparatus used during the experiment	2
Results obtained by observations in the form of a table and graph with labelled axes if applicable.	2
Discussion of precautions undertaken to ensure accuracy in the results observed.	2
Discussion of results obtained in view of the aim of the experiment.	2
	15

The above criteria provide benchmarks for teachers when awarding marks. Moderators will follow these criteria whenever possible.

Moderation

- Lab books should be grouped by class.
- When more than one lab book is presented by a student, these should be bound together in some way.
- A sheet listing the experiments presented and the marks assigned should be attached inside the lab book. The experiments presented should be clearly marked.
- The experiments presented should be representative of the different sections of the syllabus.
- The experiments should be corrected and a mark (out of 15) given.
- Standard experimental analysis involving tables, graphs, gradients and statements of precautions taken should be evident in at least some of the experiments presented.
- The experiments presented whenever possible should be the work of the student. Reports of demonstrations while valid in their own right, should not be considered when choosing the best 15 experiments, except where valid reasons, such as the apparatus involved is very expensive, are provided. Even when there is a valid reason not more than 5 reports of demonstrations should be presented.
- When demonstrations are carried out with apparatus which is very expensive such as data loggers then if possible students can carry out the experiments in small groups and take it in turns to take different sets of readings by varying one variable at a time. Then each group can present their readings to the whole class and graph plotting and discussion carried out on an individual basis.

CANDIDATES MAY BE CALLED FOR AN INTERVIEW ABOUT THEIR WORK.

Results

Grades awarded

Candidates sitting for Paper I and Paper IIA may qualify for Grades 1, 2 , 3, 4 or 5. The results of candidates who do not obtain at least a Grade 5 shall remain Unclassified (U).

Candidates sitting for Paper I and Paper IIB may qualify for Grades 4, 5, 6 or 7. The results of candidates who do not obtain at least a Grade 7 shall remain Unclassified (U).

Grade descriptors

	Grade 1 Candidates are able to:	**Grade 5** Candidates are able to:	**Grade 7** Candidates are able to:
Knowledge and Understanding	▪ recall and show understanding of a wide range of scientific facts, principles, concepts and practical techniques across all the physics syllabus; ▪ use consistently the correct scientific vocabulary and units; ▪ use consistently scientific or mathematical conventions as	▪ recall and show understanding of a range of scientific facts, principles, concepts and practical techniques across parts of the physics syllabus; ▪ use the correct scientific vocabulary in a number of cases but not consistently; ▪ use scientific or mathematical conventions in	▪ recall and show understanding of a limited range of scientific facts, principles, concepts and practical techniques across parts of the physics syllabus; ▪ use the correct scientific vocabulary in a very few cases; ▪ use scientific or mathematical conventions in

	used in physics; ▪ apply physics pricinciples in everyday situations consistently; ▪ show a very good understanding of the development of principles by key scientists within a historical context; ▪ demonstrate a very good understanding of how scientific theories can be changed by new evidence and identify areas of uncertainity in physics.	most of the instances; ▪ apply physics principles in some everyday situations; ▪ show a good understanding of the development of principles by key scientists within a historical context; ▪ demonstrate a good understanding of how scientific theories can be changed by new evidence and identify areas of uncertainity in physics.	few cases; ▪ apply physics principles in only a few everyday situations; ▪ show a very limited understanding of the development of prinicples by key scientists within a historical context; ▪ demonstrate a very limited understanding of how scientific theories can be changed by new evidence and identify only some areas of uncertainity in physics.
Application of knowledge through problem solving	▪ link the different areas of the syllabus in a meaningful way; ▪ give a very good interpretation of data presented; ▪ carry out most calculations in an accurate manner; ▪ use knowledge of physics processes and concepts in both familiar and unfamiliar situations.	▪ use and apply scientific knowledge and understanding in some general contexts; ▪ give a good interpretation of data presented; ▪ carry out a number of calculations in an accurate manner; ▪ use knowledge of physics processes and concepts in familiar situations and apply them to unfamiliar situations within limitations.	▪ use and apply scientific knowledge and understanding in a few general contexts; ▪ give a very limited interpretation of data presented; ▪ carry out only a very few calculations in an accurate manner; ▪ use a very limited knowledge of physics processes and concepts in familar situations.
Experimental skills	▪ plan and carry out experiments related to all areas of the syllabus; ▪ make clear and very good systematic observations in experiments; ▪ use safe and accurate practical techniques; ▪ record and represent data accurately using a variety of methods; ▪ interpret graphs in terms of patterns, trends, anomalous observations and salient features; ▪ recognise limitations in the evidence; ▪ draw conclusions based on scientific knowledge and understanding; ▪ suggest improvements that would enable them to collect more reliable data; ▪ communicate the data in a clear and accurate manner.	▪ plan and carry out experiments related to a number of areas in the syllabus; ▪ make good systematic observations in experiments; ▪ use safe and good practical techniques; ▪ record and represent data using a variety of methods; ▪ interpret graphs including best straight line graphs, in terms of patterns, trends, anomalous observations and salient features; ▪ suggest improvements that would enable them to collect more reliable data; ▪ communicate the data in a clear manner.	▪ plan and carry out experiments related to a few areas of the syllabus; ▪ make only simple systematic observations in experiments; ▪ use safe and good practical techniques; ▪ record and represent data; ▪ interpret straight line graphs in simple terms; ▪ appreciate that improvements in their experiments and repeated readings would enable them to collect more reliable data; ▪ communicate the data in an appropriate manner.
Positive attitudes	▪ synthesise their knowlege of science and evaluate how it affects the quality of life; ▪ use their knowledge and understanding of science to make informed choices.	▪ use their knowledge of science to understand how it affects the quality of life; ▪ use their knowledge and understanding of science in everyday life situtations.	▪ understand that science can affect the quality of life; ▪ understand the importance of science in everyday life.

SYLLABUS

	Unit	Content	Notes
1.0 Measurements			
1.1	Length	Use and describe the use of rulers and measuring cylinders to determine a length or a volume	Use of micrometer and vernier is not expected.
1.2	Time	Use and describe the use of clocks and stopwatches to determine an interval of time	State units for time, e.g. seconds, hours etc.
1.3	Mass	Use and describe the use of balances, including an electronic balance, to determine the mass of an object	State that mass is measured in kilogrammes
1.4	Density	Describe an experiment to determine the density of a liquid and of a regularly or irregularly shaped solid and make the necessary calculations	State and use the equation: **Density = mass/volume**. State units for density: kg/m^3 and g/cm^3
1.5	Units	All physical quantities should be accompanied by SI units	
2.0 Forces			
2.1	Stretching Materials	Use a newton balance to measure forces	State that force is measured in newtons.
		Describe the behaviour of a helical spring and a rubber band when subjected to an increasing force, including Hooke' s Law	State and use Hooke's law to solve simple problems.
		Understand the meaning of elastic limit	Experimental investigation of the relationship between force and the extension of a helical spring.
2.2	Pressure	Use of the equation, $\text{Pressure} = \dfrac{\text{Normal Force}}{\text{Area}}$	State that the standard unit of pressure is the Pascal (N/m^2)
		Describe situations where a force applied on a small area produces a large pressure	
		Describe situations where a force applied on a large area produces a small pressure.	
2.3	Pressure in liquids	Understand that liquids transmit pressure in all directions enabling force to be multiplied	Numerical calculations are expected. e.g. car brakes
		Describe one every day application of hydraulics.	

		Apply the equation of Pressure to simple hydraulic machines	
		Relate the pressure beneath a liquid surface to depth and to density	Use of the equation **P = ρ.g.h** is required
2.4	Atmospheric Pressure	Understand that the atmosphere exerts a pressure	
		Know that atmospheric pressure may be measured by a barometer	Details of construction are not required
		Understand that atmospheric pressure decreases to zero with increase in height above the Earth's surface	
		Appreciate that changes in atmospheric pressure may indicate a change in the weather	
2.5	Pressure in Gases	Describe qualitatively how the pressure of a fixed mass of gas is affected by changes in its temperature and volume.	Kinetic theory should be revised

3.0 Turning Effect of Forces

3.1	Moment of a Force	State that the turning effect of a force depends on the size of the force and the perpendicular distance from the pivot to the line of action of the force	Identify turning effect with the moment of a force. Illustrate by describing some practical applications of levers, e.g. spanner, door/window handles etc.
		Use the equation **Moment = Force x Perpendicular distance from pivot to line of action of force**	State appropriate units for moment, e.g. Nm
3.2	Principle of Moments	Describe an experiment, involving vertical forces, to verify that there is no net moment on a body in equilibrium	Experimental investigations are expected.
		Understand that the weight of an object acts at its centre of mass	Use of equation to solve simple problems where bodies are supported by one pivot only.
		Be familiar with the two conditions for equilibrium of a body	
		Solve problems on simple balanced systems	

4.0 Motion

4.1	Linear Motion	Use $Velocity = \frac{\text{change in displacement}}{\text{change in time}}$	Use of equation limited to situations where direction of displacement does not change.

		Interpret displacement-time graphs and calculate velocity from such graphs Use $$Acceleration = \frac{\text{change in velocity}}{\text{change in time}}$$	Use of equation limited to situations where direction of velocity does not change.
		Interpret velocity-time graphs and calculate displacement and acceleration from such graphs	
		State the factors which affect braking distance and thinking distance	
		Understand that **Stopping distance = Thinking distance + Braking distance**	
		Appreciate that bodies falling freely have the same acceleration Use the equations: $\mathbf{v = u + a.t}$ $\mathbf{s = \{(u + v)/2\}.t}$ $\mathbf{s = ut + ½at^2}$	The use of this equation is limited to situations where bodies start from rest.
		Describe how to find the acceleration of free fall by timing a falling object	Experimental investigations are required.

5.0 Forces and Motion

5.1	Newton's Laws of Motion	Understand that objects continue moving with constant velocity or remain at rest when all the forces acting on them balance	Experimental investigations are expected.
		Understand that an unbalanced force acting on an object gives the object an acceleration in the direction of the force	
		Use the equations: $\mathbf{F = m.a}$ and $\mathbf{W = m.g}$	
		Appreciate that when an object A exerts a force on object B, object B exerts an equal force in the opposite direction	
		Understand that for a body moving through a medium, resistive forces depend on body shape and speed	
		Understand that forces acting on a body which has reached terminal speed are balanced	

6.0 Momentum

6.1	Momentum	Define momentum as the product of mass and velocity	State the units of momentum as kg m/s
6.2	Law of conservation of momentum	Understand that when two objects moving in one direction interact, their total momentum is conserved if there are no external forces acting on them	An experimental approach is expected
		Use the principle of conservation of momentum in the collision of two objects and the explosion of an object	Calculations involving the principle are expected.
		Use and apply the equation: $\text{Force} = \frac{(\text{Change in momentum})}{(\text{Change in time})}$	Apply equation to practical situations like the packaging of fragile objects, the action of crumple zones and seat belts

7.0 Energy, Work and Power

7.1	Energy	Give examples of energy in different forms, its conversion and conservation and apply the principle of conservation of energy to simple examples	State that energy is measured in joules.
7.2	Energy Sources	Classify energy sources as renewable and non-renewable	
		Give examples of each class	
		State the advantages and disadvantages of fossil fuel, nuclear, wind, hydroelectric, solar and biomass sources of energy	
		Draw and explain energy flow diagrams through steady state systems such as a filament lamp, a power station, a vehicle travelling at constant speed on a level road	
7.3	Work	Use: **Work = force x distance moved in the direction of force**	
		Use: **Gravitational Potential Energy** = **Work done in raising a mass against its weight = m.g.h.**, and	
		Kinetic Energy = $m.v^2/2$	
7.4	Power	Use: **Power = work done (converted energy)/time take**	State that power is measured in watts

7.5	Energy Efficiency	Understand the efficient use of energy in the context of the home, heating and cooling of buildings, and of the internal combustion engine	
		Understand the effect on energy resources of the efficient use of these resources, considering pollution and running costs	
		Contrast the efficiencies of energy conversion devices by comparing energy input and useful energy output	
		Use the equation: **Efficiency = useful energy output/ total energy input**	Efficiency may be expressed as a percentage

8.0 Heat Energy

8.1	Temperature	Know that temperature is a measure of the Degree of hotness and is measured in degrees Celcius or Kelvin	Conversions from degrees Celcius to Kelvin is not expected
8.2	Heat	Know that a change in temperature may be caused by energy transfer and that a temperature difference may cause energy transfer called heat	
		Definition of specific heat capacity.	State that the unit for specific heat is J/kg^{o}C.
		Use the equation: **Energy transfer = mass x specific heat capacity X temperature change**	
		Describe experiments by which the specific heat capacity of a solid and a liquid may be determined, using an electrical heater of known power or joulemeter	
		Describe one everyday effect due to the relatively large specific heat of water	
8.3	Heat Transfer	Give examples of good and bad conductors of heat and describe their uses	
		Appreciate that convection currents in gases and liquids involve movement of the fluid due to differences in density	
		Describe the role of convection in space heating	
		Understand that insulation reduces energy transfer by conduction and convection	
		Understand that everyday objects radiate energy in the form of waves (infra-red) which form part of the electromagnetic spectrum	

		Appreciate that the power radiated increases with increase in temperature	
		Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation	
		Identify and explain some of the everyday applications and consequences of heat radiation, including the 'greenhouse effect'	

9.0 Waves

9.1	Waves	Describe what is meant by wave motion as illustrated by vibration in ropes, springs and by experiments with water waves	An experimental approach is desirable.
		Understand that waves are a means of energy transfer without transfer of matter	
		Understand the meaning of the term wavefront	
		Distinguish between transverse and longitudinal waves and give examples	Experimental investigations are expected, e.g. slinky springs.
		Interpret displacement-distance graphs for transverse waves	
		State the meaning of the terms frequency, periodic time, wavelength, wave velocity, amplitude	
		Understand that the wave frequency is determined by the source	
		Identify wavelength and amplitude in transverse and longitudinal waves	
		Use: **Frequency = 1/periodic time** **Wave speed = frequency x wavelength**	State that frequencies are measured in hertz.
		Describe the effect on wavelength of change in frequency of the vibrator in a ripple tank	Experimental investigations are expected
9.2	Reflection	Describe the use of a ripple tank to demonstrate reflection of waves	
		Describe the formation, and give the characteristics, of an optical image by a plane mirror Use the law: **Angle of incidence = Angle of reflection**	

9.3	Refraction	Describe the use of a ripple tank to show that refraction involves a change in wave velocity and wave length which may cause a change in wave direction Describe an experimental demonstration of the refraction of light	
		Use the terms angle of incidence and angle of refraction to describe the passage of light through parallel sided transparent material	Knowledge of Snell's law is not expected.
		Define refractive index in terms of ratio of speeds of light only	
		Describe how an image of a submerged object is formed when light rays are refracted at a water-air plane boundary	Knowledge of $n=\frac{\sin i}{\sin r}$ is not required.
9.4	Total Internal Reflection	Describe partial reflection and total internal reflection	Qualitative treatment only, prisms may be used to demonstrate total internal reflection. Knowledge of **n** = $\frac{1}{\sin C}$ is not required
		Describe the action and use of optical fibres	An experimental approach is desirable.
9.5	Converging Lenses	Describe the action of a thin converging lens on a beam of light	Knowledge of $1/f = 1/u + 1/v$ is not required
		Use the term focal length	
		Draw ray diagrams to illustrate the formation of real and virtual images by a converging lens	Calculations involving magnification are expected
		Describe and explain the common uses of a converging lens	
9.6	Dispersion	Give a qualitative account of the dispersion of white light by a prism	
9.7	Diffraction	Describe the use of water waves to show diffraction by wide and narrow gaps	
		Appreciate that diffraction of light is evidence that light behaves like waves	

10.0 Sound

10.1	Sound	Appreciate that sound waves require a medium	Appreciate that light travels a million times faster than sound.
		State approximate values for the speed of light and sound	One experimental investigation to determine the speed of sound is required.
		Describe the production of sound by vibrating sources	
		Describe the longitudinal nature of sound waves as a series of compressions and rarefactions	
		State the approximate range of audible frequencies	
		Describe how reflection of sound may produce echoes	
		Describe how a signal generator and loudspeaker may be used to produce sounds of varying frequency and loudness	
		Describe how an oscilloscope and a microphone may be used to obtain a signal trace on the oscilloscope screen	
		Describe the effect on loudness of change in amplitude and the effect on pitch of change in frequency	
10.2	Ultrasound	Know that ultrasound is a high frequency longitudinal wave	State that frequencies greater than 20 kHz are called ultrasound.
		Describe the use of ultrasound in echo sounding	
		Understand that reflection of ultrasound by body tissue enables organs to be scanned	
10.3	Resonance	Know that all objects vibrate with a characteristic or natural frequency	
		Know that when an object is made to vibrate with its natural frequency of vibration resonance occurs	
		Describe examples of resonance in everyday life	
10.4	Stretched Strings	Know the qualitative relationship between the frequency of vibration of a stretched string, its length, tension and thickness	An experimental approach is desirable, e.g. sonometer.
		Apply knowledge of stretched strings to string instruments	

11.0 Electromagnetic Waves

11.1	The Spectrum	Appreciate that light is part of a continuous spectrum of electromagnetic waves all of which travel in vacuum with the same speed State that in order of increasing wavelength (decreasing frequency) this spectrum consists of gamma rays, X-rays, ultra-violet light, infra-red, microwaves, and radio waves
11.2	Radio Waves	Appreciate that information can be transmitted by radio waves Appreciate that in a radio station, the information contained in sound waves is encoded in a radio wave, and that the radio receiver decodes the information carried by the radio waves to give the information as a sound wave
11.3	Microwaves	Appreciate that microwaves of a certain frequency cause heating when absorbed by water and cause burns when absorbed by body tissue
11.4	Infra-red waves	Understand that infra-red waves cause heating when absorbed by any object and are used in radiant heaters, optical fibre communication, and for the remote control of TV sets and VCR’s
11.5	Ultraviolet radiation	Understand that u.v. radiation can be produced by special lamps and that prolonged exposure to the sun may cause skin cancer from uv radiation
11.6	X-rays	Understand that X-rays pass through body tissue but are absorbed by the bones Describe the safety precautions that should he taken when using X-rays and gamma rays
11.7	Gamma rays	Describe the use of gamma rays to kill harmful bacteria in food, sterilise surgical instruments, and kill cancer cells

12.0 Electrostatics

12.1	Electric charge	Describe simple experiments to show the production of electric charges State that there are positive and negative charges State that like charges repel and unlike charges attract Know that charge is measured in coulombs

12.2	Conductors and insulators	Distinguish between electrical conductors and insulators and give examples of each Appreciate that conductors contain loosely bound electrons while insulators contain strongly bound electrons	Recall that electrons are particles in atoms which carry a negative charge
	Induced charges	Give an account of charging by induction, including the role of electrons in the process Describe examples of how electrostatic charges are used in everyday life Describe one situation in which static electricity is dangerous and the precautions taken to ensure that static electricity is discharged safely	

13.0 Current Electricity

13.1	Electric currents	Show understanding that an electric current (measured in amperes) is the rate of flow of charge Use the equation **I = Q/t**	Sub-multiples of the ampere.
13.2	Voltage	Know that a cell connected to a closed circuit uses up its chemical energy to push charge through the circuit, and that this chemical energy appears finally as heat Know that if a cell uses V joules of energy to drive 1 coulomb through a conductor, then the voltage (p.d.) across the conductor is V volts Show understanding that e.m.f. is defined as the energy supplied by a source in driving 1 C round a complete circuit Use the equations **Energy, W = I.V.t**	
13.3	Electrical Power	Use the equation: Power, **P = I.V** Know that the amount of energy transferred from the mains is measured in kilowatt-hours called units	
13.4	Resistance	Know how to use of an ammeter and voltmeter	A digital meter may also be used
		State that **Resistance** = **Voltage/Current** and use the equation **V** = **I.R** Use a variable resistance to control current	State that resistance is measured in ohms. Multiples of the ohm.
		Describe an experiment to determine the resistance using a voltmeter and ammeter Relate the resistance of a wire to its length and to its diameter	Qualitative treatment only. No calculations are required.

13.5	Electric circuits	Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), lamps, ammeters, voltmeters, diodes, LDR's, LED's, and thermistors	
13.6	Series circuits	Understand that the current at every point in a series circuit is the same	
		Understand that the sum of the p.d.'s across the components in a series circuit is equal to the total pd. across the supply	
		Give the combined resistance of two or more resistors in series	
13.7	Parallel circuits	Understand that the current from the source is the sum of the currents in the separate branches of a parallel circuit	The equation for combining two parallel resistors is not required.
		Understand that the voltage is the same across components in parallel	
13.8	V-I characteristic graphs	Describe experiments by which V-I graphs for a metallic conductor kept at constant temperature and a filament lamp can be drawn	
		Interpret V-I graphs for a metallic conductor, filament lamp, and thermistor	
		State how the resistance of an LDR changes with light level and how the resistance of a thermistor changes with temperature	Thermistors with negative temperature coefficient only to be treated
13.9	Alternating current	Appreciate that an alternating current, unlike a direct current, changes direction	
		Describe how a diode may be used to rectify an alternating current and how an oscilloscope may be used to demonstrate this action of a diode	
13.10	Domestic supplies	Understand the function of the live, neutral and earth wires in the domestic mains supply	
		Understand that the live wire has to be insulated from the earth and neutral wires	
		Know why domestic supplies are connected in parallel	
13.11	Earthing	Know that appliances with metal cases need to be earthed	
13.12	Fuses	Understand how fuses and circuit breakers prevent fire due to electrical faults	Calculations of the correct value for a fuse for various appliances are expected.
		Understand why fuses have various ratings	
		Understand why double insulated appliances do not need an earth wire	
		Describe how an appliance may be connected	

		correctly to a 3-pin plug Recognize dangerous practice in the use of mains electricity	

14.0 Magnetism

14.1	Magnetism	State the properties of magnets Give an account of induced magnetism Distinguish between magnetic and non-magnetic materials Describe an experiment to identify the pattern of field lines around a bar magnet Distinguish between the magnetic properties of iron and steel Distinguish between the design and the use of permanent magnets and electromagnets	

15.0 Electromagnetism

15.1	Magnetic effect of a current	Describe the pattern of the magnetic field due to currents in straight wires and in solenoids	Students are expected to recall the direction of the fields.
		Relate the strength of the field to the pattern of magnetic flux lines	
		Describe the effect of change of current, change in the number of turns, and of the introduction of an iron core on the strength of the field of a solenoid	Qualitative treatment only.
		Given appropriate diagrams, describe and explain the action of simple appliances which use the magnetic effect of electric current	Examples from: relay, door latch, electric bell, loudspeaker, etc., may be used.
15.2	Force on a current carrying conductor in a magnetic field	Describe an experiment to show that a force acts on a conductor carrying a current across a magnetic field, including the effect of reversing the current and the direction of the field	
		Give the relative directions of force, field, and current	Fleming's Left Hand Rule is expected.
		Appreciate that a current - carrying conductor placed parallel to a magnetic field has no force acting on it	
		State that a current-carrying coil in a magnetic field experiences a turning effect and this turning effect is increased by increasing the number of turns on the coil	

		Relate this turning effect to the action of an electric motor	Details of construction are not required
15.3	Electromagnetic induction	Describe an experiment to show that a changing magnetic field can induce an e.m.f in a circuit	Fleming's Right Hand rule is not expected
		State the factors affecting the magnitude of an induced e.m.f.	
		Show understanding that the direction of the induced e.m.f. opposes the change causing it and relate this phenomena to conservation of energy	
15.4	Simple transformer	Describe the construction and the principle of operation of a basic iron-cored transformer	
		Use the equations: **$(V_p/V_s) = (N_p/N_s)$** and **$(V_p.I_p) = (V_s.I_s)$** for an ideal transformer	

16.0 Radioactivity

16.1	The atom	Describe the atom as an entity made up of a positively charged nucleus and surrounding negatively charged electrons	
		State the charge and relative masses of the proton, neutron and electron	
16.2	The nucleus	Appreciate that the number of protons in a nucleus distinguishes one element from another	
		State the meaning of proton number, nucleon number and their representation in the form $^{4}_{2}He$	
16.3	Isotopes	State the meaning of the term isotopes	
16.4	Stability of nuclei	Appreciate that some nuclei are unstable, give out radiation to get rid of excess energy, and are said to be radioactive	
		Appreciate that an element may change into another element when radioactivity occurs	
16.5	Radioactive radiation	Understand that the three main types of radiation are α, β and γ and describe the nature of these types of radiation	
		Give the relative penetration of these emissions so that each emission is suited to a particular purpose	
		Describe the different abilities of these emissions to produce ionisation and describe their deflections in electric and magnetic	

		fields
16.6	Nuclear equations	Use symbolic equations to describe the changes in proton and nucleon number which occur when alpha or beta particles are emitted
16.7	Background radiation	Show awareness of the existence of background radioactivity State the sources of background radioactivity
16.8	Half-life	State the meaning of half-life Use the term half-life in simple calculations which might involve information in tables or decay curves
16.9	Applications	Give and explain examples of practical application involving the use of isotopes
16.10	Safety	Describe how radioactive materials are handled, used and stored in a safe way

17.0 The Earth and the Universe

17.1	Solar system	Appreciate that the Earth spins once a day and that half of the Earth which faces the sun is in daylight Appreciate that the Earth orbits the sun once in 365 days Appreciate that while the stars stay fixed in position, the planets orbit the sun, moving slowly across the sky Appreciate that the planets reflect light from the sun
17.2	Gravitational Forces	Know that objects which have a mass attract each other Know that attraction increases with mass and decreases with distance Understand that the moon orbits the Earth, and the planets orbit the sun because of gravitational force
17.3	Satellites	Understand that satellites can be put into orbit round the Earth because of the gravitational force between the Earth and the satellite Understand that satellites can be used to send information between places on the Earth which are far apart, to monitor conditions on Earth, including the weather, and to observe the Universe without the atmosphere getting in the way Understand that communications satellites are usually put into orbit high above the equator and that they orbit the Earth once a day so that

		they appear stationary when viewed from Earth Understand that monitoring satellites are usually put in low polar orbit so that the Earth spins beneath them and they can scan the whole Earth each day
17.4	The Universe	Appreciate that our sun is just one of many millions of stars in the Milky Way galaxy, and that the Universe is made up of more than a thousand million such galaxies Appreciate that galaxies are often millions of times further apart than the stars within the galaxy
17.5	Formation of stars	Appreciate that stars are formed when enough gas and dust from space is pulled together by gravitational attraction, that smaller masses may also form and be attracted by a larger mass to become planets
17.6	Origin of Universe	Appreciate that present theories of the origin of the Universe must take into account that light from other galaxies is shifted towards the red end of the spectrum, and that the further away galaxies are, the bigger this 'red-shift' Understand that the current way of explaining these observations is that other galaxies are moving away from us very quickly, and that the further away from us a galaxy is, the faster it is moving away from us Understand that this theory holds that the Universe is supposed to be expanding and that it might have started, billions of years ago, from a huge explosion or 'big-bang'

Appendix 1

SEC Physics

Candidates of SEC Physics are required to fill in this form and attach it to the first page of their practical report book. If additional practical books are presented the form should be attached to the first book.

Candidate's Name ____________________ School __________________________

Name of 15 experiments presented from syllabus		**Marks**	**Page No**
1.			
2.			
3.			
4.			
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6.			
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	Total number of marks:		
	Total number of experiments presented:		
	Average mark for the 15 experiments:		
	Average mark to the nearest whole number:		