BOTSWANA
EXAMINATIONS
COUNCIL

BOTSWANA GENERAL CERTIFICATE
OF SECONDARY EDUCATION

ASSESSMENT SYLLABUS

PHYSICS

CODE 0571

Effective for examination from 2020

Changes to Syllabus effective from 2020

The changes in this Assessment Syllabus are;

Syllabus Content

The syllabus content has **not** changed, but the core and extended specific objectives have been combined to make the specific objectives.

Structure of Assessment

The assessment structure has **not** changed, however, the Theory paper, the Practical Test and the Alternative to Practical paper have been renumbered.

The papers are now:

Paper 1: Multiple Choice

Paper 2: Theory

Paper 3: Practical Test

Paper 4: Alternative to Practical

Reporting

The Grade descriptors have been revised to make them communicate better.

The grade descriptors for F have been replaced by grade descriptors for E.

Assessment Grid

The relationship between the assessment objectives and components is more detailed showing the number of marks for each assessment objective per component.

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1. Introduction

As part of the Botswana General Certificate of Secondary Education, this Physics Assessment Syllabus is designed to assess the outcome of instruction for candidates who have completed a course based on the Senior Secondary Physics Teaching Syllabus.

This syllabus aims to assess positive achievement at all levels of ability. Candidates will be assessed in ways that encourage them to show what they know, understand and can do, and which provide opportunities to articulate their insights, perceptions and responses.

This Physics Assessment Syllabus should be read in conjunction with the Senior Secondary Physics Teaching Syllabus

Progression

The BGCSE is a general qualification that enables candidates to progress either directly to employment or to proceed to further qualifications.

2. Scheme of Assessment

All candidates must take **three** papers; Paper 1, Paper 2 and Paper 3 or Paper 4, which are described below.
The questions will be based on the whole syllabus.

2.1 The components

<table>
<tr><th colspan="2">All candidates must take:</th></tr>
<tr>
<td>Paper 1 1 hour
Multiple Choice

A multiple-choice paper consisting of 40 items each with 4 options.

The questions will test skills in Assessment Objectives 1 (AO 1) and 2 (AO 2) and will be of a difficulty appropriate to grades A to G.

The paper will be weighted at 30% of the final total mark</td>
<td>Paper 2 1 hour 15 minutes
Theory

A written paper consisting of short-answer and structured questions.

The questions will test skills in Assessment Objectives 1 (AO 1) and 2 (AO 2) and will be of a difficulty appropriate to grades A to G.

70 marks.

The paper will be weighted at 50% of the final total marks</td>
</tr>
<tr><th>either:</th><th>or:</th></tr>
<tr>
<td>Paper 3 2 hours
Practical Test

This paper will test Assessment Objective 3 (AO 3). It is a laboratory based paper with questions covering experimental and observational skills.

The paper will be of difficulty appropriate to grades A to G.

30 marks.

The paper will be weighted at 20% of final total mark</td>
<td>Paper 4 1 hour
Alternative to Practical Test

This paper will test Assessment Objective 3 (AO 3). It is designed to test familiarity with laboratory equipment and procedures.

The paper will be of difficulty appropriate to grades A to G.

30 marks.

The paper will be weighted at 20% of the final total mark.</td>
</tr>
</table>

2.2 Availability

This syllabus is available to both school candidates and private candidates.

2.3 Combining this syllabus with other syllabuses

Candidates may **not** combine this syllabus in an examination series with the following:

- 0568 Science Single Award
- 0569 Science Double Award

3. Syllabus Aims and Assessment Objectives

3.1 Aims

According to the Physics Teaching Syllabus, candidates following the syllabus should:

1. develop manipulative skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.

2. become confident citizens in a technological world to make informed decisions in matters of scientific interest.

3. develop desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving, developmental and nurturing.

4. develop an understanding of the applications of science and of the technological, economic, ethical and social implications of these.

5. develop an understanding of the significance of information and communication technology in the day-to-day life situations and the world of work.

6. acquire knowledge, attitudes and practices that will promote good family life and health including awareness and management of epidemics such as HIV/AIDS practices that prepare them for productive life.

7. develop positive attitudes such as open-mindedness, inventiveness, concern for accuracy and precision, objectivity, integrity and initiative towards scientific skills

8. develop an interest in and an enjoyment of science and science related-work.

9. develop an understanding of key concepts and principles of science as they are experienced in everyday life.

10. develop abilities and skills that are relevant to the study, safe practice and application of science (such as experimenting and investigating).

11. develop problem solving, critical thinking, communication, inquiry and teamwork / interpersonal skills to help them to be productive and adaptive to cope in a changing environment.

12. develop an appreciation of the role of science in improving the quality of life.

13. recognise the usefulness of science, and limitations of scientific method.

14. promote an awareness that the applications of science may be both beneficial and detrimental to the individual, the community and the environment.

3.2 Assessment Objectives

The main Assessment Objectives are:

AO1 Knowledge with Understanding

AO2 Handling Information and Problem Solving

AO3 Experimental Skills and Investigations

A description of each assessment objective is:

AO1 Knowledge with Understanding

Candidate should be able to demonstrate knowledge and understanding of:

1. the concepts, laws, theories and principles of Science;
2. the vocabulary, terminology and conventions of Science, including symbols, quantities and units;
3. applications of Science and of their technological, economic, environmental and social implications;
4. the significance of information and communication technology in the day-to-day life and in the world of work.

Questions assessing these objectives will often begin with words such as *define, state, describe, outline, etc.*

AO2 Handling Information and Solving Problems

Candidates should be able to:

1. solve problems as they relate to day-to-day life, including some of a quantitative nature;
2. use information to identify patterns, report trends, draw inferences, make predictions and propose hypotheses;
3. locate, select, organise and present information from a variety of sources;
4. translate information from one form to another;
5. manipulate numerical and other data;
6. present explanations for phenomena, patterns and relationships.

Questions assessing these objectives may contain information which is unfamiliar to candidates. In answering such questions, candidates are required to take principles and concepts in the syllabus and apply them to the situations described in the questions.

Questions assessing these objectives will often begin with words such as *discuss*, *predict*, *suggest*, *calculate*, *determine, etc*.

AO3 Experimental Skills and Investigations

Candidates should be able to:

1. follow a sequence of instructions;
2. use appropriate techniques, apparatus and materials;
3. handle instruments, apparatus and materials safely;
4. make and record observations, measurements and estimates;
5. interpret and evaluate observations and data;
6. plan investigations and / or evaluate methods and suggest possible improvements;
7. convert acquired skills into creative innovations;
8. apply knowledge and draw conclusions in practical situations.

3.3 Relationship between Assessment Objectives and Components

The table shows the raw marks and the weighting of each skill area by component as well as the total for each skill area in the overall assessment.

Assessment Objectives		Marks for Skill Areas and Weightings in Paper				Weighting of AO in qualification
		Paper 1	Paper 2	Paper 3	Paper 4	
AO1: Knowledge with Understanding	recall	12 ± 2 (30 %)	22 ± 2 (30 %)	–	–	50 %
	understanding	12 ± 2 (33 %)	22 ± 2 (33 %)	–	–	
AO2: Handling Information and Problem Solving		15 (37 %)	26 (37 %)	–	–	30 %
AO3: Experimental Skills		–	–	100 %	100%	20 %
Total Marks		40	70	30	30	
Weighting of paper in overall qualification		30 %	50 %	20 %	20 %	100 %

4. CONTENT

This section presents the content as prescribed in the Physics Teaching Syllabus.

EXPERIMENTAL / INVESTIGATION SKILLS

TOPIC	GENERAL OBJECTIVES	SPECIFIC OBJECTIVES
	Learners should	*Learners should*
Experimental / Investigation Skills	apply basic skills for scientific investigation:	
	• using and organising apparatus and materials:	- follow a sequence of instructions - identify apparatus and materials useful for scientific activities - practise accepted safety procedures - apply appropriate techniques in manipulating laboratory equipment and materials
	• collecting data	- make observations using the senses - collect qualitative and quantitative data - measure and make estimations - accurately record an observation - record data on a table or chart or graphs
	• handling experimental observations and data	-- predict outcome of an event based upon previous observations - identify relationships among phenomena - draw and interpret graphs or tables - interpolate or extrapolate conclusions when given appropriate data - identify conditions which cause or influence change - distinguish among independent, dependent or controlled variables - draw conclusions - comment, recognise anomalies and make modifications - describe orally and in writing a sequence of events occurring in an experiment or investigation
	• apply basic process skills to problem solving	- identify a problem - plan for an investigation - carry out an investigation - evaluate investigations

1. GENERAL PHYSICS

Topic	General Objectives	Specific Objectives
	Candidates should be able to:	***Candidates should be able to:***
1.1. Length and Time	1.1.1 perform accurate measurement of length and time	1.1.1.1. state fundamental physical quantities and give their SI units. 1.1.1.2. measure small lengths accurately using rulers, Vernier caliper and micrometer screw gauge. 1.1.1.3. identify sources of errors in measurement of length from a given measuring instrument. 1.1.1.4. measure time accurately using stop clock / watch. 1.1.1.5. estimate the accuracy of a given measuring instrument. 1.1.1.6. identify sources of errors in measurements of time. 1.1.1.7. determine the period of a pendulum.
1.2. Motion	1.2.1. show understanding of motion and the relationship between the variables	1.2.1.1. define distance, displacement, speed, velocity and acceleration. 1.2.1.2. use simple equations to calculate speed, velocity, distance and acceleration. 1.2.1.3. identify motion with uniform and non-uniform velocity. 1.2.1.4. identify uniformly accelerated and non-uniformly accelerated motion. 1.2.1.5. plot and interpret distance-time, speed-time graphs for uniform motion. 1.2.1.6. plot and interpret distance-time, speed-time graphs for non-uniform motion. 1.2.1.7. use equations of motion in simple calculation. 1.2.1.8. define *g* (acceleration due to gravity) 1.2.1.9. use *g* in solving problems on motion 1.2.1.10. state that acceleration of free fall for a body near earth is constant. 1.2.1.11. describe the motion of a body freely falling in air. 1.2.1.12. describe qualitatively the motion of objects falling in a liquid. 1.2.1.13. understand the meaning of the term “terminal velocity”.
1.3. Mass, Weight and Centre of Mass	1.3.1. show the relationship between mass, weight and centre of mass	1.3.1.1. demonstrate an understanding that mass is a measure of the amount of substance in a body. 1.3.1.2. define inertia and relate it to mass 1.3.1.3. define weight and its relationship to mass 1.3.1.4. measure mass and weight using appropriate balances 1.3.1.5. define centre of mass 1.3.1.6. determine centre of mass of plane laminas 1.3.1.7. perform and explain an experiment to determine the centre of mass of an irregular lamina 1.3.1.8. demonstrate and describe factors affecting the stability of objects

1.4. Density	1.4.1. measure density of various objects	1.4.1.1. define density. 1.4.1.2. determine densities of solids and liquids experimentally. 1.4.1.3. use the equation $\rho = \frac{m}{V}$ in simple calculations. 1.4.1.4. describe an experiment to determine the density of air. 1.4.1.5. use a hydrometer to measure densities of liquids.
1.5. (a). Forces effects on shape and size	1.5.1. show understanding of the effects of forces on shape and size of objects	1.5.1.1. demonstrate that force may cause change in shape/size of objects. 1.5.1.2. determine the relationship between load and extension. 1.5.1.3. plot, draw and interpret extension-load graphs and describe the associated experimental procedure 1.5.1.4. recognise the significance of the term "Limit of Proportionality" for an extension -load graph and use proportionality in simple calculations 1.5.1.5. describe quantitatively the extensions of elastic materials in series and parallel
(b). effects on motion	1.5.2. show understanding of the effects of force on motion	1.5.2.1. describe ways in which a force may cause change in the motion of a body. 1.5.2.2. use the relationship $F = ma$ in calculations. 1.5.2.3. demonstrate the effects of friction on the motion of a body. 1.5.2.4. perform simple calculations in cases where there is friction. 1.5.2.5. describe the effects of centripetal force on the motion along curved paths. 1.5.2.6. state and use Newton's laws of motion.
(c). turning effects of forces	1.5.3. acquire knowledge on turning effects of forces and appreciate their role in everyday life	1.5.3.1. describe the moment of a force in terms of its turning effect, including levers, and give everyday examples 1.5.3.2. perform and describe an experiment to verify the principle of moments 1.5.3.3. use the concept of moment of force in simple calculations 1.5.3.4. describe the effects of parallel forces on an object 1.5.3.5. determine the conditions of equilibrium for parallel forces 1.5.3.6. describe couples and give simple examples of couples in equilibrium and causing rotation.
1.6. Scalars and vectors	1.6.1. distinguish between scalar and vector quantities	1.6.1.1. define scalar and vector quantities and give examples 1.6.1.2. determine the resultant of any two vectors. 1.6.1.3. classify any physical quantity as a vector or a scalar.

1.7. Energy, Work and Power (a) Energy	1.7.1. acquire knowledge on sources of energy and their limitations	1.7.1.1. list various forms of energy and identify their sources. 1.7.1.2. describe energy conversions and apply the principle of conservation of energy giving examples. 1.7.1.3. describe and express a qualitative understanding of processes by which energy is converted from one form to another, including reference to; (i) chemical/fuel energy (a re-grouping of atoms) (ii) hydroelectric generation (emphasising the mechanical energies involved) (iii) solar energy (nuclei of atoms in the Sun) (iv) nuclear energy (fusion and fission) (v) geothermal energy (vi) wind energy 1.7.1.4. define kinetic and potential energy (mechanical). 1.7.1.5. use kinetic and gravitational potential energy in calculations involving energy conversions. 1.7.1.6. list major energy sources in Botswana. 1.7.1.7. describe the socio economic and environmental impact of each energy sources locally and globally. 1.7.1.8. determine the efficiency of energy converters.
(b). Work	1.7.2. show the relationship between work, energy	1.7.2.1. relate work done to the magnitude of a force and the distance moved and make calculations involving F x s 1.7.2.2. describe the relationship between work and energy
(c). Power	1.7.3 show the relationship between work and power	1.7.3.1. define power 1.7.3.2. use the equation $P = \frac{W}{t}$ in simple calculations

1.8. Pressure	1.8.1. acquire knowledge on pressure and appreciate the wide application of pressure in everyday life situations	1.8.1.1. relate pressure to force and area, using appropriate examples and the equation $P = \frac{F}{A}$ 1.8.1.2. describe the effects of atmospheric pressure 1.8.1.3. describe the simple mercury barometer and its use in measuring atmospheric pressure 1.8.1.4. use isobar patterns on weather charts and pressure (in millibars) to predict type of weather, including wind strength and direction 1.8.1.5. relate quantitatively the pressure beneath a fluid surface to depth and density of fluid, using appropriate examples 1.8.1.6. use and describe the use to a manometer

2. THERMAL PHYSICS

Topic	General Objectives	Specific Objectives
	Candidates should be able to:	***Candidates should be able to:***
2.1. Simple kinetic molecular model of matter	2.1.1 recognise the differences between the three states of matter	2.1.1.1. state the distinguishing properties of solids, liquids and gases
	2.1.2. show understanding of the molecular model	2.1.2.1. describe qualitatively, with relation to the forces and distances between molecules, the molecular structure of solids, liquids and gases 2.1.2.2. interpret the temperature of a gas in terms of the motion of its molecules 2.1.2.3. interpret the pressure of a gas in terms of the motion of its molecules 2.1.2.4. describe qualitatively the effect of a change of temperature on the pressure of a gas at constant volume 2.1.2.5. show an understanding of the random motion of particles in a suspension 2.1.2.6. describe this motion (Brownian motion) in terms of random molecular bombardment
	2.1.3. show understanding of the term evaporation and its applications	2.1.3.1. describe evaporation in terms of the escape of more energetic molecules from the surface of a liquid 2.1.3.2. demonstrate an understanding of how temperature, humidity, surface area and draught over a surface influence evaporation 2.1.3.3. explain how evaporation causes cooling and give examples 2.1.3.4. give everyday applications of cooling by evaporation
	2.1.4. acquire knowledge on the behaviour of a fixed mass of a gas in relation to pressure and volume	2.1.4.1. relate the change in volume of a gas to change in pressure applied to the gas at constant temperature 2.1.4.2. use the equation PV = constant at constant temperature in simple calculations

2.2. Thermal expansion of matter	2.2.1. understand the concept of thermal expansion of matter	2.2.1.1. describe and demonstrate the thermal expansion of solids, liquids and gases 2.2.1.2. show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases 2.2.1.3. identify and explain some of the everyday applications and consequences of thermal expansion including thermostat 2.2.1.4. describe and show qualitatively the effect of a change of temperature on the volume of a gas at constant pressure 2.2.1.5. show an understanding of absolute zero as the minimum possible temperature 2.2.1.6. relate the Kelvin scale to the Celsius scale
2.3. Measurement of temperature	2.3.1 demonstrate understanding of the concepts and instruments involved in the measurement of temperature	2.3.1.1. appreciate how a physical property which varies with temperature may be used for the measurement of temperature e.g. thermal expansion and e.m.f. 2.3.1.2. recognise the need for and identify fixed points of a temperature scale 2.3.1.3. demonstrate understanding of sensitivity, range and linearity 2.3.1.4. describe the structure and action of liquid-in-glass thermometers (Laboratory and Clinical) 2.3.1.5. describe the structure and action of a thermocouple 2.3.1.6. show understanding of the use of a thermocouple for measuring high temperatures and those which vary rapidly
2.4. Heat capacity	2.4.1 understand the concept of heat capacity	2.4.1.1. relate a rise in temperature of a body to an increase in internal energy (random thermal energy) 2.4.1.2. show understanding of the term heat capacity and specific heat capacity 2.4.1.3. perform and describe experiments to measure the specific heat capacity of solids and liquids 2.4.1.4. perform simple calculations related to heat capacity

2.5. Melting and boiling	2.5.1. acquire knowledge on the concepts of melting and boiling	2.5.1.1. describe melting/solidification and boiling/condensation in terms of energy input without a change in temperature 2.5.1.2. state the meaning of melting point and boiling point 2.5.1.3. state the difference between boiling and evaporation 2.5.1.4. sketch and interpret cooling curves 2.5.1.5. describe and appreciate the unusual expansion of water and its consequences 2.5.1.6. show understanding of the terms latent heat and specific latent heat 2.5.1.7. use the term latent heat and give a molecular interpretation of latent heat 2.5.1.8. relate the concept of latent heat to refrigeration. 2.5.1.9. describe an experiment to determine the specific latent heat for steam and for ice and make the necessary calculations
2.6. Transfer of thermal energy	2.6.1. acquire knowledge on heat transfer by conduction, convection and radiation	2.6.1.1. give a simple molecular account of heat transfer in solids 2.6.1.2. perform and describe experiments to demonstrate good and bad conductors of heat 2.6.1.3. relate convection in fluids to density changes 2.6.1.4. perform and describe experiments to illustrate convection 2.6.1.5. show understanding of the term radiation (infrared) 2.6.1.6. perform and describe experiments to distinguish between good and bad emitters/absorbers of heat.
	2.6.2. acquire knowledge on the applications and consequences of energy transfer	2.6.2.1. identify and explain some of the everyday applications of conduction, convection and radiation including Thermos flask, car cooling system, water heating system 2.6.2.2. identify and explain some of the everyday consequences of conduction, convection and radiation including cyclones, land and sea breezes, days and nights in deserts, typhoons, global warming and the greenhouse effect

3. PROPERTIES OF WAVES, INCLUDING LIGHT AND SOUND

Topic	General Objectives	Specific Objectives
	Candidates should be able to:	***Candidates should be able to:***
3.1. General wave properties	3.1.1. acquire basic knowledge about wave motion	3.1.1.1. describe wave motion 3.1.1.2. define the terms wave front, speed, frequency, wavelength and amplitude 3.1.1.3. perform experiments to show: (i) wave motion and wave front (ii) relationship between speed, frequency and wavelength 3.1.1.4. use the wave equation $v = f\lambda$ 3.1.1.5. sketch and interpret displacement – time graphs 3.1.1.6. sketch and interpret displacement – distance graphs
	3.1.2. recognise the differences between transverse and longitudinal waves.	3.1.2.1. describe transverse and longitudinal waves and their nature 3.1.2.2. give examples of transverse and longitudinal waves 3.1.2.3. demonstrate how transverse and longitudinal waves are formed
	3.1.3. use water waves to show reflection, refraction and diffraction of waves.	3.1.3.1. demonstrate the formation of water waves 3.1.3.2. perform an experiment to show the effect of depth on the speed of a wave 3.1.3.3. use a ripple tank to show and describe: (i) reflection at a plane surface (ii) refraction due to a change of speed.
3.2. Light	3.2.1. demonstrate understanding of reflection of light by plane and curved surfaces	3.2.1.1. define reflection and give examples 3.2.1.2. perform and describe an experiment to illustrate the laws of reflection. 3.2.1.3. observe and describe the characteristics of images formed by plane surfaces. 3.2.1.4. construct ray diagrams to show images formed by plane mirrors 3.2.1.5. give examples of uses of plane and curved mirrors 3.2.1.6. use the law $i = r$ in reflection 3.2.1.7. perform measurements and calculations involving angles

3.2. Light	3.2.2. demonstrate understanding of refraction of light, total internal reflection and refractive index	3.2.2.1. describe and perform experiments to demonstrate refraction of light through glass blocks 3.2.2.2. use the terminology for the angles i and r in refraction and describe the passage of light through parallel-sided transparent material 3.2.2.3. use the equation $\frac{\sin i}{\sin r}$ = constant 3.2.2.4. give the meaning of refractive index 3.2.2.5. understand the terms real depth and apparent depth and use them to determine the refractive index 3.2.2.6. give the meaning of critical angle 3.2.2.7. show understanding of total internal reflection and the formation of mirages 3.2.2.8. describe the action of optical fibres. 3.2.2.9. explain the formation of mirages
	3.2.3. understand the action of a thin lens on a beam of light	3.2.3.1. differentiate between the converging and diverging lenses 3.2.3.2. describe the action of a thin lens on a beam of light 3.2.3.3. use and understand the meaning of the terms focal length, principal focus and principal axis with respect to a thin converging lens 3.2.3.4. determine experimentally the focal length of a thin converging lens 3.2.3.5. draw ray diagrams to illustrate the formation of real and virtual images of an object by a thin converging lens 3.2.3.6. use and describe the use of a single lens as a magnifying glass 3.2.3.7. describe the use of a single lens to form a real image, e.g. a camera, a projector, a photographic enlarger 3.2.3.8. determine the magnification of a thin converging lens.
3.3. Electro-magnetic spectrum	3.3.1. show an understanding of the main features of the electro-magnetic spectrum	3.3.1.1. describe the main components of the electromagnetic spectrum 3.3.1.2. state and describe their methods of detection 3.3.1.3. state the uses, sources and side effects of the components of the electromagnetic spectrum.
	3.3.2. appreciate that all e.m. waves travel with the same high speed in vacuum	3.3.2.1. state that all e.m. waves travel with the same high speed in vacuum 3.3.2.2. state the magnitude of this speed 3.3.2.3. use the wave equation $c = f\lambda$ in simple calculations

3.4. Sound	3.4.1. understand how sound is produced	3.4.1.1. describe the production of sound by vibrating sources 3.4.1.2. describe the longitudinal nature of sound waves and describe compression and rarefaction in relation to pressure variations
	3.4.2. recognise that sound waves require a medium for their transmission	3.4.2.3. show understanding that a medium is required in order to transmit sound waves 3.4.2.4. state the approximate range of audible frequencies for human beings and other animals 3.4.2.5. perform an experiment to determine the range of audible frequencies for human beings 3.4.2.6. state the uses of ultra-sonic sound waves 3.4.2.7. understand noise pollution 3.4.2.8. perform an experiment to determine the speed of sound in air and make necessary calculations 3.4.2.9. state the order of magnitude of the speeds of sound in gases, liquids and solids 3.4.2.10. perform simple calculations based on the speed of sound in gases, liquids and solids
	3.4.3. understand reflection of sound waves	3.4.3.1. describe how the reflection of sound may produce an echo 3.4.3.2. describe how multiple reflections may produce reverberations
	3.4.4. understand the terms pitch, loudness and quality of sound	3.4.4.1. perform an experiment to relate the loudness and pitch of sound to amplitude and frequency respectively 3.4.4.2. describe the factors which influence the quality (timbre) of sound waves 3.4.4.3. describe the effect of multiple reflections of sound waves (acoustics) on the quality of sound

4. ELECTRICITY AND MAGNETISM

Topic	General Objectives	Specific Objectives
	Candidates should be able to:	***Candidates should be able to:***
4.1. Magnetism	4.1.1. understand simple phenomena of magnetism	4.1.1.1. state the properties of magnets 4.1.1.2. distinguish between magnetic and non-magnetic materials 4.1.1.3. describe the phenomenon of induced magnetism 4.1.1.4. describe different methods of magnetisation e.g. electricity, stroking, 4.1.1.5. describe different methods of demagnetisation e.g. electricity, hitting and heating 4.1.1.6. give an account of magnetic saturation 4.1.1.7. describe and demonstrate methods of detecting a magnetic field around a magnet 4.1.1.8. use a plotting compass to plot the field lines of a magnetic field of a bar magnet 4.1.1.9. distinguish between the magnetic properties of iron and steel 4.1.1.10. distinguish between the design and use of permanent magnets and electromagnets 4.1.1.11. give reasons for the choice of material for, and use of, magnetic screening 4.1.1.12. give examples of the use of magnetic materials.
4.2. Electricity	4.2.1. understand the concept of electric charge	4.2.1.1. describe the phenomenon of electrostatic charging 4.2.1.2. perform simple experiments to show electrostatic charging 4.2.1.3. state the two types of charges, namely positive and negative 4.2.1.4. state that charge is measured in coulombs 4.2.1.5. demonstrate that unlike charges attract and that like charges repel 4.2.1.6. understand how the gold leaf electroscope is used to detect charge 4.2.1.7. understand the concept of discharging and relate it to occurrence of lightning 4.2.1.8. describe the design and use of a lightning conductor 4.2.1.9. describe an electric field as a region in which an electric charge experiences an electric force 4.2.1.10. state the direction of lines of force and describe simple field patterns 4.2.1.11. give an account of charging by induction e.g. touching and separation of charges 4.2.1.12. use the electron model to distinguish between electrical conductors and insulators and give examples

4.2. Electricity	4.2.2. understand the concept of electric current	4.2.2.1. perform simple experiments to show the relationship between flow of charge and current 4.2.2.2. define electric current as the rate of flow of charge. 4.2.2.3. use the equation $I = \frac{Q}{t}$ 4.2.2.4. use and describe the use of an ammeter with different ranges including a milliampere range
	4.2.3. understand the concept of electro-motive force	4.2.3.1. understand that the e.m.f. is measured by the energy dissipated by a source in driving a charge round a complete circuit (e.m.f = $\frac{W}{Q}$) 4.2.3.2. state that the e.m.f of a source of electrical energy is measured in volts 4.2.3.3. give a definition of the volt [Energy / Charge (J / C)]
	4.2.4. show an understanding of potential difference	4.2.4.1. give an explanation of potential difference 4.2.4.2. state that the potential difference across a circuit component is measured in volts 4.2.4.3. use and describe the use of a voltmeter with different ranges
	4.2.5. show an understanding of resistance	4.2.5.1. give an explanation of resistance 4.2.5.2. state that resistance is measured in ohms 4.2.5.3. state that resistance = $\frac{\text{potential difference}}{\text{current}}$ and use the equation $R = \frac{V}{I}$ 4.2.5.4. perform and describe an experiment to determine resistance using a voltmeter and an ammeter and make the necessary calculation 4.2.5.5. describe qualitatively the relationship between resistance, length and cross-sectional area. 4.2.5.6. use quantitatively the proportionality between resistance and the length and the cross-sectional area of a wire ($R = \frac{\rho l}{A}$) 4.2.5.7. show understanding of internal resistance
	4.2.6. show an understanding of V / I characteristic graph (Ohms Law)	4.2.6.1. sketch and interpret the V / I characteristic graphs for metallic (ohmic) conductors. 4.2.6.2. sketch and interpret the V / I characteristic graphs for non-ohmic conductors 4.2.6.3. appreciate the limitations of Ohm's law

4.2. Electricity	4.2.7. show an understanding of electric circuits	4.2.7.1. identify circuit components and their symbols 4.2.7.2. perform experiments using simple electric circuits 4.2.7.3. draw and interpret circuit diagrams 4.2.7.4. perform experiments to show that (i) current is the same at every point in a series circuit (ii) the sum of the p.d's in a series circuit is equal to the terminal p.d. across the source. (iii) the current from the source is the sum of the currents in the separate branches of a parallel circuit. (iv) the p.d. across components in parallel is the same as the terminal p.d. 4.2.7.5. calculate the total resistance of two resistors in series 4.2.7.6. calculate the total resistance of two or three resistors in parallel 4.2.7.7. perform calculations involving components in different circuit combinations
4.3. Practical electric circuitry	4.3.1. appreciate the use of electricity in everyday life situations	4.3.1.1. state the use of electricity in heating, lighting machines, security, communication 4.3.1.2. use the equations $P = VI$, $E = VIt$ 4.3.1.3. calculate the cost of using electrical appliances
	4.3.2. understand the dangers of electricity	4.3.2.1. state the hazards of (i) damaged insulation (ii) overheating of cables (iii) damp conditions (iv) overloading of sockets 4.3.2.2. explain how these hazards can be prevented
	4.3.3. acquire knowledge on the safe use of electricity in the home	4.3.3.1. show understanding of the use of fuses and fuse ratings 4.3.3.2. explain the need for earthing metal cases and for double insulation of electrical appliances 4.3.3.3. give the meaning of the terms: live, neutral and earth 4.3.3.4. describe and correctly wire, a mains plug 4.3.3.5. understand simple lighting (including lamps in parallel), and ring-main circuits in the house 4.3.3.6. give the reason for connecting switches and fuses in live wires 4.3.3.7. describe the necessary diagnostic steps to be followed when there is an electrical fault in an appliance

4.4. Electromagnetic effects	4.4.1. understand the concept of electromagnetic induction	4.4.1.1. perform and describe an experiment which shows that a changing magnetic field can induce an e.m.f. in a circuit 4.4.1.2. state the factors affecting the magnitude of the induced e.m.f. 4.4.1.3. show understanding that the direction of an induced e.m.f. opposes the change producing it (Lenz's law)
	4.4.2. acquire basic knowledge on the operation of an a.c. generator	4.4.2.1. describe a simple form of an a.c. generator (e.g. rotating coil or rotating magnet) and the use of slip rings 4.4.2.2. sketch and interpret a graph of voltage output against time for a simple a.c. generator
	4.4.3. acquire knowledge on the operation of a Transformer	4.4.3.1. describe the structure of a basic iron-cored transformer as used for voltage transformations 4.4.3.2. describe the principle of operation of a transformer 4.4.3.3. use the equations $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ and $V_pI_p = V_sI_s$ (for 100% efficiency) in calculations 4.4.3.4. perform experiments to demonstrate the difference between a step-up transformer and a step-down transformer 4.4.3.5. describe the use of the transformer in high voltage transmission of electricity 4.4.3.6. discuss the energy loss in cables and transformers 4.4.3.7. give the advantages of high voltage transmission
	4.4.4. show understanding of the magnetic effect of a current	4.4.4.1. perform and describe an experiment to show the pattern and direction of the magnetic field due to currents in straight wires and in solenoids 4.4.4.2. state the qualitative variation of the strength of the magnetic field over salient parts of the pattern 4.4.4.3. describe the effect on the magnetic field of changing the magnitude of the current
	4.4.5. acquire knowledge on the structure and use of electromagnets	4.4.5.1. describe the structure of a simple electromagnet 4.4.5.2. demonstrate the factors that affect the strength of an electromagnet 4.4.5.3. describe applications of the magnetic effect of a current including the circuit and action of an electric bell and a simple relay

4.4. Electromagnetic effects	4.4.6. recognise that a current carrying conductor experiences a force in a magnetic field	4.4.6.1. perform and describe an experiment to show the force on a current-carrying conductor in a magnetic field, including the effect of reversing (i) the current, (ii) the direction of the field 4.4.6.2. determine the relative directions of force, field and current 4.4.6.3. describe the field patterns between parallel conductors carrying currents and relate these to the forces which exist between the conductors
	4.4.7. acquire basic knowledge on the operation of a d.c. motor	4.4.7.1. show understanding that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by increasing; (i) the number of turns on the coil, (ii) the current 4.4.7.2. relate this turning effect to the action of an electric motor 4.4.7.3. construct a simple d.c. motor 4.4.7.4. describe and show understanding of the action of a split-ring commutator in a two-pole, single-coil motor and the effect of a soft-iron cylinder between the poles of the magnet 4.4.7.5. state the uses of electric motors
	4.4.8. show understanding of the operation of a microphone and a loudspeaker	4.4.8.1. describe the action of a microphone 4.4.8.2. describe the action of a loudspeaker (details of the cone will not be required) 4.4.8.3. relate the use of microphones and loudspeakers to communication e.g. telephone receiver
4.5. Introductory electronics	4.5.1. acquire basic knowledge on thermionic emission	4.5.1.1. show understanding that charged particles are emitted by a hot metal filament and describe their deflection in electric fields and magnetic fields 4.5.1.2. deduce that the particles emitted in thermionic emission are negatively charged and can be identified as electrons 4.5.1.3. distinguish between the direction of flow of electron current and conventional current
	4.5.2. understand the basic structure and use of cathode-ray oscilloscope	4.5.2.1. describe in outline the basic structure and action of a cathode-ray oscilloscope (detailed circuits are not required) 4.5.2.2. use and describe the use of a cathode-ray oscilloscope to display wave forms. 4.5.2.3. measure p.d's and short intervals of time (detailed circuits are not required) 4.5.2.4. relate the principle of the CRO to a TV set

4.5. Introductory electronics	4.5.3. acquire knowledge on action and use of circuit components	4.5.3.1. show understanding of the function of resistors in circuits 4.5.3.2. use a given colour code for resistance values 4.5.3.3. show an appreciation of the need to choose components with suitable power ratings 4.5.3.4. describe the action of a variable potential divider (potentiometer) 4.5.3.5. describe the action of thermistors and light-dependent resistors and show understanding of their use as input transducers 4.5.3.6. describe the action of a capacitor as an energy store and show understanding of its use in time delay circuits 4.5.3.7. describe the action of a reed switch and reed relay 4.5.3.8. show understanding of the use of reed relays in switching circuits 4.5.3.9. recognise and show understanding of circuits operating as light sensitive switches and temperature operated alarms (using a reed relay or other circuits)
	4.5.4. understand the action and use of diodes in electrical circuits	4.5.4.1. describe the action of a diode as a unidirectional conductor of electricity 4.5.4.2. describe the use of diodes as rectifiers in a circuit

5. ATOMIC PHYSICS

Topic	General Objectives	Specific Objectives
	Candidates should be able to:	***Candidates should be able to:***
5.1. Radioactivity	5.1.1. appreciate the existence of radioactive emissions	5.1.1.1. describe the process of radioactivity. 5.1.1.2. give examples of radioactive materials 5.1.1.3. state the dangers of exposure to radioactive emissions 5.1.1.4. describe the safe handling and storage of radioactive material in a laboratory 5.1.1.5. state that alpha, beta and gamma emissions can be emitted during the process of radioactivity 5.1.1.6. describe methods of detection of these emissions by Geiger-Muller tubes 5.1.1.7. show awareness of the existence of background radiation
	5.1.2. understand the characteristics of the three emissions	5.1.2.1. show understanding that radioactive emissions occur randomly over space and time 5.1.2.2. state, for each radioactive emission: (i) its nature (ii) its relative ionising effect (iii) its relative penetrating power 5.1.2.3. describe their deflection in electric and magnetic fields 5.1.2.4. interpret their relative ionising effects
	5.1.3. describe the composition of the nucleus	5.1.3.1. describe the composition of the nucleus in terms of protons and neutrons 5.1.3.2. use and explain the terms (i) proton number = atomic number (Z) (ii) nucleon number = mass number (A) 5.1.3.3. use the term nuclide and the nuclide notation ${}^{A}_{Z}X$ 5.1.3.4. describe an isotope as nuclide with same Z but different A 5.1.3.5. give examples of isotopes and their uses

5.1. Radioactivity	5.1.4. understand nuclear reactions	5.1.4.1. state the meaning of radioactive decay as a process by which a heavy nuclide breaks down to smaller and more stable nuclides 5.1.4.2. use equations (involving symbols) to represent changes in the composition of the nucleus when particles are emitted 5.1.4.3. distinguish between fission and fusion 5.1.4.4. describe chain reactions as applied in nuclear reactors 5.1.4.5. relate fusion to energy production in the sun 5.1.4.6. discuss the advantages and disadvantages of using these processes to provide energy 5.1.4.7. use the equation $E = mc^2$ in simple calculations
	5.1.5. understand the term half-life	5.1.5.1. define half-life as the time for half the original number of radioactive particles to decay 5.1.5.2. use half-life in simple calculations 5.1.5.3. plot and interpret decay curves
	5.1.6. appreciate the uses and dangers of radioactive materials	5.1.6.1. state the uses of radioactive materials in industries, agriculture, medicine and production of electricity 5.1.6.2. describe the dangers of waste products of radioactive materials and give suggestions on safer disposal of these waste products

5. OTHER INFORMATION

5.1 GRADING AND REPORTING

BGCSE results are reported on a scale of A* – G, A* being the highest and G the lowest. Ungraded (U) indicates that the candidate's performance fell short of the standard required for grade G. Ungraded (U) will be reported on the statement of results but not on the certificate. The letters Q (result pending) and X (no result) may also appear on the statement of results.

5.2 GRADE DESCRIPTORS

As a guide to what might be expected of a candidate, Grade Descriptors are given as follows.

A **Grade A** candidate should be able to:

- recall a wide range of scientific facts, concepts, principles and theories and use complex scientific knowledge
- understand the relationship between complex scientific concepts and relate them to scientific principles and theories in real life situations
- apply appropriate scientific knowledge and understanding, identify complex patterns, and report trends from given information and draw appropriate conclusions and give recommendations to novel situations
- translate abstract information from one form to another: process information from graphs, tables and charts; represent information in the form of graphs, tables and charts
- make concise and complete experimental procedures (plan); critically discuss the plan; generate hypotheses to solve a scientific problem, identify and deal with a wide range of variables
- use appropriate apparatus and techniques safely and correctly; follow all given instructions to perform an experiment
- make accurate observations; decide the level of precision needed in measurements and record detailed experimental data; process data, make appropriate conclusions and generalisations; identify and explain anomalous observation

A **Grade C** candidate should be able to:

- recall a range of scientific facts, concepts, principles and theories and use scientific knowledge
- understand the relationship between scientific concepts and relate them to scientific principles and theories in real life situations
- apply scientific knowledge and understanding, identify patterns, and report trends from given information and draw relevant conclusions and give recommendation to simple situations
- translate information from one form to another: process information from graphs, tables and charts; represent information in the form of graphs, tables and charts
- make concise and complete experimental procedures (plan); generate hypotheses to solve a scientific problem and identify some key factors to vary and control
- use appropriate apparatus and techniques safely and correctly; follow most given instructions to perform an experiment
- make accurate observations, measurements and record experimental data; process data, make conclusions and generalisations; recognise when it is necessary to repeat observation and measurement

A **Grade E** candidate should be able to:

- recall simple scientific facts, concepts, principles and theories and use simple scientific knowledge
- understand the relationship between simple scientific concepts and relate them to simple scientific principles and theories in real life situations
- apply simple scientific knowledge and understanding, identify patterns, and report trends from given information and draw conclusions and give recommendation to familiar situations
- translate simple information from one form to another: process information from graphs, tables and charts with some assistance; represent information in the form of graphs, tables and charts
- make simple and complete experimental procedures (plan); devise a fair test which only involves a few factors, generate hypotheses
- use basic apparatus and techniques safely and correctly; follow a few given instructions to perform an experiment involving a few steps
- make simple observations; measurements and record experimental data; process data, make conclusions where appropriate

6. Appendices

A. MATHEMATICAL SKILLS

Candidates will be required to perform quantitative work, including calculations. They should be able to use scientific calculators and mathematical instruments.

The mathematical requirements, which form part of this syllabus, are listed below.

add, subtract, multiply and divide numbers
recognize and use expression in decimal form
use simple formulae
understand and use averages
read, interpret and draw simple inferences from tables and statistical diagrams
find fractions or percentages of quantities
construct and interpret pie-charts
calculate with fractions, decimals, percentage or ratios
manipulate and solve simple equations
substitute numbers in simple equations
recognize and use expressions in standard form
interpret and use graphs
choose by simple inspection and then draw the best smooth curve through a set of points on a graph
select appropriate axes and scales for plotting a graph
determine the intercept of a linear graph
understand and use direct and indirect proportion

B. PHYSICAL QUANTITIES, SYMBOLS AND UNITS

Candidates will be required to demonstrate an understanding of the physical quantities, and their corresponding SI units, listed below. They will be required to use them in quantitative work and calculations.

physical quantity	**symbols**	**SI unit(s)**	**other unit(s)**
length	*l, h*	metre (m)	kilometre(km); centimetre (cm); millimetre (mm)
mass	*M, m*	kilogram (kg)	gram (g); milligram (mg)
time	*t*	seconds (s)	milliseconds (ms), minutes (min), hours (h)
temperature	*θ, T*	Kelvin (K)	degree Celsius (^{o}C)
current	*I*	ampere (A)	milliampere (mA)

DERIVED QUANTITIES AND UNITS

physical quantity	**symbols**	**unit(s)**
area	*A*	cm^2; m^2
volume	*V*	cm^3; m^3
density	ρ	kg/m^3; g/cm^3
force	*F*	newton (N)
pressure	*P*	pascal (Pa); N/m^2; N/cm^2
speed	*u, v*	m/s; km/h
acceleration	*a*	m/s^2
energy	*E*	joule (J); kilojoule (kJ); megajoule (MJ)
power	*P*	watt (W); kilowatt (kW); megawatt(MW)
frequency	*f*	hertz (Hz); kilohertz (kHz)
electrical charge	*Q, q*	coulomb (C)
potential difference	*V*	volt (V)
resistance	*R*	ohm (Ω)
weight	*W*	newton (N)
acceleration of free fall	*g*	m/s^2, N/kg
work	*W*	joule (J)
specific heat capacity	*c*	J/(g °C), J/(kg °C)
specific latent heat	*l*	J/kg, J/g
wavelength	λ	m, cm
electromotive force	*E*	V

NOTE

Units, significant figures. Candidates would be advised in each question on the number of significant figures or decimal places they have to express their answers to. If there is no advice on such, answers can be given to any number of significant figures. Candidates should be aware that misuse of units that is, failure to code units where necessary or the inclusion of units in quantities defined as ratios is liable to be penalised.

Conventions (e.g. signs, symbols, terminology and nomenclature)
Syllabuses and question papers will conform to generally accepted international practice

C. GLOSSARY OF TERMS

Learning objectives in the content section of the syllabus are expressed in terms of what candidates **know**, **understand** and **can do**. The words used on the examination papers in connection with the assessment of these learning outcomes are contained in this glossary. This is neither exhaustive nor definitive but is meant to provide some useful guidance.

1. Writing questions about what candidates are expected to know

About 25 % of the marks are involved with *recall.* Words used on examination papers in connection with such questions may include:

"State...", "List...", "Give...", "Name....", "Define...", "Draw…", "Write…", "What…", "How…..", What is meant by….."

State or Name… implies a concise answer with little or no supporting argument.

List… requires a number of points generally each of one word, with no elaboration.

Define… is intended literally, only a formal statement or equivalent paraphrase being required.

What is meant by... normally implies that a definition should be given together with some relevant comment on the significance or context of the term(s) concerned, especially when two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

2. Writing questions about understanding

"***Understand***" may be associated with simple factual recall. In this sense the candidate is required to recall the relevant part of the defined syllabus and to use this recalled information to amplify, extend or expand this in a wider context. This wider context will include situations or materials with which the candidates are familiar.

Questions may include such words as:

"*Explain…" "Complete..." "Why.", "Construct...", "Which…*

Explain… may imply reasoning or some of reference to theory, depending on the context.

"**Understand**" may also be associated with skills other than factual recall. It can be used to assess the candidate's abilities in problem solving, interpretation and evaluation, data handling and in communication of scientific ideas, principles and concepts. Words such as "*Suggest...", "Work out…", "How would you know that*…" may be used in questions.

Suggest… Is used in two main contexts: either to imply that there is no unique answer or to imply that candidates are expected to apply their general knowledge to a situation that may not formally be in the syllabus. This would be related to the Assessment Objective 2.

3. Writing questions about "be able to".

The use of this phrase is always associated with higher-order skills of interpretation, evaluation, calculation and communication. It involves the ability to recall the appropriate material from the content and apply this knowledge.

Questions may include *"Be able to…", "deduce…", "relate….", "interpret…", "explain…", "carry out…", "evaluate…" "predict…..", "discuss…", "construct…", "suggest…", "calculate…", "find…", "demonstrate…", "estimate…", "determine..".*

deduce… is used in a similar way as predict except that some supporting statement is required, e.g., reference to a law or principle, or the necessary reasoning to be included in the answer.

predict… implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an early part of the question.

calculate… is used when a numerical answer is required. In general, working should be shown when two or more steps are involved.

find… is general term that may be interpreted as calculate, measure, determine, etc.

measure… implies that the quantity concerned can be directly obtained from suitable measuring instruments.

estimate… implies a reasoned order of magnitude statement or calculation of the quantity concerned making such implying assumptions as may be necessary about points of principle and about the values of quantities not otherwise used in the question.

discuss… requires the candidates to give critical account of the points involved in the topic.

determine… often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into standard formula.

D. PRESENTATION OF DATA

Tables

- Each column of a table will be headed with the physical quantity and the appropriate SI units, e.g., time / s, rather than time (s)
  There are two acceptable methods of stating units, e.g., m / s or ms^{-1}

- Candidates should use the number of significant figures appropriate to the precision of the measuring instrument.

- The column headings of the table can then be directly transferred to the axes of a constructed graph.

Graphs

- The independent variable will be plotted on the x-axis (horizontal axis) and the dependent variable plotted on the y-axis (vertical axis).

- The graph is the whole diagrammatic presentation. It may have one or several curves / lines plotted on it.

- Points on the curve / line should be clearly marked as crosses (**×**) or encircled dot (**⊙**).
  If a further curve / line is included, vertical crosses (**+**) may be used to mark the points.

- Plots of points should have an accuracy of better than 1mm and all read-offs.
  Plots should be made with a sharp pencil.