ADVANCED SYLLABUS PHYSICS (A14)

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Introduction

This physics 'A' level syllabus is based on a wide range of syllabi both National and International. The concepts treated are broad in nature and each concept forms a part on which other sub concepts are further based. The sections treated are:

(1) General physics
(2) Newtonians mechanics
(3) Matter
(4) Oscillations and waves
(5) Electricity and magnetism
(6) Modern physics.

Aims

The aims of the present syllabus are to.

1. Provide a proper understanding of the basic concepts, principles and approach of physics and their relevant application to general science and technology.

2. Develop scientific skills and attitudes as prerequisites for further scientific activities and endeavours.

3. Recognize the usefulness and limitations of different scientific methods and appreciate their applicability to various disciplines

4. Develop attitudes relevant to science such as concern for accuracy, precision, objectivity, intuition, initiative and inventiveness.

Examination scheme

There will be two (2) papers

Paper 1: A14-1: Short structures and Essay.

This paper consists of two sections; A and B

Section A consist of (20) compulsory short structured questions for 100 marks in one hour thirty minutes ($1\,{}^{1}/_{2}$ hours)

Section B comprises seven (7) Essay questions from which candidates are expected to attempt six (6), one each from each of the sections listed above for 120 marks in one hour thirty minutes ($1\,{}^{1}/_{2}$ hours)

Paper 2: A14-2: Practical.

This paper consists of three (3) Practical questions and candidate are expected to attempt two (2) questions in three (3) hours for 80 marks.

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S/N	TOPIC/OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
I.	General Physics and Mechanics. 1.0 Physical quantities and units. 1.1 Explain Physical quantities. 1.2 Define S.I units.	(1) Explanation that all physical quantities consist of a numerical magnitude and a unit. (2) Definition of fundamental and derived units in S.I system. (3) Concept of derived units as products or quotients of the S.I base units. (4) S.I base units and homogeneity of physical equations.	Recall the following S.I base quantities and their units; mass (kg), length (m), time (s), currant (A), temperature (k), amount of mole substance (mol).
	1.3 The Avogadro constant.	(1) Definition of the Avogadro constant which is the number of atoms in 0.012kg of carbon 12. (2) Molar quantities – one mole of any substance is the amount containing a number of particles equal to the Avogadro constant.	Use the following prefixes and their symbols to indicate decimal submultiples or multiples of both base and derived units pico (P), nano (n), micro (μ) milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T).
	1.4 Scalars and vectors.	(1) Distinguish between scalar and vector quantities and give examples of each. (2) Addition and subtraction of coplanar forces. (3) Representation of a vector as two perpendicular components.	
	2.0 Measurement techniques. 2.1 measurements 2.2 errors and uncertainties.	(1) Measurement of length, volume, angle, mass, time, temperature and electrical quantities. (2) Analogue scales and digital displays. (3) uses of calibration curves (4) Distinctions between precision and accuracy. (5) Uncertainty in a derived quantity by simple addition of actual, fractional or percentage uncertainties (a rigorous statistical treatment in not required).	The use of the following measuring instruments should be treated; ruler, vernier scale, micro meter, spring and lever balances, protractor, clocks, stop watches, calibrated time-base of a cathode-ray oscilloscope (c.r.o), thermometer as a sensor, ammeter, voltmeter and galvanometer etc.

S/NO	TOPIC/OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
II	3.0 Kinematics 3.1 Linear motion.	(1) Concept of speed, velocity, displacement and acceleration. (2) Graphical methods to represent displacement, speed, velocity and acceleration. (3) Calculation of displacement from the area under a velocity-time graph. (4) Velocity as a slope of a displacement-time graph. (5) Calculation of acceleration as a slope of velocity-time graph. (6) Derivation of equations that represent uniformly accelerated motion in a straight line from the definitions of velocity and acceleration. (7) Problems on the equations of motion, including the motion of bodies falling in a uniform gravitational field without air resistance. (8) Experiment to determine the acceleration of free fall using a falling body. (9) Qualitative description of the motion of bodies falling in a uniform gravitational field with air resistance.	recall that F = mg
	3.2 Non-linear motion	(1) Description and explanation of motion due to a uniform velocity in one direction and a uniform acceleration in a perpendicular direction.	
	4.0 Dynamics 4.1 a State Newton's laws of motion. 4.1b Explain the consequences of each law. 4.1c Solve problems	(1) Newton's laws of motion. (2) Consequences of each of the laws (e.g. concept or inertia, meaning of force, calculation of the weight of a body, rocket and jet propulsion).	

	based on the laws of motion. 4.2 linear momentum and its conservation. a. Define linear momentum. b. State the law of conservation of linear momentum c. Solve problems involving colliding bodies.	(1) Definition and unit of momentum. (2) Conservation of linear momentum. (3) Types of collisions. (4) Simple problems involving collision of bodies.	Show an understanding that while momentum of a system is always conserved in interactions between bodies, some change in kinetic energy usually takes place.
	5.0 Forces 5.1a State types of forces. a. Equilibrium of forces b. Explains the concept of equilibrium of concurrent and non concurrent forces. c. State the conditions for equilibrium of coplanar forces. 5.2 Differentiate between concurrent and non - current forces. 5.3 Centre of gravity. a. Define centre of	(1) Description of forces on mass and charge in uniform gravitational and electric fields. (2) Origin of the upthrust acting on a body in a fluid. (3) Qualitative explanation of frictional forces and viscous forces including air resistance (no treatment of the coefficients of friction and viscosity is required). (1) Concept of equilibrium of forces; resultant and equilibrant forces. (2) Conditions for equilibrium of coplanar forces. (3) Distinction of concurrent and non-concurrent forces. (4) A vector triangle to represent forces in equilibrium. (1) Explanation that the weight of a body may be taken as acting at a single point known as its centre of gravity.	Illustrate with simple examples.

	gravity. 5.4 Turning effects of forces. a. Define moment, couple and torque. 6.0 Works, Energy, Power. 6.1 Energy, conversion and conservation. 6.2 Work 6.3 Potential energy, kinetic energy and internal energy.	(1) Definition and unit of moment. (2) Principles of moment. (3) Couples. (4) Torque. (5) Explain the relationship between torque and force. (6) Work done (and power) by torque. (7) Problems using; W = T Q where W = Work done T = Torque Q = Angular displacement in radian (1) Examples of energy in different forms, its conversion and conservation. (2) Concept of work. (3) Work done in solid. (4) Work done by gas, W = PΔV. (5) Derive from the equations of motion, the formula $E_k = ½ MV^2$. (6) Application of the formula $E_k = ½ MV^2$. (7) Distinction between gravitational potential energy, electrical potential energy and elastic potential energy. (8) Derive, from the defining equation. W = Fs, the formula Ep = mgh for potential energy changes near the earth's surface. (9) Concept of internal energy. (10) Efficiency of a system. (11) Energy losses in practical devices. (12) Problem solving using the concept efficiency.	

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	6.4 Power 7.0 Motion in a circle. 7.1 Kinematics of uniform circular motion. 7.2 Centripetal acceleration. 7.3 Centripetal force 8.0 Gravitational field 8.1 Gravitational field 8.2 Force between two masses 8.3 Field of a point mass 8.4 Field near to the surface of the earth 8.5 Gravitational potential.	(13) Definition of power and derive P = Force X velocity. (14) Solving problems using the relationships P = w/t and P = FV (1) Angular displacement in radians. (2) Concept of angular velocity to solve problems. (3) Use of $V = r\omega$ to solve problem. (4) Qualitative description of motion in a curved path due to a perpendicular force and the centripetal acceleration in the case of uniform motion in a circle. (5) Use centripetal acceleration, $a = r\omega^2$, $a = \frac{V^2}{r}$ (6) Centripetal force $F = mr\omega^2$, $F = \frac{mv^2}{r}$ (1) Concept of a gravitational field. (2) Gravitational field strength – force per unit mass. (3) Newton's law of gravitation in the form $F = \frac{GM_1M_2}{r^2}$ to solve problems. (4) Derivation of $g = \frac{GM}{r^2}$ of a point mass. (5) Concept of g, as also called acceleration of free fall constant on the surface of the earth. (6) Definition of potential at a point. (7) Solving problems using the equation $\emptyset = -\frac{GM}{r}$ for the potential in the field of a point mass. (8) Analogy between certain qualitative and quantitative aspects of gravitational field and electric field. (9) Analysis of circular orbits in inverse square law fields by relating the gravitational force to the centripetal acceleration it causes.	

11	9.0 phases of matter 9.1 Density a. Define density and relature density	(1) Definition of density and relative density (2) Solids, liquids and gases: relate the difference in the structures and densities of solids, liquids and gases to simple ideas of the spacing, ordering and motion of molecules (3) A simple kinetic model for solids, liquids and gases	
	9.2 Solids, liquids gases.	(4) Description of an experiment that demonstrates Brownian motion and use it to illustrate the evidence for the movement of molecules provided by such an experiment.	
	9.3 Pressure in fluids a. Define pressure b. Use the kinetic model to explain the pressure exerted by gases. 9.4 Change of phase a. Explain the three phases.	(5) Distinction between the structure of crystalline and non-crystalline solids, with particular reference to metals, polymers and amorphous materials. (6) Definition of pressure and using the kinetic model to explain the pressure exerted by gases. (7) Archimedes principle (8) Law of flotation. (9) derivation of the equation, $P = \rho gh$ from the definitions of pressure and density. (10) Use the equation $P = \rho gh$. (11) Distinction between the processes of melting, boiling and evaporation.	
	10.0 Deformation of solids 10.1 stress, strain 10.2 Elastic and plastic behaviour.	(1) Deformation in one dimension: tensile or compressive. (2) Description of the behaviour of springs in terms of load, extension, elastic unit, Hooke's law and the spring constant (i.e. forces per unit extension). (3) Definition and the use of the terms: stress, strain and the young modulus. (4) Description of an experiment to determine the young modulus of a metal in the form of a wire. (5) Distinction between elastic and plastic deformation of a material.	

		(6) Deduction of the strain energy in a deformed material from the area under the force-extension graph. (7) Demonstration of the force-extension graphs for typical ductile, brittle and polymeric materials.	
	11.0 Ideal gases 11.1 Equation of state. 11.2 kinetic theory of gases. 11.3 Pressure of a gas 11.4 Kinetic energy of a molecule.	(1) Solve problem using the equation of state for an ideal gas expressed as PV=nRT (n= number of moles). (2) Inference from a Brownian motion experiment the evidence for the movement of molecules. (3) Basic assumptions of the kinetic theory of gases. (4) Explanation on how molecular movement causes the pressure exerted by a gas and hence deduce the relationship. $P=\frac{1}{3}\frac{nm}{V}< c^2 >$ (N= number of molecules). (5) Compare Pv = $\frac{1}{3}$ nm $<c^2>$ with PV= NKT and hence deduce that the average translational kinetic energy of a molecule is proportional to T.	A rigorous derivation is not required.
IV	12.0 Temperature 12.1 Thermal equilibrium. 12.2 Temperature scales 12.3 Practical thermometers.	(1) Explanation on transfer of thermal energy from a region of higher temperature to a region of lower temperature. (2) Explanation that regions of equal temperature are in thermal equilibrium. (3) Measurement of temperature with physical properties that varies with temperature and state examples of such properties. (4) Comparism between advantages and disadvantage of resistance and thermocouple thermometers as previously calibrated instruments. (5) The thermodynamic scale and the concept of absolute zero ie explanation that there is an absolute scale of temperature that does not depend on the property of any particular substance	

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	13.0 Thermal properties of materials. 13.1 Specific heat Capacity 13.2 Specific latent heat 13.3 Internal energy 13.4 First law of Thermodynamics	(6) Conversion of temperatures measured in Kelvin to degrees Celsius and recall that $T/K = T/^0C + 273.15$. (1) Explanation using a simple kinetic model for matter why. • Meeting and boiling take place without a change in temperature. • The specific latent heat of vaporisation is higher than specific latent heat of fussion for the same substance • A cooling effect accompanies evaporation. (2) Definition and use of the concept of specific heat capacity, and identify the main principles of its determination by electrical methods. (3) Definition and use of the concept of specific latent heat and the main principles of its determination by electrical methods. (4) Relate a rise in temperature of a body to an increase in its internal energy. (5) Explanation that internal energy is determined by the state of the system and that it can be expressed as the sum of a random distribution of kinetic and potential energy associated with the molecules of a system. (6) Recall and use the first law of thermodynamics expressed in terms of the work done on the system.	

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V	14 Oscillations 14.1 Simple Harmonic Motion. 14.2 Energy in simple harmonic motion. 14.3 Damped and forced oscillations resonance.	(1) Description of simple examples of free oscillations. (2) Investigation of the motion of an oscillator using experimental and graphical methods. (3) Definitions of amplitude, period, frequency, angular frequency and phase difference and express the period in terms of both frequency and angular frequency. (4) Equation of simple harmonic motion i.e $a= -\omega^2x$. (5) Recall and use $X= X_0 \sin \omega t$ as a solution to the equation $a= -\omega^2x$. (6) Recognition and the use of $V= V_0 \cos \omega t$, $V= \pm \omega \sqrt{(X_0^2 - X^2)}$ (7) Graphical illustrations of the changes in displacement, velocity and acceleration during simple harmonic motion. (8) Description of the interchange between kinetic and potential energy during simple harmonic motion. (9) Practical examples of damped oscillation 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. (10) Practical examples of forced oscillation and resonance. (11) Graphical description of the amplitude of a forced oscillation change with frequency near to the natural frequency of the system and understanding qualitatively the factors that determine the frequency response and sharpness of the resonance. (12) Useful circumstances of resonance and where resonance should be avoided.	

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VI	15.0 Waves	(1) Definition and description of wave motion as illustrated by vibration in ropes, spring and ripple tanks.	
	15.1 Progressive Waves	(2) Definition and the use of the terms displacement, amplitude, phase difference, period, frequency, wavelength and speed.	
		(3) Deduction of V= fλ.	
	15.2 Transverse and longitudinal waves.	(4) Recall and use the equation V= fλ.	
		(5) Transfer of energy due to a progressive wave.	
		(6) Recall and use the relationship, intensity is proportuarial to $(amplitude)^2$.	
		(7) Comparism between transverse and longitudinal waves.	
	15.3 Polarisation	(8) Analysis and interpretation of graphical representations of transverse and longitudinal waves.	
	15.4 Determination of speed, frequency and wavelength.	(9) Polarisation in transverse waves.	
		(10) Frequency of sound using a calibrated c.r.o.	
		(11) Determination of the wavelength of sound using stationary waves.	
	15.5 Electromagnetic spectrum.	(12) Electromagnetic waves; state that all electromagnetic waves travel with the same speed in free space and recall the orders of magnitude of the wavelengths of the principal radiations from radio waves to γ-rays.	
		(1) Principle of superposition in simple applications.	
		(2) Experimental demonstration of stationary waves using micro waves, stretched strings and air columns.	
	16.0 Superposition 16.1 Stationary	(3) Explanation of formation of a stationary waves using a graphical method and identify nodes and antinodes.	

	waves. 16.2 Diffraction 16.3 Interference 16.4 two-source interference patterns. 16.5 Diffraction grating.	(4) Meaning of diffraction. (5) Experiments that demonstrate diffraction including the diffraction of water waves in a ripple tank with both a wide gap and a narrow gap. (6) Explaining interference and coherence. (7) Experiments that demonstrate two-source interference using water, light and micro waves. (8) Conditions required for two-source interference fringes to be observed. (9) Solve problems with equation $\lambda = \frac{ax}{D}$ For double-slit interference using light. (10) Solve problems with formula d sin $\emptyset = n\lambda$ and describe the use of a diffraction grating to determine the wavelength of light (the structure and use of the spectrometer are not included).	
VII	17.0 Electric fields 17.1 concept of an electric field 17.2 uniform electric field 17.3 force between point charges 17.4 Electric field of a point charge 17.5 Electric potential	(1) Concept of an electric field as an example of a field of force and definition of electric field strength. (2) Representation of an electric field by means of field lines. (3) Recall and use $E=\frac{V}{d}$ to calculate the field strength of the uniform field between charged parallel plates in terms of potential difference and separation. (4) Calculation of forces on charges in uniform electric fields. (5) Description of the effect of a uniform electric field on the motion of charged particles. (6) Coulomb's law, $F= Q_1 Q_2/4\pi E_0 r^2$ for the force between two point charges in free space or air. (7) Recall and use $E= Q_1 Q_2/4\pi E_0 r^2$ for the field strength of a point charge in free space or air.	

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		(8) Definition of potential at a point in terms of the work done in bringing unit positive charge from infinity to the point.	
		(9) Potential gradient.	
		(10) Use the equation V= $\frac{Q}{4\pi E_0 r}$ for the potential in the field of a point charge.	
	18.0 Capacitance	(1) Functions of capacitors in simple circuits.	
		(2) Definition of capacitors and the farad.	
	18.1 Capacitors and Capacitance	(3) Solve problem using C=$\frac{Q}{V}$.	
		(4) Derive, using the formula C= $\frac{Q}{V}$, conservation of charge and the addition of p.d.s, formulae for capacitors in series and in parallel.	
	18.2 Energy stored in a Capacitor	(5) Deduce, from the area under a potential-charge graph, the equation w= ½ QV and hence w= ½ CV^2.	
		(1) Definition of electric current as the flow of charged particles.	
	19.0 Current and Electricity	(2) Definition of charge and the coulomb.	
		(3) Solve problem using equation Q= It.	
	19.1 Electric current	(4) Definition of potential difference and the volt.	
		(5) Solve problem using V= $\frac{W}{Q}$, P= VI , P= I^2V.	
	19.2 Potential difference	(6) Definition of resistance and the ohm.	
		(7) State ohm's law.	
		(8) Solve problem using V= IR.	
		(9) Sketch and explain the I-V characteristics of a metallic conductor at constant temperature, a semiconductor diode and a filament lamp.	

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	19.3 resistance and resistivity	(10) Sketch the temperature characteristic of a thermistor (thermistor will be assumed to be the negative temperature coefficient type).	
	19.4 sources of Electromotive force	(11) Definition of e.m.f in terms of the energy transferred by a source in driving unit charge round a complete circuit.	
		(12) Distinction between e.m.f and p.d in terms of energy considerations.	
		(13) Effects of the internal resistance of a source e.m.f on the terminal potential difference and output power.	
	20.0 D,C. Circuits	(1) Draw and interprete circuit diagrams containing sources, switches, resistors, ammeters, voltmeters, and / or any other type of components referred to in the syllabus.	
	20.1 practical circuits	(2) Kirchhoff's first law and conservation of charge.	Use appropriate circuit symbols.
	20.2 conservation of charge and energy	(3) Using kirchhoff's laws, derive a formula for the combined resistance of two or more resistors in series.	Solve problems using the formula for the combined resistance of two or more resistors in series and in parallel.
	20.3 Balanced potentials.	(4) Application of kirchhoff's laws to solve simple circuit problems.	
		(5) Potential divider circuit as source of variable p.d.	
		(6) Solve problems using the principle of the potentiometer as a means of comparing potential differences.	
	21.0 Magnetic fields 21.1 concept of magnetic field.	(1) Concept of a magnetic field as an example of a field of force produced either by current-carrying conductors or by permanent magnets.	Representation of a magnetic field by field line.
	22 .0 Electromagnetism 22.1 Force on a currant- carrying conductor	(1) Explanation that a force might act on a current-carrying conductor placed in a magnetic field. (2) Definition of magnetic flux density and the tesla. (3) Measurement of the flux density of a magnetic field using current balance of the force on a current-carrying conduction.	Solve problems using the equation F= BIl sin Ø, with directions as interpreted by Fleming's left-hand rule.

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	22.2 Force on a moving charge 22.3 magnetic fields due to current. 22.4 force between current- currying conductors.	(4) Prediction of the direction of the force on a charge moving in a magnetic field. (5) Sketch flux patterns due to a long straight wire, a flat circular coil and a long solenoid. (6) Effects of a ferrous core on the field due to a solenoid. (7) Forces between current-carrying conductors and predict the direction of the forces. (8) The cyclotron. (9) Description and comparism of the forces on mass, charge and current in gravitational, electric and magnetic fields as appropriate. (10) Biot-savart law in a medium of permeability, μ	
	23.0 Electromagnetic induction 23.1 Laws of electromagnetic induction. 24.0 Alternating currents 24.1 Characteristics of alternating current	(1) Definition of magnetic flux and the Webber. (2) Definition of magnetic flux linkage. (3) Infer from appropriate experiments on electromagnetic induction: • That a changing magnetic flux can induce an e.m.f in a circuit. • That the directions of an induced e.m.f oppose the change producing it. • The factors affecting the magnitude of the induced e.m.f. (4) Simple applications of electromagnetic induction. (1) A.C concept, R.M.S. value, A.C. measurement. (2) Advantages of A.C for power supply. (3) Current through an inductance and capacitance. (4) Reactance, phase and vector representation. (5) Series L.C.R circuits.	Solve problem with $\emptyset = BA$ Solve problems using faraday's law of electromagnetic induction and Lenz's law. Recall $X = X_o \sin wt$ for sinusoidal alternating current or voltage equation and use $I_{rms} = \frac{I_0}{\sqrt{2}}$ Solve problems with $\frac{N_s}{} = \frac{V_s}{} = I_p$

	24.2 The transformer 24.3 Transmission of electrical energy 24.4 Rectification 25.0 Charged particles 25.1 Electrons 25.2 Beams of charged particles	(6) Impedance using vector diagram. (7) Power factor and resonance oscillations in a series L.C.R circuit. (8) Principle of operation of a simple laminated iron-cored transformer. (9) half-ware and full-ware rectification using a single diode and four diodes (bridge rectifier) respectively. (10) Triode as an amplifier and L.C oscillator. Modulation and demodulation of radio carrier wave. (11) Fundamentals of semi-conductors and semiconductor devices. (12) Transistor configuration. (13) Amplification, feed back, digital electronics-basic logic gates. (1) Main principle of determination of e by Millikan's experiment. (2) Summary and interpretation of the experimental evidence for quantization of charge. (3) Deflection of beams of charge particles by uniform electric and uniform magnetic fields. (4) Velocity selection by electric and magnetic fields. (5) One method for the determination of V and $\frac{e}{m_e}$ for electrons.	N_p V_p I_s for an ideal transformer.
VIII	26.0 Quantum physics 26.1 Photoelectricity and atomic spectra. 26.2 Photo electric emission of electrons 26.3 Wave-particle duality	(1) Outline of the experimental result; Planck's constant and quata of light energy. (2) Einstein's photo electric theory. (3) Photocells, characteristic spectra of elements, lines and series spectra. (4) Emission and absorption spectra. (5) Rutherford nuclear model. (6) Boar's theory for hydrogen like atoms. (7) Lyman, Balmer, Paschen, Brackett and Ffund series. (8) Excitation and Ionization potentials.	Explain photo electric phenomena spectra in terms of photon energy and work function energy.

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	26.4 Energy levels in atoms 26.5 Line spectra	(9) Laser principles and operations. (10) Wave particle duality: De Broglie hypothesis. (11) Momentum and energy. (12) Electron diffraction. (13) Nature and properties of X-rays, Basic idea of production of X-rays. (14) Line and continuous spectrum, Brags law, Mosley's law. (15) Application of X-rays.	Details of energy levels, energy level diagrams, explanations of observed spectra using Bohr's theory Recall, use and explain $hf = \emptyset + \frac{1}{2} MV^2_{max}$.
	27.0 Nuclear physics 27.1 The nucleus 27.2 Isotopes 27.3 Nuclear processes 27.4 mass excess and nuclear binding energy 27.5 radioactive decay	(1) $\propto, B, \varphi$ rays properties. (2) The Geiger- muller tube and counter. (3) cloud chamber, Bubble chamber. (4) Decay and half-life of radio active nuclei. (5) Radioactive series, proton, Neutron. (6) Isotopes, Nuclear composition, Bainbridge mass spectrometer. (7) Concept $E = MC^2$. (8) Representation of simple nuclear reactions by nuclear equation: ${}^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$ (9) Concept of Binding energy; and variation of B.E with atomic number. Release of energy by nuclear fission and nuclear fusion. (10) Applications: reactors, radioisotope, dating, radiotherapy, etc.	Detailed treatment. Nucleon number, proton number, and mass-energy are all conserved in nuclear processes. Solve problems using: $A = \lambda N$ $X = X_0 \exp(-\lambda t)$ $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
	28.0 Medical physics 28.1 production and use of X-rays 28.2 Production and use of ultrasound.	(1) Basic applications of physics to life sciences. (2) Fundamental principles and application of ultrasound, X-ray and Nuclear magnetic resonance. (3) Biomechanics, Blood pressure. (4) Elements of nuclear medicine. (5) Radioisotope detection and applications.	

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IX		APPLICATIONS OF PHYSICS:	
	29.0 Direct sensing 29.1 sensing devices 29.2 The ideal operational amplifier. 29.3 Operational amplifier circuits. 29.4 Output devices	Gathering and communication information. (1) Definition of electronic sensor. (2) light-dependent resistor (LDR) (3) Sketch of the temperature characteristic of a negative temperature coefficient thermistor. (4) Action of a piezo-electric transducer and its applications in a simple microphone. (5) Description of the structure of a metal-wire strain gauge. (6) Properties of the ideal operational amplifier (op-amp). (7) Operational amplifier as a comparator. (8) Effects of negative feedback on the gain of an operational amplifier. (9) Circuit diagrams for both the inverting and the non-inverting amplifier for single signal input. (10) Relays in electronic circuits. (11) light-emitting diodes (LEDs). (12) The need for calibration where digital or analogue meter are used as output devices.	
	30.0 remote sensing 30.1 production and use of X-rays 30.2 productive and use of ultrasound 30.3 Use of magnetic resonance as an image technique.	(1) Need for remote sensing (non-invasive techniques of diagnoses) in medicine. (2) Production of X-rays by electron bombardment of a metal target. (3) Features of a modern X-ray tube. (4) The use of X-rays in imaging internal body structures, including a simple analysis of the causes of sharpness and contrast in X-ray imaging. (5) Purpose of computed tomography or CT scanning. (6) Principles of CT scanning. (7) Development of the image of an 8-Voxel cube using CT scanning.	Solve problem by using the equation $I = I_o e^{-\mu x}$ for the attenuation of X-rays and of ultrasound in matter.

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		(8) Generation and detection of ultrasonic waves using piezo-electric transducers. (9) Main principles behind the use of ultrasound. (10) Specific acoustic impedance and its importance to the intensity reflection coefficient at a boundary. (11) Principles behind the use of magnetic resonance to obtain diagnostic information about internal structures.	
	31.0 Communication information. 31.1 Principles of modulation. 31.2 Sidebands and bandwidths.	(1) Modulation, distinction between amplitude modulation (AM) and frequency modulation (FM). (2) Sideband frequencies. (3) Definition of the term bandwidth. (4) Advantages of AM and FM transmissions. (5) Advantages of the transmission of data in digital form compared to the transmission of data in analogue form. (6) Analogue–to–digital conversion (ADC) on transmission and digital-to-analogue conversion (DAC) on reception. (7) The effect of the sample rate and the number of bits in each sample rate on the reproduction of an input signal. (8) Information carrier channels-wire-pairs, coaxial cables, radio and microwave links and optic fibres. (9) Advantages and disadvantages of channels of communication in terms of available bandwidth, noice, cross-linking, security, signal attenuation, repeaters and regeneration, cost and conveniences. (10) The use of satellites in communication. (11) Merits of both geostationary and polar orbiting satellites for communicating information. (12) Frequencies and wavelengths used in different channels of communication.	Recall and use the expression number of dB = 10 log $(\frac{p1}{p2})$ for the ratio of two powers. Only explanation is required.

		(13) The use of signal alternation expressed in dB and dB per unit length. (14) Linking of the public switched telephone network (PSTN) to base stations via a cellular exchange in a mobile-phone system. (15) The role of the base station and the cellular exchange during the making of a call from a mobile phone handset. (16) A simplified block diagram of a mobile phone handset and the function of each block.	