

ADVANCED LEVEL PHYSICS780

1. Introduction

The aims, examination schemes and syllabus content, have been designed to take account of the needs of different groups of candidates: on the one hand, those who will not be continuing their studies beyond A level, and those who may be proceeding to higher education. It is assumed that the syllabus will be taught as a two-year course, at a rate of six theory hours and two practical hours per week, to candidates who have taken an Ordinary level Physics course. The candidate's programme of practical work will include both experimental work designed to support the candidate's understanding of the principles of Physics and experiments which develop specific laboratory skills.

The aims of the syllabus set out below will closely match the objectives of teaching the course. The assessment objectives indicate the range of skills that will be tested in the examination. The list of operational objectives attempts to relate the content and skills to the examination papers as far as is possible.

2. Aims

The aims of the syllabus are:

- A) to foster the acquisition of knowledge and understanding of concepts and principles through the development of observational, practical and processing skills;
- B) to promote the application of concepts and principles of physics in technology and their social, economic and environmental implications;
- C) to encourage the study of physics through fieldwork and experimentation;
- D) To empower students with skills that will enable them to be competitive on the job market.

3. Assessment objectives

The assessment objectives of the syllabus will test:

AO1. Knowledge. The ability to:

- Recall basic physical principles, terminology, facts, and methods;
- State how physics is fundamental to many technological developments;
- Describe how physics contributes to the social, historical, environmental, technological and economic life of society.

AO2. Comprehension. Demonstrate an understanding of:

- Scientific facts and concepts;
- Scientific methods and techniques;
- Scientific terminology;
- Methods of presenting scientific information.

AO3. Application. Apply and use:

- Scientific facts and concepts;
- Scientific methods and techniques;
- Scientific terminology to communicate effectively;
- Appropriate method to present scientific information;
- Concepts and simple models in conjunction with laws and principles to interpret familiar or novel phenomena;
- Familiar laboratory apparatus effectively, taking into account safety measures.

AO4. Analysis, Separate or organize:

- Material or concepts into component parts.
- Scientific methods and techniques.
- Scientific terminology to communicate effectively.
- Appropriate method to present scientific information.
- Experiments clearly, positively and critically.

AO5. Synthesis. Build or construct:

- Patterns from diverse elements.
- Scientific methods and techniques.
- Scientific facts and concepts.
- Simple experiments, present data so obtained effectively, analyse this data satisfactorily, and recognize and respond to major sources of error.
- Hypotheses and test them graphically or by other means.

AO6. Evaluation. Judge or discriminate:

- Between values and ideas.
- Scientific facts and concepts.
- Scientific terminologies.
- Scientific methods and techniques.

4. Structure of the Examination

4.1. Weighting of Examination and Scheme of Assessment

Paper	Type of Question	Duration	Marks	Weighting	Number of Questions and Specifications	Weighting of Assessment Objectives
1	MCQs	1 ½ hours	100	30%	50 questions viz.: 5 on knowledge& comprehension, 10 on application, 15 on analysis, 15 on synthesis, 5 on evaluation	AO1 &AO2 = 10% AO3 = 20% AO4 = 30% AO5 = 300% AO6 = 10%
2	Short and long questions	1 hour	50	25%	Section 1: 5 compulsory short questions and 1 pair of long question (either/or type of question).	AO1 = 10% AO2 = 10% AO3 = 25% AO4 = 30% AO5 = 15% AO6 = 10%
	Data Analysis	30 minutes	20	5%	Section 2: 1 compulsory question on data analysis.	AO1 = 5% AO2 = 5% AO3 = 15% AO4 = 35% AO5 = 20% AO6 = 20%
	Long questions	1 hour	30	20%	Section 3: 1 question per option; candidate chooses 2 out of 4.	AO1 = 15% AO2 = 18% AO3 = 27% AO4 = 15% AO5 = 15% AO6 = 10%

Paper	Type of Question	Duration	Marks	Weighting	Number of Questions and Specifications	Weighting of Assessment Objectives
3	Practical book and field work project	SBA*	20	5%	A local examiner appointed by the CGCE Board will assess candidates' practical books.	AO1 = 5% AO2 = 5% AO3 = 15% AO4 = 35% AO5 = 20% AO6 = 20%
	Practical test	2 hours	80	15%	4 questions will be set; each to be done in 10 minutes and candidates will rotate through in 40 minutes. A mainstream practical test to be done in 1 h 20 min. Candidates will be provided with instructions on how to carry out the practical test.	

* School Based Assessment

4.2. Table of specifications

Question number	Objective(s)	Marks	Level of difficulty	Section
1	<i>Knowledge /Comprehension</i>	6	4 questions shall be a star (*), 3 questions a double stars (**) and 1 question a triple star (***) . Note that the *** stars question should be at most 4/40.	
2	<i>Application</i>	6		
3	<i>Analysis</i>	6		
4	<i>Synthesis</i>	5		
5	<i>Evaluation</i>	7		
6	<i>Knowledge</i>	3	Each question in this section	

Question number	Objective(s)	Marks	Level of difficulty	Section
Pair of long questions	<i>Comprehension</i>	3	carries twenty marks. The marks shall be awarded as follows: * questions carries 12/20 marks, ** questions carries 6/20 marks, and *** questions carries 2/20 marks.	
	<i>Application</i>	6		
	<i>Analysis</i>	3		
	<i>Synthesis</i>	3		
	<i>Evaluation</i>	2		
7 Data analysis	<i>Knowledge</i>	3	The question in this section carries twenty marks. The marks shall be awarded as follows * questions carries 12/20 marks, ** questions carries 6/20 marks, and *** questions carries 2/20 marks.	core
	<i>Comprehension</i>	3		
	<i>Application</i>	6		
	<i>Analysis</i>	3		
	<i>Synthesis</i>	3		
	<i>Evaluation</i>	2		
8,9,10, and 11 Long questions	<i>Knowledge</i>	2	Each question in this section carries fifteen marks. The marks shall be awarded as follows * questions carries 9/15 marks, ** questions carries 4/15 marks, and *** questions carries 2/15 marks.	Options Answer two out of the four questions
	<i>Comprehension</i>	2		
	<i>Application</i>	4		
	<i>Analysis</i>	3		
	<i>Synthesis</i>	2		
	<i>Evaluation</i>	2		

5. Cross Curricula Demands

A. **Calculus**. Candidates will be expected to use calculus.

B. **Arithmetic**. Candidates should, for example, be able to:

1. recognise and use expressions in decimal and standard form (scientific) notation, recognise abbreviations for 10^{-12} , 10^{-9} , 10^{-6} , 10^{-3} , 10^3 , 10^6 and 10^9 , use an electronic calculator for addition, subtraction, multiplication, division, and for finding arithmetic means, reciprocals, squares, square roots, sines, cosines, tangents, exponentials and logarithms, and their inverses;
2. take account of accuracy in numerical work and handle calculations so that significant figures are neither lost unnecessarily nor beyond what is justified;
3. make approximate evaluations of numerical expressions (e.g. $\pi^2 \approx 10$) and use such approximations to check the magnitude of machine calculations.

C. **Algebra**. Candidates should be able to:

1. change the subject of an equation (most relevant equations involve only the simpler operations but may include positive and negative indices and square roots),
2. solve simple algebraic equations (most relevant equations are linear but some may involve inverse and inverse square relationships),
3. substitute physical quantities into physical equations using consistent units, and check the dimensional consistency of such equations,
4. formulate simple algebraic equations as mathematical models of physical situations,
5. recognise and use the logarithm forms of expressions like ab , $\frac{a}{b}$, x^n , e^{kx} .
6. express small changes or uncertainties as percentages and vice versa,
7. comprehend and use the symbols $<$, $>$, \gg , \ll , \approx , \propto , $\langle x \rangle = x$, $\sum X$, ΔX .

D. **Geometry and Trigonometry**. Candidates should be able to:

1. calculate the areas of right-angled triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres,
2. use Pythagoras' theorem, similarity of triangles, the sum of the angle in a triangle,
3. use sines, cosines and tangent in physical problems,
4. recall $\sin \theta \approx \tan \theta \approx \theta$ and $\cos \theta \approx 1$ for small θ , in radian,
5. understand the relationship between degrees and radians (defined as arc/radius),

E. **Vectors**. *Vector treatment and representation, wherever possible, will be required.* As a result candidates should be able to:

1. find the resultant to two coplanar vectors, recognising situations where vector addition is appropriate;

2. obtain expressions for components of a vector in perpendicular directions, recognising situations where vector resolution is appropriate;
3. use scalar and cross products of vectors;
4. do vector differentiation;
5. understand and use direction cosines.

F. *Graphs.* Candidates should be able to:

1. translate information between graphical, numerical, algebraic and verbal forms;
2. select appropriate variables and scales for graph plotting;
3. determine the gradient and intercept of a linear graph and allocate appropriate physical units to them;
4. choose by inspection a straight line which will serve as the best straight line through a set of data points presented graphically;
5. recall the standard linear form $y = mx + c$ and rearrange relationships into linear form where appropriate;
6. sketch and recognise the forms of plots of common simple expressions like $\frac{1}{x}$, x^2 , $\frac{1}{x^2}$, $\sin x$, $\cos x$, e^{-x} ;
7. use logarithmic plots, \log or $\ln (\log_e)$, to test exponential and power law variations;
8. understand and use the gradient of a tangent of a curve;
9. understand the notation $\frac{dx}{dt}$ for the rate of change of x with t (the ability to differentiate is required);
10. understand and use the area between a curve and the relevant axis where the area has physical significance (the ability to integrate is required).

G. *Information and Communication Technologies (ICTs) requirements.*

1. Calculators are allowed.
2. Candidates should be exposed to the use of ICTs as appropriate.

6. PRACTICAL WORK

1. Digital and mechanical stopwatches.
2. Metre rule, Ruler, wooden rule, bob, protractor.
3. Boss, clamp and stand.
4. Thermometer (1 °C, 0.5 °C, 0.2 °C), calorimeters.
5. Arm and spring balance, masses (10 g... 1000 g and a variety of each).
6. Measuring cylinder.

7. Ticker-timer and tape, air track and accessories.
8. Newton meter, manometer, barometer.
9. Springs, slinky coil.
10. Analogue and digital multimeter, centre zero galvanometer.
11. Solenoid, Coils, iron core to fit in the coils.
12. Resistor, potentiometer, torch light bulb and holder, poor conductor or insulator, conductor, resistor (range $1\ \Omega$ to $10^5\ \Omega$, capacitor, diode (power and zener), light emitting diode, Light Dependent Resistor, transistor, thermistor, electrolytic and ceramic capacitor (ranging 10 mF to μF , 8 feet and 14 feet integrated circuit (IC)).
13. Bob, thread, string.
14. Rectangular glass block, Semicircular glass block, Prism.
15. Lens (biconvex, biconcave, plano), mirror (concave, convex, plan), optical pins, and optical bench.
16. Plotting compass, Compass, Protractor.
17. Metre rule, Micrometer screw gauge and vernier callipers.
18. Thread or string.
19. dc power supply (1.5 V, 4.5 V, 9 V) with accessories (holder and connectors); ac and dc variable power supply with accessories.
20. Water and containers to carry water, Beaker, Capillary tube (50 cm).
21. Heating source (candle, burner), Pyrex beaker or metal cup, Burette.
22. 1m wooden rule with holes at regular intervals.
23. Glass block, prism, semicircular block, optical pins, Sheet of white paper.
24. Magnet, Ruler.
25. Connecting cable, crocodile clips, circuit board.
26. Graphite rod (from a pencil).
27. Resonance tube (fluorescence bulb), Set of tuning forks.
28. White sheet of paper A4, pin stock in a cork, clamp, stand and boss.
29. Dual beam cathode ray oscilloscope, signal generator.
30. Microwave generator, LASER tube, sodium lamps, diffraction grating.

7. FIELD WORK

Students are expected to visit one of the following sites and write a report.

1. Industrial sites.
2. Geological sites.

3. Recreational sites.

8. THE SYLLABUSCONTENT

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
1.0 PHYSICAL QUANTITIES AND EXPERIMENTAL PHYSICS		
1.1 Physical Quantities	<ul style="list-style-type: none"> The magnitude of a physical quantity is written as the product of the number and the unit. 	<p>a) Show an understanding of the magnitude of a physical quantity and be able to calculate such magnitude.</p>
1.2 Base Quantities and Units of System internal (SI) units	<ul style="list-style-type: none"> Base quantities; length, mass, time, current, temperature interval, amount of substance. Base units; metre, kilogram, second, ampere, Kelvin, mole. 	<p>a) State and breakdown the following SI base quantities and their units: mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol).</p> <p>b) Understand that these quantities and their units form one possible minimum set in terms of which all other physical quantities and units may be defined.</p> <p>c) Explain that these quantities are fixed by convention. (<i>Luminous intensity and the candela are not included. Definitions will not be examined</i>).</p> <p>d) Explain the implications of the definition of the ampere for the value of μ_0.</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
1.3 Derived Units (SI)	<ul style="list-style-type: none"> • Relationship between derived quantities. • Homogeneity of physical equations. 	<ul style="list-style-type: none"> a) Express derived units as products or quotients of the base units and use the named units listed in this syllabus as appropriate. b) Use base units to check the homogeneity of physical equations. c) Show an understanding of the ultimate dependence of all definitions of derived units on base units. d) Recall and show that homogeneity is necessary with respect to either units or dimensions, but that this is not a sufficient test for correctness. (<i>The use of units or dimensions to predict simple physical relationships is not required. Demonstration of homogeneity is required.</i>)

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
1.4 Scalar and Vector Quantities	<ul style="list-style-type: none"> • Distinction between vector and scalar quantities. • Vector nature of physical quantities: everyday examples. • Composition of perpendicular vectors. • Resolution of co-planar vectors. 	a) Recognize whether or not a physical quantity is a vector from definition. b) Calculate the magnitudes of physical quantities. c) Distinguish between scalar and vector quantities and give examples of each. d) Add and subtract coplanar vectors. e) represent a vector as two perpendicular components
1.5 Experimental Physics	<ul style="list-style-type: none"> • Null methods (potentiometer). • Use of standard instruments. 	a) Display an understanding of the techniques for the measurement of length, volume, angle, mass, time, temperature and electrical quantities appropriate to the ranges of magnitude implied by the relevant parts of the syllabus. b) Use a galvanometer in null methods. c) Appreciate the limitations of the techniques used.
1.6 Accuracy and Sensitivity	<ul style="list-style-type: none"> • Need to calibrate measuring instruments; use of standards. 	a) Calibrate measuring instruments. b) show an understanding of the distinction between precision and accuracy.
1.7 Instruments	<ul style="list-style-type: none"> • Use of the cathode ray oscilloscope. 	a) Use the CRO with a known resistor as a voltmeter, ammeter and as a clock. b) Use a CRO to measure p.d., current and time of alternating currents.
2.0 MECHANICS		
2.1 Rectilinear Motion	<ul style="list-style-type: none"> • Displacement. • Velocity. • Acceleration. 	a) Define each quantity and state their units. b) Measure velocity and acceleration, using any suitable apparatus. c) Draw and use of distance-time, velocity-time graphs. d) Measure g , the acceleration due to gravity. e) Appreciate the vector nature of displacement, velocity and acceleration. f) Do appropriate calculations using the equations of motion (Derivation of

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
		<p>equations may be required).</p> <p>g) Appreciate the role of rectilinear motion in sports.</p>
2.2 Circular Motion	<ul style="list-style-type: none"> Angular speed. Angular velocity. Centripetal acceleration for a particle moving along a circular path at constant speed. 	<p>a) Define angular speed, the unit vectors $\hat{\theta}$ and \hat{r}, angular velocity, and centripetal acceleration.</p> <p>b) Derive the equation $\bar{v} = \omega r \hat{r}$ and $\bar{a} = \omega^2 r \hat{r}$, $\omega r = \frac{v^2}{r}$,</p> <p>c) Express angular displacement in radians.</p> <p>d) Understand and use the concept of angular velocity to solve problems.</p> <p>e) Use the equations in b) above, to solve problems.</p> <p>f) Describe qualitative motion in a curved path due to a perpendicular force, and show understanding of centripetal acceleration in the case of uniform motion in a circle.</p> <p>g) recall and apply centripetal force as</p> $\bar{F} = m\omega^2 r \hat{r} = \frac{mv^2}{r} \hat{r}$
2.3. Forces	<ul style="list-style-type: none"> Force as a pull or push. 	<p>a) State, define and use with different types of forces.</p> <p>b) Calculate weight, $\bar{W} = mg$</p> <p>c) Appreciate the importance of friction in everyday experience, e.g. walking, use of lubricants, etc.</p>
2.4 Turning Effects of Forces	<ul style="list-style-type: none"> Moments. Couple. Torque. Static and dynamic equilibrium. Coplanar forces. Conditions of equilibrium. 	<p>a) Define and apply the moment of a force and the torque of a couple (h)</p> <p>b) Show an understanding of the conditions of a system is in equilibrium: i.e. that, when there is no resultant force and no resultant torque.</p> <p>c) Define a couple as a pair of forces that tends to produce rotation only.</p> <p>d) State and apply the principle of moments.</p> <p>e) State and use the conditions of static and dynamic equilibrium of a body.</p> <p>f) Explain the use of couples and torques in everyday life.</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
2.5. Newton's Laws of Motion and Momentum	<ul style="list-style-type: none"> • Statement of the three laws. • Force and momentum. <ul style="list-style-type: none"> ◦ definitions and units. • Vector nature of forces to be stressed. 	<ul style="list-style-type: none"> a) Find resultants using Newton balances or pulleys. b) State the three laws. c) Define momentum. d) Appreciate the vector nature of forces and momentum. e) Appreciate $\vec{F} = m\vec{a}$ as a special case of Newton's second law. f) Do appropriate calculations. (Problems involving change of mass need not be considered). g) Demonstrate the laws using air track <i>or</i> tickertape timer <i>or</i> powder track timer, etc. h) Apply the use of each law in everyday life e.g. in seat belts, rocket travel, Lifts, escalators, sports, all ball games, etc. i) State, explain and use the principle of conservation of momentum. j) Appreciate elastic and inelastic collisions.
2.6 Work, Energy and Power	<ul style="list-style-type: none"> • Work. • Power. • Kinetic energy. • Potential energy. • Gravitational potential energy. • Elastic potential energy. • Law of conservation of energy. • Conservative forces. • Elastic and inelastic collisions. 	<ul style="list-style-type: none"> a) Define and state the units of Work. b) Appreciate work as energy transferred by some physical processes. c) Recall different forms of energy e.g. gravitational potential energy, $E_p = mgh$, Kinetic energy, $E_K = \frac{1}{2}mv^2$ and elastic potential energy. d) Apply the law of conservation of energy. e) Use the work-energy equation in calculations. f) Show an understanding of Einstein's mass-energy relation, $E = mc^2$ g) Appreciate the efficient use of energy in the home. h) Define power as the rate of doing work or rate of energy conversion and state its unit.

3.0 SIMPLE HARMONIC MOTION (SHM) AND WAVES

3.1 Simple Harmonic Motion	<ul style="list-style-type: none"> • Definition of simple harmonic motion. 	<ul style="list-style-type: none"> a) Give and describe simple examples of free oscillations. b) Investigate the motion of an oscillator using
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TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> • The equation $a = -\omega^2 x$, where ω is a constant, should be understood physically, algebraically and graphically. • Experimental study of simple harmonic motion of <ul style="list-style-type: none"> (i) a simple pendulum, and (ii) a mass attached to a helical spring. • Analytical treatment of a vertical mass-spring oscillator. • Simple harmonic oscillators and energy. • Mechanical resonance: qualitative and experimental discussion of free, damped and forced oscillators and of resonance. 	<p>experimental and graphical methods.</p> <p>c) Understand and use the terms amplitude, period, frequency, angular frequency and phase difference and express the period in terms of both frequency and angular frequency.</p> <p>d) Use the equation $\vec{a} = -\omega^2 \vec{x}$ as the defining equation of simple harmonic motion.</p> <p>e) Recall and apply $x = x_0 \sin \omega t$ as a solution to the equation $a = -\omega^2 x$</p> <p>f) Recognise and apply $v = v_0 \cos \omega t$, $v = \pm \omega x$</p> <p>g) Describe, with graphical illustrations, the changes in displacement, velocity and acceleration during simple harmonic motion.</p> <p>h) Describe the interchange between kinetic and potential energy during simple harmonic motion.</p> <p>i) Describe practical examples of damped oscillations with particular reference to the effects of the degree of damping and the importance of critical damping in cases such as a car suspension system.</p> <p>j) Give practical examples of forced oscillations and resonance.</p> <p>k) Describe graphically how the amplitude of a forced oscillation changes with frequency near to the natural frequency of the system, and understand qualitatively the factors that determine the frequency response and sharpness of the resonance.</p> <p>l) Appreciate circumstances in which resonance is useful and other circumstances in which resonance should be avoided.</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
3.2 Mechanical Waves	<ul style="list-style-type: none"> • Mechanical waves on water, along springs and in air. • Progressive waves, amplitude speed wavelength frequency and phase interpreted graphically. • Longitudinal and transverse waves. • Reflection and refraction of water waves in a shallow tray, wave fronts. • The factors affecting the speeds of transverse waves on taut strings and wires. 	<ul style="list-style-type: none"> a) Distinguish between longitudinal and transverse waves and give examples of each type of wave. b) Define and describe wave fronts. c) Draw displacement-time graphs and displacement-distance graphs. d) Establish the definitions of period, amplitude, wavelength and frequency. e) Associate progressive waves with energy transfer.

4.0 ENERGETICS – THERMAL ENERGY

4.1 Temperature	<ul style="list-style-type: none"> • Basic concepts of thermal equilibrium and temperature. • Thermometers. • Liquid-in-glass and thermocouples to measure Celsius temperature. $\theta/^\circ C = T/ K - 273.15$	<ul style="list-style-type: none"> a) Show an appreciation that thermal energy is transferred from a region of higher temperature to a region of lower temperature. b) Show an understanding that regions of equal temperature are in thermal equilibrium. c) Show an understanding of a physical property that varies with temperature may be used for the measurement of temperature and state examples of such properties. d) Compare the relative advantages and disadvantages of resistance and thermocouple thermometers as previously calibrated instruments. e) Show an understanding that there is an absolute scale of temperature that does not depend on the property of any particular substance (i.e. the thermodynamic scale and the concept of absolute zero). f) convert temperatures measured in kelvin to degrees Celsius: $\theta/^\circ C = T/ K - 273.15$
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TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
4.2 Energy Transfer	<ul style="list-style-type: none"> • Forms of energy. • Concepts of energy transfer and energy conversion. • Law of conservation of energy. • Internal energy. 	<p>a) Give examples of energy in different forms, its conversion and conservation, and apply the principle of energy conservation to simple examples.</p> <p>b) Relate a rise in temperature of a body to an increase in its internal energy.</p> <p>c) State and explain the concept of internal energy.</p> <p>d) Appreciate the implications of energy losses in practical devices and use the concept of efficiency to solve problems.</p> <p>e) show an understanding <ul style="list-style-type: none"> i. of internal energy as determined by the state of the system and ii. that internal energy can be expressed as the sum of a random distribution of kinetic and potential energies associated with the molecules of a system. </p> <p>f) Apply the first law of thermodynamics expressed in terms of the increase in internal energy, the heating of the system and the work done on the system.</p>
4.3 Heating Matter	<ul style="list-style-type: none"> • Definitions and meaning of heat capacity, specific heat capacity, latent heat and specific latent heat. • Measurements of specific heat capacities of solids and liquids and specific latent heat of fusion of ice and vaporisation of water. 	<p>a) Explain using a simple kinetic model for matter why <ul style="list-style-type: none"> i. melting and boiling takes place without a change in temperature. ii. the specific latent heat of vaporisation is higher than specific latent heat of fusion for the same substance. iii. a cooling effect accompanies evaporation. </p> <p>b) Define and use the concept of specific heat capacity, and identify the main principles of its determination by electrical methods.</p>
4.4 Thermal Energy Transfer	<ul style="list-style-type: none"> • Conduction, convection and radiation. • Definition of thermal conductivity. • Simple numerical examples 	<p>a) Describe experiments to demonstrate the properties of good and bad conductors of heat.</p> <p>b) Give a simple molecular account of heat transfer in solids.</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	in one dimension only. <ul style="list-style-type: none"> • Good and poor conductors. • Newton's law of cooling. 	c) Relate convection in fluids to density changes and describe experiments to illustrate convection. d) Identify infra-red radiation as part of the electromagnetic spectrum. e) Describe experiments to show the properties of good and bad <ul style="list-style-type: none"> i. emitters; ii. absorbers of infra-red radiation. f) Identify and explain everyday applications and consequences of conduction, convection and radiation.
4.5 Solids and Liquids	<ul style="list-style-type: none"> • Solids are rigid and transmit forces while fluids transmit pressure. • Direct measurement of density • Pressure difference in fluids: $p = \rho gh$: manometers. Hydrostatic force. • Stresses and strains in one direction. • Hooke's law and the elastic limit, yield point and plastic flow. • Experiment to measure Young's modulus. • Energy and area between the force-extension graph and extension axes, when elastic limit is not exceeded. • Use of curves to explain macroscopic properties such as Hookian behaviour and thermal expansion. • Simple phenomena. 	Defined density. a) Relate the difference in the structures and densities of solids, liquids and gases to simple ideas of the spacing, ordering and motion of molecules. b) Describe a simple kinetic model for solids, liquids and gases. c) Distinguish between the structure of crystalline and non-crystalline solids with particular reference to metals, polymers and amorphous materials. d) Derive and use the equation $p = \rho gh$. e) Appreciate that surfaces in contact with a liquid are subjected to a force. f) Appreciate that deformation is caused by a force and that, in one dimension, the deformation can be tensile or compressive. g) Describe the behaviour of springs in terms of load, extension, elastic limit, Hooke's law and the spring constant (i.e. force per unit extension). h) Define and use the terms stress, strain and the Young modulus. i) Describe an experiment to determine the Young modulus of a metal in the form of a wire. j) Distinguish between elastic and plastic

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> Pressure difference across a spherical interface. 	deformation of a material. k) Deduce the strain energy in a deformed material from the area under the force-extension graph. l) Demonstrate knowledge of the force-extension graphs for typical ductile, brittle and polymeric materials, including an understanding of ultimate tensile stress.
4.6 Gases	<ul style="list-style-type: none"> Brownian motion in gases. The behaviour of an ideal gas with changes of pressure, volume and temperature. The kinetic theory of an ideal gas. The kinetic theory of an ideal gas: assumptions which define the model, and derivation of $p = \frac{1}{3} \rho c^2$ The distribution of molecular speeds. The Boltzmann constant, k. The relation $\frac{1}{2} mc^2 = \frac{3}{2} kT$ 	a) Define the term pressure and use the kinetic model to explain the pressure exerted by gases. b) Recall and solve problems using the equation of state for an ideal gas expressed as $pV = nRT$ (n = number of moles). c) Infer from a Brownian motion experiment the evidence for the movement of molecules. d) State and apply the basic assumptions of the kinetic theory of gases. e) Explain how molecular movement causes the pressure exerted by a gas and hence deduce the relationship (N = number of molecules) $PV = NkT$ and hence deduce that the average translational kinetic energy of a molecule is proportional to T . f) Deduce the expression.

5.0 ATOMIC AND NUCLEAR PHYSICS

5.1 Electron flow in Metals	<ul style="list-style-type: none"> The relation $I = nAve$. Temperature coefficient of resistance. Temperature coefficient of resistance. 	a) Derive and use the equation $I = nAve$. b) Distinguish between conductors and insulators. c) Define temperature coefficient of resistance and relate the sign to conductors, semiconductors and insulators. d) Calculate the temperature coefficient of resistance from graph.
5.2 Conduction Mechanisms	<ul style="list-style-type: none"> Application of the relation to any charge carrier should 	a) Show an understanding that conductivity in semiconductors is due to electrons and holes. b) Explain the action of the semiconductor

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	be understood.	<p>diode and the p-n junction.</p> <p>c) Describe the action of the diode in forward and reverse bias modes.</p> <p>d) Appreciate minority and majority carriers in semiconductors.</p> <p>e) Show an understanding of the current-voltage relation; reverse bias and breakdown.</p> <p>f) Show that many semiconductor devices depend on effects at the boundary between p- and n-materials formed in the same continuous crystal lattice.</p>
5.3 Semiconductors	<ul style="list-style-type: none"> Differences in size and sign between metals and semiconductors should be related to $I = nAve$ 	<p>a) Describe the carrier concentration in intrinsic semiconductor.</p> <p>b) Explain doping in extrinsic semiconductors.</p> <p>c) State the difference between intrinsic and extrinsic semiconductors.</p> <p>d) State the difference between a p-type and an n-type semiconductor.</p>
5.4 Electronic Devices	<ul style="list-style-type: none"> The p-n junction and the LED. Semiconductor diode. Zener diode. The bipolar transistor. Common emitter class A a.c. amplifier. The transistor as a switch. Integrated circuits. Logic gates: OR, AND, NOT, NAND and NOR. 	<p>a) Give the functions of a junction diode.</p> <p>b) Appreciate and state the applications of LEDs in daily life.</p> <p>c) State the functions of a transistor as a switch and an amplifier.</p> <p>d) Describe the action of a bipolar npn transistor as an electrically operated switch and explain its use in switching circuits.</p> <p>e) State in words and in truth table form, the action of the following logic gates, AND, OR, NAND, NOR and NOT (inverter).</p> <p>f) State the symbols for the logic gates listed above.</p>
5.5 The Nucleus	<ul style="list-style-type: none"> Evidence for the existence of atomic nuclei. Relative atomic mass, nucleon number (mass number), proton number (atomic number), isotopes. Extra-nuclear electrons. Nuclear fission and nuclear 	<p>a) Infer from the results of the α-particle scattering experiment the existence and small size of the nucleus.</p> <p>b) Describe a simple model for the nuclear atom to include protons, neutrons and orbital electrons.</p> <p>c) Distinguish between nucleon number (mass number) and proton number (atomic number).</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	fusion.	<p>d) Show an understanding that an element can exist in various isotopic forms, each with a different number of neutrons.</p> <p>e) Use the notation for the representation of nuclides.</p> <p>f) Appreciate that nucleon number, proton number, and mass-energy are all conserved in nuclear processes.</p>
5.6 Radioactive Decay	<ul style="list-style-type: none"> The existence of natural and induced radioactivity. Properties of alpha, beta (+and-) and gamma radiation and corresponding disintegration processes. Radioactivity as a random process. $\frac{dN}{dt} = -\lambda N$ and the exponential decay law: decay constant and half life. Stable and unstable nuclei. 	<p>a) Represent simple nuclear reactions by nuclear equations of the form.</p> <p>b) Show an appreciation of the spontaneous and random nature of nuclear decay.</p> <p>c) Show an understanding of the nature and properties of α-, β- and γ-radiations.</p> <p>d) Show an appreciation of the association between energy and mass as represented by $E = c^2 \Delta m$ and solve problems using this relationship.</p> <p>e) Sketch the variation of binding energy per nucleon with nucleon number.</p> <p>f) Explain the relevance of binding energy per nucleon to nuclear fusion and to nuclear fission.</p> <p>g) Define the terms activity and decay constant and solve problems using $A = \lambda N$</p> <p>h) Infer and sketch the exponential nature of radioactive decay and solve problems using the relationship $N = N_0 e^{(-\lambda t)}$, where N could represent number of undecayed particles or received count rate.</p> <p>i) Define half-life.</p> <p>j) solve problems using the relation</p> $\lambda t_{\frac{1}{2}} = \ln 2 \quad i.e. \quad \lambda = \frac{0.693}{t_{\frac{1}{2}}}$
6.0 FIELDS		
6.1 Gravitational Fields	<ul style="list-style-type: none"> Newton's laws of gravitation: gravitational field strength, g. 	<p>a) State the laws of gravitation; Prove of Kepler's laws and apply it to motion of moon and the movement of planets.</p> <p>b) Apply Newton's law of gravitation to</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> Qualitative description of the earth's gravitational field. Inverse square law for fields of spherically symmetrical masses. Variation of inside and outside earth. 	<p>problems solving orbiting bodies</p> $\mathbf{F} = G \frac{m_1 m_2}{r^3} \mathbf{r}$ <p>c) Define gravitational field strength. d) Derive g from force of gravity for uniform field. e) Draw and interpret graphs showing variation of g with distance from the centre of the earth. f) Sketch graphs showing the variation of V with distance from centre of mass. g) Apply potential energy to planetary and satellite motions. h) Define potential energy and derive</p> $V = -G \frac{m}{r}$
6.2 Electric Fields	<ul style="list-style-type: none"> Measurement of charge. Electrostatic phenomena and electric charge. Current as rate of flow of charge. Coulomb's law. Electric field dipole and torque. Electric flux. Gauss's law. Electric potential. Conductors and insulators. 	<p>a) show an understanding of the concept of an electric field as an example of a field of force</p> <p>b) Define electric field strength (as force per unit positive charge acting on a stationary point charge).</p> <p>c) Represent an electric field by means of field lines.</p> <p>d) Apply $E = V/d$ to calculate the field strength of the uniform field between charged parallel plates in terms of potential difference and separation.</p> <p>e) Calculate the forces on charges in uniform electric fields.</p> <p>f) Describe the effect of a uniform electric field on the motion of charged particles.</p> <p>g) use Coulomb's law in the form</p> $\mathbf{F} = G \frac{Q_1 Q_2}{r^3} \mathbf{r}$ <p>for the force between two point charges in free space or air</p> $\mathbf{E} = \frac{Q}{4\pi\epsilon_0 r^3} \mathbf{r}$ <p>h) State and use $\frac{Q}{4\pi\epsilon_0 r^3}$ for the field strength of a point charge in free space or air.</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
		i) Define potential at a point in terms of the work done in bringing unit positive charge from infinity to the point. j) Show an understanding of the field strength of the field at a point as numerically equal to the potential gradient at that point. $V = \frac{Q}{4\pi\epsilon_0 r}$ k) Apply the equation $V = \frac{Q}{4\pi\epsilon_0 r}$ for the potential in the field of a point charge. l) Recognise the analogy between certain qualitative and quantitative aspects of electric fields and gravitational fields.
6.3 Capacitors	<ul style="list-style-type: none"> • Meaning and measurement of capacitance. • Factors affecting capacitance of a parallel plate capacitor: relative permittivity. • Capacitors in series and parallel. • Exponential growth and decay of charge stored in a capacitor in series with a resistor. • Time constant. • Energy of a charged capacitor. 	a) State the function of capacitors in simple circuits. b) Define capacitance and the farad. c) Describe an experiment to measure the capacitance of a capacitor. d) Derive the equation for series and parallel arrangements of capacitors; e) Solve problems using $C = Q/V$. f) Solve problems using formulae for capacitors in series and in parallel. g) Deduce from the area under a potential-charge graph the equation $W = \frac{1}{2} QV$ and hence $W = \frac{1}{2} CV^2$.

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
6.4 Magnetic Fields	<ul style="list-style-type: none"> • Magnetic flux density: the tesla. • Quantitative study of the force on a current carrying conductor in a magnetic field and in a magnetic field and on a charged particle moving through a magnetic field. • Measurement of e/m_0. • Couple of rectangular coil in a magnetic field. • Magnetic effect of a steady current: Biot-Savart law. • Ampere's law. • Magnetic flux density within a long solenoid and near a long straight wire. • Force between parallel current-carrying conductors; the definition of the Amperes and μ_0. • Force on current carrying conductor in uniform magnetic field. • Effects of ferrous core in solenoid. • Earth's magnetic field. Para- dia- and ferromagnetic substances. • Electromagnets. • Magnetic shielding. Lorentz force. 	<p>Candidates should be able to:</p> <p>a) Understand and show that a magnetic field is an example of a field of force produced either by current-carrying conductors or by permanent magnets.</p> <p>b) Represent a magnetic field by field lines.</p> <p>c) Show an appreciation that a force might act on a current-carrying conductor placed in a magnetic field.</p> <p>d) Solve problems using the equation</p> $F = BI l \sin\theta,$ <p>with directions as interpreted by Fleming's left-hand rule.</p> <p>e) Define magnetic flux density and the tesla.</p> <p>f) Show that the force on a current-carrying conductor can be used to measure the flux density of a magnetic field using a current balance.</p> <p>g) Predict the direction of the force on a charge moving in a magnetic field.</p> <p>h) Apply $F = BQv \sin\theta$ in solving problems.</p> <p>i) Sketch flux patterns due to a long straight wire, a flat circular coil and a long solenoid.</p> <p>j) Display an understanding that the field due to a solenoid may be influenced by the presence of a ferrous core.</p> <p>k) Explain the forces between current-carrying conductors and predict their direction.</p> <p>l) Describe and compare the forces on mass, charge and current in gravitational, electric and magnetic fields, as appropriate.</p>
7.0 ENERGETICS – ELECTRICAL ENERGY		
7.1 Current Electricity	<ul style="list-style-type: none"> • Flow of electric charge in a metallic conductor. • Electrical current. 	<p>a) Express electric current as the rate of flow of charged particles.</p> <p>b) Solve problems using $V = WQ$, $P = VI = I^2R$.</p> <p>c) Sketch and explain the I-V characteristics of a metallic conductor at constant temperature,</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> • Electrical potential difference. E.m.f. of a cell. • Current–potential difference relationship. • Ohm's law. • Electrical energy and Power. • Resistance, resistivity, conductivity and superconductivity. • Temperature dependence of resistance. • Internal resistance of a cell. • Resistors in series and in parallel, rheostats and potential dividers. • Circuit calculations: applying the laws of conservation of charge and conservation of energy (Kirchoff's laws) to simple series and parallel circuits. • Wheatstone bridge and Meter Bridge. • Potentiometer and application. 	<p>a) a semiconductor diode and a filament lamp.</p> <p>d) Sketch the temperature characteristic of a thermistor (thermistors will be assumed to be of the negative temperature coefficient type).</p> <p>e) Solve problems using.</p> <p>f) Define e.m.f. in terms of the energy transferred by a source in driving unit charge round a complete circuit.</p> <p>g) Distinguish between e.m.f. and p.d. in terms of energy considerations.</p> <p>h) Describe the effects of the internal resistance of a source of e.m.f. on the terminal potential difference and output power</p> <p>i) Use appropriate circuit symbols.</p> <p>j) Draw and interpret circuit diagrams containing sources, switches, resistors, ammeters, voltmeters, and/or any other type of component.</p> <p>k) Apply Kirchhoff's first law and appreciate the link to conservation of charge.</p> <p>l) Recall Kirchhoff's second law and appreciate the link to conservation of energy.</p> <p>m) Derive, using Kirchhoff's laws, a formula for the combined resistance of two or more resistors in series and in parallel.</p> <p>n) Apply Kirchhoff's laws in solving simple circuit problems.</p> <p>o) Show an understanding of the use of a potential divider circuit as a source of variable p.d.</p> <p>p) Explain the use of thermistors and light-dependent resistors in potential dividers to provide a potential difference that is dependent on temperature and illumination respectively.</p>

8.0 MOTION IN FIELDS

8.1 Projectile	<ul style="list-style-type: none"> • Motion with non uniform acceleration. 	<p>a) Resolve motion of a body into two dimensions.</p> <p>b) Find the range of movement of a projectile.</p> <p>c) Calculate the maximum height and</p>
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TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
		maximum displacement of a projectile.
8.2 Gravitational Field, Gravitational Potential and Energy	<ul style="list-style-type: none"> Energy transfer when a mass moves through a uniform gravitational field, meaning of gravitational potential difference in orbits. Kepler's laws, orbital velocity and geostationary satellite. 	a) Apply Kepler's laws to describe the motion of moon and the movement of planets around the sun. b) Explain the conditions for a satellite to remain in a stable circular orbit in a gravitational field (PE and KE of satellite). c) Calculate the parameters of satellite in stable circular orbit. This will include applying the relationships; $v_{av} = \frac{s}{t}$, $a_c = \frac{v^2}{r}$, $F_g = G \frac{m_1 m_2}{r^2}$, $g = G \frac{M}{r^2}$
8.3 Electric and Magnetic Fields, Potential and Energy	<ul style="list-style-type: none"> Electric and magnetic field strength: uniform and inverse square law fields in vacuum (or air). Energy transferred when charge moves through a uniform electric and magnetic fields; meaning of electric potential difference. 	a) Understand and list the forces acting on charged particles in motion: <ul style="list-style-type: none"> i) an electric field. ii) a magnetic field. b) Describe the trajectory of the charged particles in the fields. c) Explain the electrostatic acceleration and focussing as used in science and in everyday applications. <ul style="list-style-type: none"> i. X-ray generation from e-beam. ii. electron microscope iii) welding and television and Computer monitor.
9.0 THERMAL PHYSICS-THERMODYNAMICS		
9.1 Gas Laws	<ul style="list-style-type: none"> Ideal gas and real gas. Absolute zero of temperature and Kelvin temperature. P-V diagrams. 	a) Define pressure and use the kinetic model to explain the pressure exerted by gases. b) <u>Solve problems using the equation of state for an ideal gas expressed as</u> $pV = nRT$ (n = number of moles). c) Infer from a Brownian motion experiment the evidence for the movement of molecules. d) State the basic assumptions of the kinetic theory of gases. e) Explain how molecular movement causes the pressure exerted by a gas and hence deduce the relationship $p = \frac{1}{3} \rho \bar{c}^2$. f) Compare with $pV = NkT$ and hence deduce that the average translational kinetic energy of a molecule is proportional to T .

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
		<p>g) Deduce the expression.</p> <p>a) Explain using a simple kinetic model for matter why <ul style="list-style-type: none"> i. melting and boiling take place without a change in temperature. ii. the specific latent heat of vaporisation is higher than specific latent heat of fusion for the same substance. iii. a cooling effect accompanies evaporation. </p> <p>b) Use the concept of specific heat capacity and identify the main principles of its determination by electrical methods.</p> <p>c) Use the concept of specific latent heat, and identify the main principles of its determination by electrical methods.</p>
9.3 Second Law of Thermo-dynamics	<ul style="list-style-type: none"> • Statement of the law. • Degrees of disorder in a system. • Reversible and irreversible processes. • Entropy change. 	<p>a) Appreciate that an efficiency of more than 100% for a machine is impracticable.</p> <p>b) Understand basic concept of entropy.</p>
10.0 WAVE PHENOMENA		
10.1 The Doppler Effect in sound	<ul style="list-style-type: none"> • For moving detector, moving source. In measurement of speed. 	<p>a) Describe the term 'Doppler effect'.</p> <p>b) Derive the associated equations.</p> <p>c) Use the associated equations in solving simple problems.</p>
10.2 Superposition of Mechanical Waves	<ul style="list-style-type: none"> • The principle of superposition illustrated by <ul style="list-style-type: none"> a) the overlapping of two sets of spherical sound waves, and b) Stationary waves on a taut wire or long stretched spring. 	<p>a) Explain and use the principle of superposition in simple applications.</p> <p>b) Show an understanding of experiments that demonstrate stationary waves using microwaves, stretched strings and air columns.</p> <p>c) Explain the formation of a stationary wave using a graphical method, and identify nodes and antinodes.</p> <p>d) Explain the meaning of the term diffraction</p> <p>e) Describe experiments that demonstrate</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> Phase difference and path difference. Measurement of speed of sound in free air. 	<p>diffraction including the diffraction of water waves in a ripple tank with both a wide gap and a narrow gap.</p> <p>f) Explain the terms interference and coherence.</p> <p>g) Describe experiments that demonstrate two-source interference using water, light and microwaves.</p> <p>h) Explain and state the conditions required if two-source interference fringes are to be observed.</p> <p>i) Solve problems using the equation $\lambda = \frac{ax}{D}$ for double-slit interference using light.</p>
10.2 Electromagnetic Waves	<ul style="list-style-type: none"> Displacement current, EM waves and their characteristics. EM spectrum and uses. Reflection and refraction at plain surfaces. Laws of refraction. Refractive index. Dispersion. Total internal reflection and critical angle. Familiarity with practical situations in which a single converging lens produces a magnified or diminished image. Method of production of the chief properties of the main divisions. Meaning and applications of plain polarisation. 	<p>a) Explain the movement of electromagnetic by Stating that all electromagnetic waves travel with the same speed in free space and</p> <p>b) Explain the orders of magnitude of the wavelengths of the principal radiations from radio waves to γ-rays.</p> <p>c) Understand and explain polarisation as a phenomenon associated with transverse waves.</p>
10.3 Superposition of e.m. Waves	<ul style="list-style-type: none"> Fraunhofer diffraction at a single slit and a circular aperture. Two-source interference patterns. Young's double slit 	<p>a) Describe Fraunhofer diffraction pattern at a single slit and aperture.</p> <p>b) State the conditions for interference of water waves using two slits.</p> <p>c) Use the equation $\lambda = \frac{xs}{D}$ in solving problems.</p>

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<p>experiment and the measurement of wavelength. Dimensions are expected.</p> <ul style="list-style-type: none"> • Light sources. • Optical transmission grating with normal incidence. 	<p>d) Explain coherence and the conditions necessary for its occurrence.</p> <p>e) Determine wavelength by method of Young's double slit experiment.</p> <p>f) Recall and state approximate dimensions of slit size, slit separation and screen distance.</p> <p>g) Derive the diffraction equation $n\lambda = d\sin\theta$ and use it to solve problems.</p> <p>h) Explain the effect of diffraction grating on white light (spectrum production).</p> <p>i) Describe the method of production of light by gas discharge lamps and by a LASER.</p> <p>j) Give advantages of LASER over the gas discharge tube.</p> <p>k) Solve problems using the formula $d \sin \theta = n\lambda$ and</p> <p>l) Use a diffraction grating to determine the wavelength of light (the structure and use of the spectrometer are not included).</p>
10.4 Geometrical Optics	<ul style="list-style-type: none"> • Prism, lenses, dioptric, optical instruments: microscope, astronomical telescope. • Multipleslit diffraction. 	
11.0 ELECTROMAGNETIC INDUCTION		
11.1 Magnetic Flux	<ul style="list-style-type: none"> • Magnetic flux, flux linkage and the phenomenon of magnetic induction. • Faraday's and Lenz's laws of magnetic induction. • Meaning of self inductance and mutual inductance: the Henry. 	<p>a) Define magnetic flux and the weber.</p> <p>b) Solve problems using $\Phi = BA$.</p> <p>c) Define magnetic flux linkage.</p> <p>d) Infer from appropriate experiments on electromagnetic induction</p> <ul style="list-style-type: none"> i. that a changing magnetic flux can induce an e.m.f. in a circuit. ii. that the direction of the induced e.m.f. opposes the change producing it.

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> • Transformer. • Simple d.c motor/generator. 	<ul style="list-style-type: none"> iii. the factors affecting the magnitude of the induced e.m.f. e) Solve problems using Faraday's law of electromagnetic induction and Lenz's law. f) Give simple applications of electromagnetic induction. g) Show an understanding of the principle of operation of a simple iron-cored transformer and solve problems using for an ideal transformer. h) Explain the scientific and economic advantages of alternating current and of high voltages for the transmission of electrical energy.
11.2 Alternating Currents	<ul style="list-style-type: none"> • Meaning of r.m.s. and peak values and their relationship for sinusoidal currents and p.ds. • Energy and power. • Rectification and smoothing. 	<ul style="list-style-type: none"> a) Show an understanding of and use the terms period, frequency, peak value and root-mean-square value as applied to an alternating current or voltage. b) Deduce that the mean power in a resistive load (i.e. half the maximum power for a sinusoidal alternating current). c) Represent a sinusoidal alternating current or voltage by an equation of the form $x = x_0 \sin \omega t$. d) Distinguish between r.m.s. and peak values and recall and solve problems using the relationship for the sinusoidal case. e) Distinguish graphically between half-wave and full-wave rectification. f) Explain the use of a single diode for the half-wave rectification of an alternating current. g) Explain the use of four diodes (bridge rectifier) for the full-wave rectification of an alternating current. h) Analyse the effect of a single capacitor in smoothing, including the effect of the value of capacitance in relation to the load resistance.
11.3 Electrical oscillations	<ul style="list-style-type: none"> • RL, RC, RLC circuits. 	<ul style="list-style-type: none"> a) Explain and describe the series connections only, b) Show an understanding of and use the of phasor diagrams,

TOPIC	NOTES	ATTAINMENT TARGETS Candidates shall be assessed on their ability to:
	<ul style="list-style-type: none"> • Resonance. • Impedance 	<ul style="list-style-type: none"> d) Draw diagrams showing input and output singles as applied to the various circuits. e) Explain the use of the circuits as high / low pass filters. e) Calculate impedance and reactance. f) Appreciate real and apparent power lost. g) Determine resonance point and its uses. h) Calculate quality factor.
12.0 QUANTUM PHYSICS		
12.1 Photons and Energy Levels.	<ul style="list-style-type: none"> • Conservation of energy for waves in free space from a point source. • Inverse square law. • The photoelectric effect. • Photons: The Planck constant. • Einstein's photoelectric equation. • Wave particle duality. • Line spectra: emission and absorption. • Energy levels - 'electron in a box'. • The electron volt. • Excitation and ionisation energies. 	<ul style="list-style-type: none"> a) Show an appreciation of the particulate nature of electromagnetic radiation. b) Use $E = hf$ in solving simple problems. c) Explain that the photoelectric effect provides evidence for a particulate nature of electromagnetic radiation while phenomena such as interference and diffraction provide evidence for a wave nature. d) Understand and state the significance of threshold frequency. e) Explain photoelectric phenomena in terms of photon energy and work function energy. f) Explain why the maximum photoelectric energy is independent of intensity, whereas the photoelectric current is proportional to intensity. g) use and explain the significance of $hf = \Phi + \frac{1}{2} mv_{max}^2$ h) Describe and interpret qualitatively the evidence provided by electron diffraction for the wave nature of particles. i) use the relation for the de Broglie wavelength $\lambda = h/p$.
12.2 Atomic Spectra	<ul style="list-style-type: none"> • Schrodinger model of Hydrogen atom. • Heisenberg uncertainty principle: position-momentum, time-energy. 	<ul style="list-style-type: none"> a) Show an understanding of the existence of discrete electron energy levels in isolated atoms (e.g. atomic hydrogen) and deduce how this leads to spectral lines. b) Distinguish between emission and absorption line spectra. c) Solve problems using the relation $hf = E_1 - E_2$.

Option 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

Topic	Note	Assessment objectives: Candidates should be able to:
Energy Resources.	Primary and Secondary energy. Finite and renewable resources. Patterns of consumption in Cameroon. Reserves energy and their sources: estimates of fossil fuels and uranium resources. Solar power. Energy of winds, waves and tides.	a) Distinguish between primary and secondary sources of energy. b) List renewable and non-renewable energy sources. c) Give the definition and use of Fossil fuels, fossil materials and biofuels as stores of energy. d) State and describe geothermal energy, solar energy, tidal energy, wind energy, biomass, biofuel, wave energy. Example of locations in Cameroon. e) Distinguish between direct energy source and indirect energy source (convertible) sources of energy. Express all contributions in a common unit. f) Appreciate the non-uniform distribution of worldwide energy sources. g) Use the Solar constant in simple calculations on kinetic energy of wind, potential energy of stored water. h) Give a description of deep water waves.
Energy Conversion	Hydroelectric power: efficiency of a power station. Fission reactor as a boiler. Alternative sources of electric energy: solar cells and solar power stations,	Describe the processes by which energy is converted from one form to another, with reference to: (1) chemical/fuel energy (a re-grouping of atoms), i.e. Compare the advantages and cost of using natural gas, gasoil and HFO (Heavy Fuel Oil) for electricity generation and in car consumption.

Environmental Physics Climate change	wind turbines, wave systems, Fusion reactor. Radiation hazard and its consequences to human health and the environment. Geophysical hazard and its consequences to human health and the	(2) Hydroelectric generation and transmission (emphasising the mechanical energies involved). (3) solar energy (nuclei of atoms in the Sun), solar Cells; <i>i.e. Candidates should be able to</i> i) design a simple solar cell and panel ii) do simple calculations. (4) nuclear energy, (5) geothermal energy, (6) wind energy. (7) Biomass/biofuel; <i>i.e. be able to</i> i. Show daily and seasonal variations in demand. ii. Solve the problem of storage of electrical energy. iii. Explain nuclear fusion and fission in terms of energy releasing processes. iv. Qualitatively describe fission and the chain reaction, the role of fuel, moderator, coolant and control, is expected. v. Calculate the efficiency of an energy conversion using the formula $\text{efficiency} = \frac{\text{energy converted to the required form}}{\text{total energy input}}$
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Space Weather	environment. Global warming; Greenhouse effect, effort to reduce greenhouse effect or mitigation method. Effect of air navigation. Satellites and power plants. Information on collection of satellite data Ground armature means of tracking data from difference satellite.	prevention of destruction caused by seismic waves (tsunami and volcanoes). a) Appreciate the movement of air over the earth surface due to cosmic radiation. b) Detection of air movement by satellite. a) Describe methods of measurement of humidity. b) State and describe simple methods of weather forecast. c) Describe the variation and the consequences in rain fall in Cameroon. d) Appreciate the use of satellite in collecting weather parameters.
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Option 2: Communication

Topic	Note	Assessment objectives: Candidates should be able to:
Radio Systems	Simple a.m. radio transmitter and receiver. Tuning circuits. Parallel-tuned L-C circuits: the dependence of f on the product LC required. Principles of modulation.	a) Draw block diagrams for a simple radio transmitter and receiver. b) Use tuning circuit to explain the principle of operation of a radio receiver. c) Describe super-heterodyne system. d) Distinguish between AM and FM transmission. e) Understand the term modulation and be able to

Topic	Note	Assessment objectives: Candidates should be able to:
Optical Fibres	<p>Difference between AM and FM transmissions.</p> <p>Sidebands and bandwidth.</p> <p>Transmission of information by digital means.</p> <p>Attenuation.</p> <p>Different modes of transmission.</p>	<p>distinguish between amplitude modulation (AM) and frequency modulation (FM).</p> <p>f) Give the relative advantages of AM and FM transmissions.</p> <p>g) Explain that a carrier wave amplitude modulated by a single audio frequency is equivalent to the carrier wave frequency together with two sideband frequencies.</p> <p>h) Define the term bandwidth</p> <p>i) State the advantages of the transmission of data in digital form.</p> <p>j) Understand and explain that the digital transmission of speech or music involves analogue-to-digital conversion (ADC) on transmission and digital-to-analogue conversion (DAC) on reception.</p>
The Mobile-phone	Structure and functions of a mobile phone.	<p>a) Discuss the relative advantages and disadvantages of channels of communication in terms of available bandwidth, noise, cross-linking, security, signal attenuation, repeaters and regeneration, cost and convenience.</p> <p>b) Describe the use of satellites in communication.</p> <p>c) Analyse the phone as a transmitter and as a receiver.</p> <p>d) Explain the link between the base stations (via a cellular exchange) and the public switched telephone network (PSTN) in a mobile-phone system.</p> <p>e) Explain the need for an area to be divided into a number of cells in the satellite station, each cell</p>

Topic	Note	Assessment objectives: Candidates should be able to:
		<p>served by a base station.</p> <p>f) Explain the role of the base station and the cellular exchange during the making of a call from a mobile phone handset.</p> <p>g) Draw a simplified block diagram of a mobile phone handset and give the function of each block.</p>

Option 3: ELECTRONICS

Topic	Note	Assessment objectives: Candidates should be able to:
Electronics	<p>Thermionic emission.</p> <p>Action and use of circuit components.</p> <p>Colour code.</p> <p>CR, and LR circuits</p> <p>LCR Circuits(in series).</p>	<p>a) Explain emission of electrons by a hot metal filament.</p> <p>b) Explain that to cause a continuous flow of emitted electrons requires (1) high positive potential and (2) very low gas pressure.</p> <p>c) Identify and list components found in electrical circuit.</p> <p>d) Give the values of some component (resistors, capacitors, inductors, etc.) found in a circuit.</p> <p>e) Explain how the values of resistors are chosen According to a colour code and why widely different values are needed in different types of circuit.</p> <p>f) State and apply Ohm's law.</p> <p>g) Discuss the need to choose components with suitable power ratings.</p> <p>h) display an understanding of the charging and discharging of a <ul style="list-style-type: none"> i. capacitor Time Constant ii. Capacitor coupling iii. Explain the effect of an inductor in a circuit. </p> <p>i) Draw a phasor diagram.</p> <p>j) Calculate the reactance X and impedance Z</p>

Topic	Note	Assessment objectives: Candidates should be able to:
Heat and Light Sensors. Relays and reed switches	Transformers. Centre tapped transformer in rectification. Thermistor and LDR Relay. Reed switch	Oscillatory system. k) Identify transformer in circuit for rectification (Half wave and full wave rectification). l) Describe the action of heat and light-dependent resistors and explain their use as input sensors. m) Describe and explain the action of reed relays in switching circuits. n) Explain the use of reed relays in switching circuit.
Semiconductor Devices and the P-N Junction	<ul style="list-style-type: none"> • Semiconductors. • Pure SC materials. • Extrinsic SC materials. • P-N junction and the Zener diode. • Characteristics of P-N junction • Zener diode. • LED. • Photodiode. • Band theory. • Hall effect. 	a) Define a semiconductor. b) State the difference between intrinsic and extrinsic semiconductors. c) Differentiate between a p-type and an n-type semiconductor. d) Describe how the junction diode functions. e) Use the Zener diode in voltage regulation. f) Construct simple circuit with LED and photodiode. g) Use the band theory to differentiate between insulators, conductors and semiconductors.
Transistors	Transistor as a current amplifier.	a) Display an understanding of the action of a transistor; that is <ul style="list-style-type: none"> i. n-p-n and p-n-p transistor in the common emitter mode. ii. characteristic of a transistor. (Input and output

Topic	Note	Assessment objectives: Candidates should be able to:
		characteristic for n-p-n transistor). iii. Saturation. b) Calculate current gain. c) Display an understanding of the: i. the transistor as a switch ii. Alarm circuit (Temperature, Time and lightoperated). d) Describe
Analogue and Digital Electronics	Voltage amplification by a transistor. Logic gate.	i. Common emitter amplifier ii. Loadline iii. The Thermal run away and iv. Coupling Choosing the d.c. operation point
Binary systems	Action and characteristic.	e) State in words and in truth table form, the action of the following logic gates, AND, OR, NAND, NOR and NOT (inverter).
Operational Amplifier (op.amp).	Bistable and astable circuits.	f) State the symbols for the logic gates listed above (American ANSI Y 32.14 symbols will be used). g) Explain and solve simple problems on transfer characteristic. Understand Negative feedback. h) Describe the use of a bistable circuit. i) Discuss the fact that bistable circuits exhibit the property of memory. j) Describe the use of an astable circuit (pulse generator). k) Describe how the frequency of an astable circuit is related to the values of the resistive and capacitative components.

Option 4: Medical Physics

Topic	Note	Assessment objectives Candidates should be able to:
Physics of the Eye	Physics of vision. Sensitivity of the eye. Spatial resolution. Persistence of vision. Lenses. Ray diagrams. Defects of vision. Correction of defects of vision using lenses.	a) Draw a simple structure of the eye. b) Show an understanding of the eye as an optical refracting system; include ray diagrams of image formation. c) Explain Spectral response as a photo detector. d) Give explanation in terms of the behaviour of rods and cones. e) Show an understanding of what is meant by persistence of vision. f) Explain the Properties of converging and diverging lenses; principal focus, focal length and power.
Physics of the Ear	The ear as a sound detection system. Sensitivity and frequency response.	Image formation. g) Trace and explain the origin of Myopia, hypermetropia and astigmatism. h) Draw ray diagrams. i) Do calculations of powers (in dioptres) of correcting lenses for myopia and hypermetropia. j) Show an understanding of the format of prescriptions for astigmatism. a) Draw and describe the simple structure of the ear and transmission processes. b) Describe the production and interpretation of equal loudness curves. Human perception of relative intensity levels and

Topic	Note	Assessment objectives Candidates should be able to:
	Relative intensity levels of sounds. Defects of hearing.	the need for a logarithmic scale to reflect this Physics of the Ear. c) Measure the sound intensity levels and the use of dB and dBA scales. d) Define intensity. e) Describe the threshold of hearing and its values. f) Explain the effect on equal loudness curves and the changes experienced in terms of hearing loss of: injury resulting from exposure to excessive noise; deterioration with age (excluding physiological changes).
Biological Measurement	Basic structure of the heart. Electrical signals and their detection; action potentials. Simple ECG machines and the normal ECG waveform.	a) Describe the heart as a double pump with identified valves. b) Understand the biological generation and conduction of electrical signals; action potential of a nerve cell; methods of detection of electrical signals at the skin surface. c) The response of the heart to the action potential originating at the Sino-atrial node; action potential of heart muscle. d) Explain the principles of operation for obtaining the ECG waveform; explain of the characteristic shape of a normal ECG waveform.
Non-Ionising Imaging	Ultrasound imaging.	e) Explain reflection and transmission characteristics of sound waves at tissue boundaries, acoustic impedance, and attenuation.

Topic	Note	Assessment objectives Candidates should be able to:
Radiation	Piezoelectric devices. A-scan and B-scan. Radio isotopes for nuclear medicine, meta stable radio nuclides.	f) State the advantages and disadvantages of ultrasound imaging in comparison with alternatives including safety issues and resolution. g) Understand the principles of generation and detection of ultrasound pulses. Give examples of its applications h) Explain basic principles of radiological protection.
Fibre Optics and Endoscopy	Properties of fibre optics and applications in medical physics.	a) State the properties of fibre optics. b) Show the applications of fibre optics in medical practice. c) Recall the total internal reflection at the core-cladding interface as a physical principle of the optical. d) Explain the system of a flexible Endoscope. e) Understand and give the use of coherent and non-coherent fibre bundles; with the examples of use for internal imaging and related advantages.
Magnetic Resonance (MR) Scanner	Basic principles of MR scanner.	a) Explain how the MR scanner works. b) Explain how a cross-section of patient is scanned using magnetic fields is produced c) Explain the reaction of hydrogen nuclei during the scanning (i.e. understand that they are excited during the scan, emit radio frequency (RF) signals as they de-excite: RF signals detected and processed by a computer to produce a visual image). <i>NB: Candidates will not be asked about the magnetic</i>

Topic	Note	Assessment objectives Candidates should be able to:
X-ray Imaging	X-rays. Physical principles of the production of X-rays. Differential tissue absorption of X-rays. Radiographic image detection.	<p><i>fields used in an MRI scanner, or about de-excitation relaxation times.</i></p> <p>a) Explain the physics of diagnostic X-rays. b) Show an understanding the rotating-anode X-ray tube; methods of controlling the beam intensity, the photon energy, the image sharpness and contrast the patient dose.</p> <p>Qualitative description of the absorption processes. c) Photographic detection with intensifying screen and fluoroscopic image. d) Intensification; reasons for using these x-ray Imaging.</p>
Computer Tomography (CT) Scanner	Basic principles of CT scanner.	<p>a) Elaborate the basic principles of CT scanners. b) Compare ultrasound, CT and MR scans. c) State the advantages, disadvantages and limitations in image resolution, cost and safety issues.</p>