PHYSICS

Paper – 1
(THEORY)

Three hours and a quarter

(The first 15 minutes of the examination are for reading the paper only.

Candidates must NOT start writing during this time).

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*Answer **all** questions in Part I and **nine** questions from Part II, choosing **four** questions from Sections A, three questions from Section B and two questions from Section C.*

All workings, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.

The intended marks for questions are given in brackets [ ].

(Materials to be supplied: Log tables including Trigonometric functions)
A list of useful physical constants is given in the end of this paper.

PART I (40 marks)

Answer **all** *questions.*

Question 1.

(a) Each question is followed by four possible choices of answers.

Choose the correct answer and write it in the answer booklet. **[10]**

(i) For rectifying action of a.c into d.c we use a

A choke.

B diode.

C condenser.

D transformer.

(ii) A ray of light from air is incident on a glass plate at Brewster's angle i_p. If μ is the refractive index of glass relative to air, then the angle between the reflected and refracted ray is

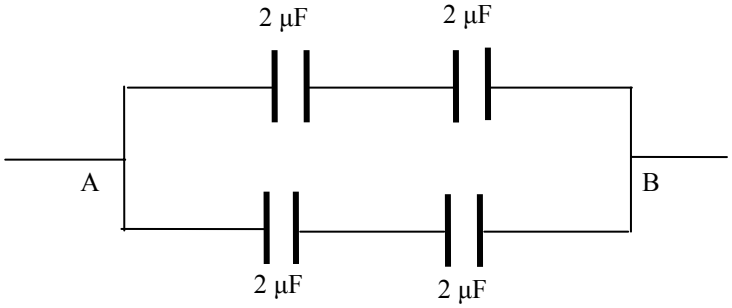
A $90°$.

B $90° - i_p$.

C $90° + i_p$.

D $90° – 45°$.

(iii) In the diagram given below the equivalent capacitance between A and B is



A 2μF.

B 4μF.

C 6μF.

D 8μF.

(iv) Polaroid glass is used in sun glasses because it

A reduces the light intensity to nearly one half on account of polarisation.

B has good colour.

C is fashionable.

D is cheap.

(v) Optical fibres are used as the mode in the transport of light energy from one end to another through a curved path. The reason for choosing optical fibres is

A it refracts light energy very well.

B total internal reflection happens.

C it diffracts the light very well.

D polarisation happens.

(vi) Given that the absolute refractive indices of water and glass are $\frac{4}{3}$ and $\frac{3}{2}$ respectively. The refractive index of glass with respect to water is

A $\frac{2}{3}$.

B $\frac{8}{9}$.

C $\frac{9}{8}$.

D $\frac{3}{4}$.

(vii) The strength of the photoelectric current depends upon

A angle of incident radiation.

B intensity of incident radiation.

C frequency of incident radiation.

D distance between emitter and collector.

(viii) In an electron-gun, the control grid is made negative to the cathode in order to

A decelerate the electrons.

B control the number of electrons.

C increase the energy of the electrons.

D select the electrons of the same velocity.

(ix) In a nuclear reaction the following happens:

$$^{220}_{86}Rn \rightarrow {}^{216}_{84}Po + {}^{4}_{2}He + \text{Q}$$

The correct property of Q is

A it is deflected by magnetic field.

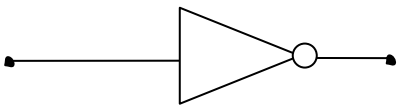
B it is deflected by electric field.

C it is a form of energy.

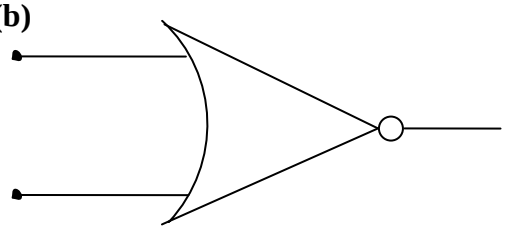
D it is a particle.

(x) Which of the following symbols of combination will give NAND gate?

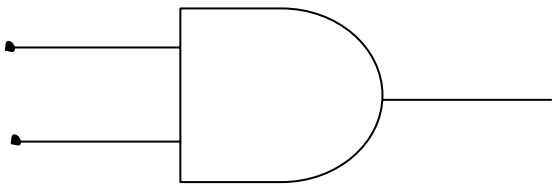
(a)



(b)



(c)



A (a) and (b)

B (b) and (c)

C (a) and (c)

D none of the above

(b) Fill in the blanks with appropriate words given in brackets. **[6]**

(i) Critical temperature of a conductor, is the temperature below which it's ……. falls to zero and the conductor becomes a …….. (capacity, resistivity, conductivity, super conductor, resistor)

(ii) The amount of heat produced in a conductor due to a constant current flowing through it is ……. proportional to the square of …… (directly, inversely, current, resistance)

(iii) Neutral points near a bar magnet are the points where the magnetic field due to …….. is exactly neutralised by that due to the …… (bar magnet, earth's magnetism, nearby objects, magnetic field)

(iv) The strength of a magnetic filed is said to be one Tesla if a charge of one ……. moving at right angles to it with a velocity of one …….. experiences a force of 1Newton. (ampere, coulomb, cm/s, m/s)

(v) In the nuclear fission reaction …….. breaks up into lighter nuclei of comparable …….. (protons / heavy nucleus / electrons / masses)

(vi) ${}_1H^3 + ... \rightarrow {}_2He^4 + {}_0n^1 + ...$

(${}_1H^1$, ${}_1H^2$, heat energy, nuclear energy)

(c) Match the items in Column A with the items given in Column B and rewrite the correct pairs. Item 1 has been done as an example. Example: 1(b) **[4]**

Column A	**Column B**
1. Inductance	a. MeV
2. Binding energy	b. Henry
3. Hydrogen bomb	c. size of nucleus
4. Michelson experiment	d. fusion of reaction
5. Rutherford scattering experiment	e. speed of light
6. Electric potential	f. carbon dating
7. Radio activity	g. conversion of light energy to electrical energy
8. Refraction	h. volt
9. Photo electric effect	i. change in speed of light
	j. Ohms
	k. Fission reaction

(d) State true or false and support your answer with reasons OR equations. **[4]**

(i) During nuclear fusion, lighter nuclei combine together to form a heavy nucleus.

(ii) When a pn junction diode is given reverse biasing, current does not flow through it.

(iii) A charged particle placed in-between two parallel plates connected to a high potential difference will follow a parabolic path.

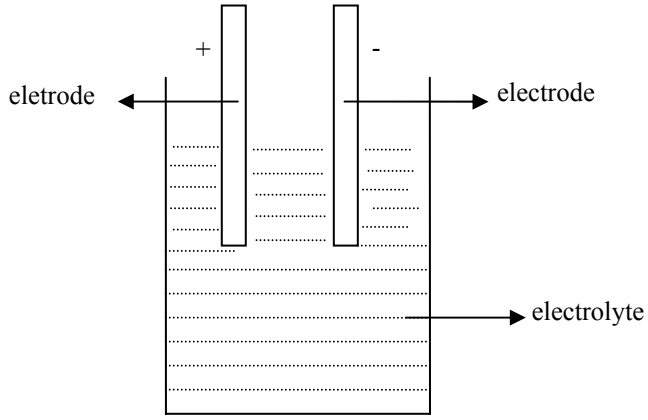
(iv) Red light deviates more than violet light when it is passed through a glass prism.

(e) Answer the following questions briefly.

(i) State and write down the expression for the Radioactive decay law. **[2]**

(ii) Explain briefly in terms of electron theory why and how the resistance of a metal wire changes when heated. **[2]**

(iii) In the diagram given below, show the direction of the follow of electrons and the direction of the conventional current in the external circuit. **[2]**

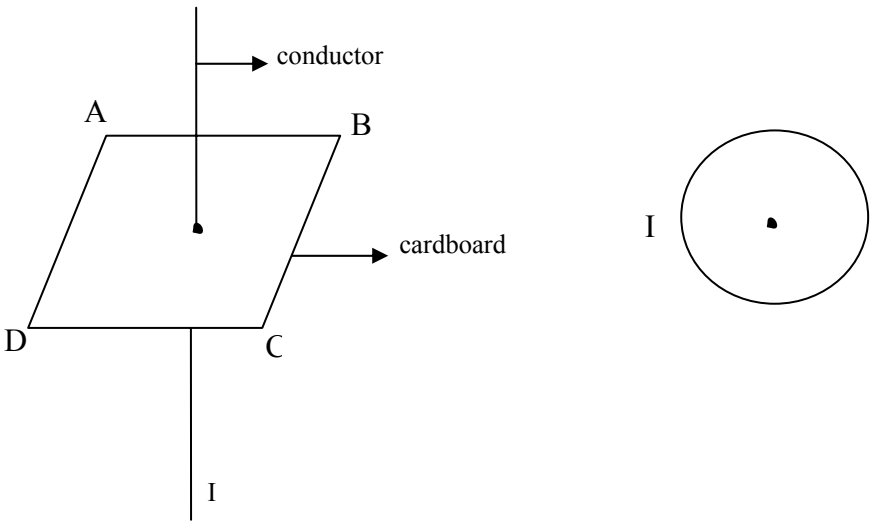


(iv) Write down the equation relating relative permeability (μ_r) and magnetic susceptibility (χ_m). Also give the defining equation of χ_m. **[2]**

(v) Draw a labelled diagram of a nuclear reactor with any of its four main parts. **[2]**

(vi) Mention *two* uses of X-rays. **[2]**

(vii) In the figure given below, a straight wire and a circular wire are carrying current I. Copy the figure and mark the direction of the magnetic field on the cardboard ABCD and at the centre of the circular wire. **[2]**



(viii) Name the parts of a LED and mention *one* of its applications. **[2]**

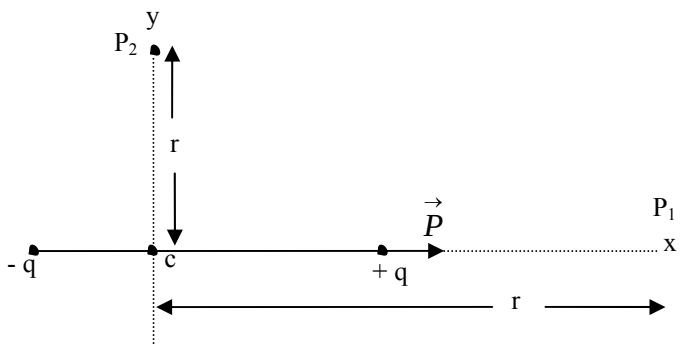
Part II

SECTION A (28 marks)

Answer any FOUR questions.

Question 2.

(a) In the figure given below, P_1 and P_2 are points on the axis and equilateral line of an electric dipole. Write down the expressions for the electric field at P_1 and P_2 due to the dipole moment p_E. Assume the distance of P_1 and P_2 from the centre of the dipole (r) is >>the length of the dipole. Indicate the direction of E_1 nd E_2. **[2]**



(b) The total electric flux of 6.0×10^3 SI unit is found to emit from a sphere with some electric charge inside it. Calculate the magnitude of the charge inside the sphere. If the whole charge is placed on the surface of the sphere, what is the electric field at its centre? **[3]**

(c) Write two methods to increase the capacitance of a parallel plate capacitor. **[2]**

Question 3.

(a) Draw a graph showing variation of thermo e.m.f (ε) with temperature difference between the junctions. Mark the neutral temperature and temperature of inversion. From the expression of thermo e.m.f, obtain the expression for thermoelectric power. **[3]**

(b) Derive the formula to determine an unknown resistance using a balanced Wheatstone bridge with the help of a diagram. **[3]**

(c) From the definition of pd, $V = \frac{W}{q}$, obtain the expression for Joule heating $Q = W = \frac{V^2 t}{R}$. **[1]**

Question 4.

(a) State Biot-Savart's law in vector form for the magnetic field dB due to a current element Idl. Apply this to obtain the magnetic field B at the centre of a circular loop of radius r carrying current I. **[3]**

(b) A small bar magnet vibrating horizontally (torsional vibration) in the earth's field has a period of 4.0 seconds. When another magnet is brought near it the time period becomes 3.0 seconds. Write down the formulae relating the time period and magnetic fields. Calculate the ratio of the combined field (of earth and magnet) to the earth's field. **[3]**

(c) Why do we prefer a small compass needle at the centre of a tangent galvanometer? **[1]**

Question 5.

(a) Describe briefly the theory and working of a tangent galvanometer. Include vector diagram of magnetic fields. Derive the formula B = H tan θ. **[4]**

(b) Draw a labelled diagram of an a.c generator and state its principle. **[3]**

Question 6.

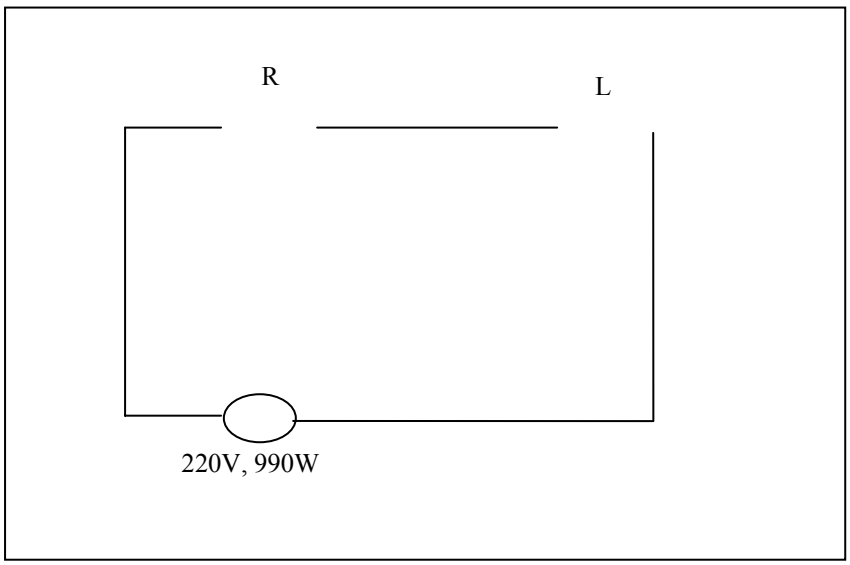
(a) Obtain the formula I = Kθ for a moving coil galvanometer, given deflecting torque $\overrightarrow{\tau_d} = \overrightarrow{m} \text{ X } \overrightarrow{B}$ where $\overrightarrow{m}$ is the magnetic dipole moment of the coil placed in a magnetic field B. **[3]**

(b) Explain the principle and working of a step up transformer with a sketch. **[4]**

Question 7.

(a) With the help of a phasor impedance diagram establish the relationship for the impedance (z) of a circuit having inductance L, capacitance C and resistance 'R' in series in terms of resistance R and reactance X_L and X_C. Give the expression for phase difference ϕ. **[3]**

(b) A resistor and inductor are connected in series with an a.c source 220V and the power drawn is 990W. The power factor is 0.75. Draw a phasor diagram showing R, X_L, Z and Φ. Calculate the values of current I and Z. **[3]**



(c) What is an ideal inductor? **[1]**

SECTION B (18 marks)

Answer any THREE questions

Question 8.

(a) With the help of a diagram, briefly describe the method used by Michelson to find the speed of light. **[3]**

(b) Using Huygen's principle, verify the law of reflection. Draw diagrams showing incident and reflected wave fronts. **[3]**

Question 9.

(a) A screen is placed at a distance of 1.0 m from a narrow slit. The slit is illuminated by light of wavelength 500 nm. If the first minimum of the diffraction pattern is seen at a distance of 5 mm from the central maximum, find the width of the slit? **[3]**

(b) Draw a ray diagram to illustrate Young's double slit experiment for interference. Derive the formula for fringe width in terms of measurable parameters. **[3]**

Question 10.

(a) Establish the relationship between refractive index μ, angle of prism A and angle of minimum deviation δ_m for a prism assuming $i_1 + i_2 = A + \delta_m$, $r_1 + r_2 = A$ and $r_1 = r_2$ and $i_1 = i_2$ in minimum deviation position. **[3]**

(b) Draw ray diagrams to illustrate chromatic aberration and spherical aberration. **[2]**

(c) Write the relation between focal length f, radius of curvature and refractive index for a plano convex lens. **[1]**

Question 11.

(a) Draw a labelled diagram of an astronomical telescope showing the formation of image at infinity. **[2]**

(b) Two lamps of 50 candela and 36 candela are placed along a straight line at 10 cm and 6 cm respectively on the same side of the grease spot in a Bunsen photometer. Where should a 96 candela lamp be placed on the other side in order to make the spot disappear? **[3]**

(c) In a simple microscope where should the object be placed to have the image formed at infinity? **[1]**

SECTION C (14 marks)

Answer any TWO questions

Question 12.

(a) Explain briefly why red light does not produce photoelectrons in a metal in which violet light produces photoelectrons. **[2]**

(b) State de broglie's equation for λ of particles. If the velocity of a particle is doubled, how does de Broglie λ change? **[2]**

(c) State the *three* main postulates of Bohr's theory of hydrogen atom. **[3]**

Question 13.

(a) Write down the expressions for kinetic energy and potential energy of an electron in Bohr model. **[2]**

(b) Describe briefly the mechanisms of α – decay, β – decay and γ – decay showing what changes take place within the nucleus. Write an equation for each to support your answer. **[3]**

(c) How is energy generated in the atom bomb? Write an equation showing the reaction to support your answer. **[2]**

Question 14.

(a) Mention *two* uses of photoelectric effect in our daily lives. **[1]**

(b) Distinguish between conductors, semi-conductors and insulators in terms of energy band diagram. **[3]**

(c) Draw a labelled circuit diagram of a transistor as an oscillator (common emitter). Explain briefly its working. **[3]**

PHYSICAL CONSTANTS AND RELATIONS

Permittivity of free space	ε_0	$= 8.85 \times 10^{-12}$ Fm^{-1}
Planck constant	h	$= 6.63 \times 10^{-34}$ J.s
Electron charge	e	$= 1.6 \times 10^{-19}$ C
1 electron volt	1 eV	$= 1.60 \times 10^{-19}$ J
Speed of electromagnetic wave	c	$= 3.00 \times 10^{8}$ ms^{-1}
Energy equivalent of	1u	= 931 MeV
Mass of an electron	m_e	$= 9.10 \times 10^{-31}$ kg