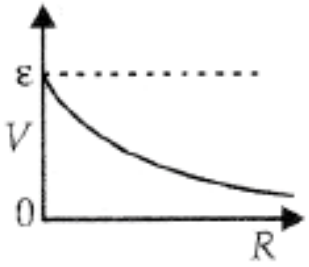
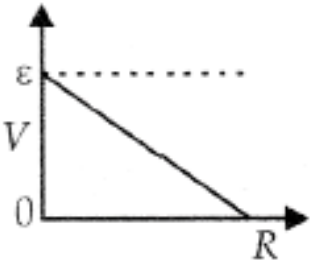
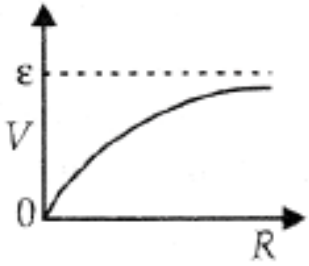
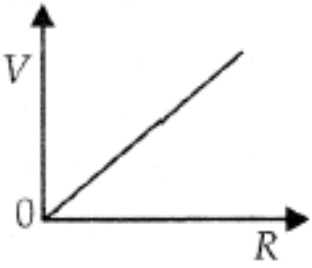
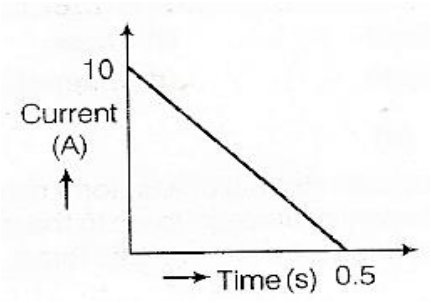
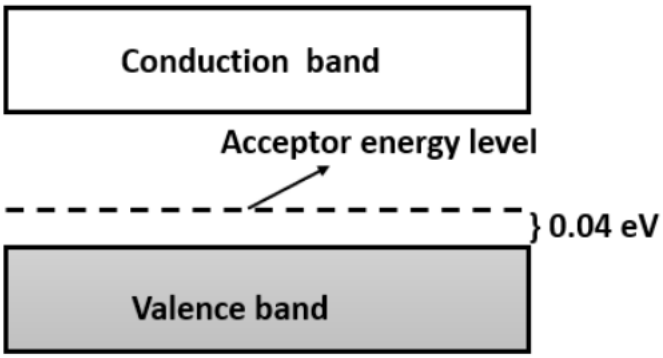
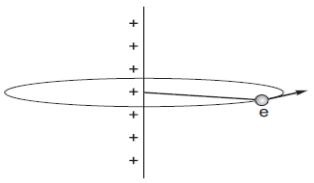
IDEAL INDIAN SCHOOL, DOHA-QATAR
PRE BOARD I EXAMINATION, DECEMBER 2023
PHYSICS (042)

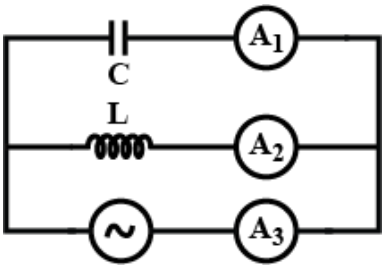
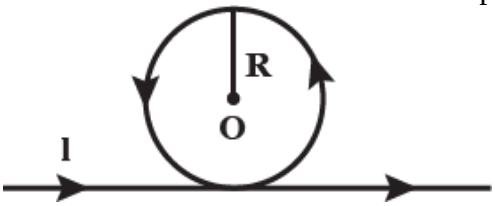
Class: XII **Max Marks: 70**
Date: 10.12.2023 **SET -1** **Duration: 3 hours**

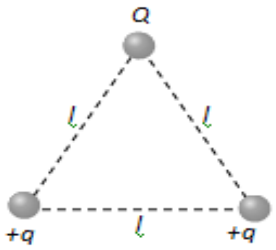
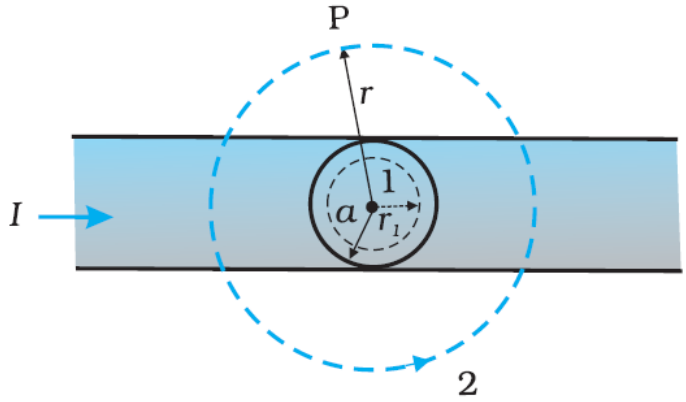
General Instructions:

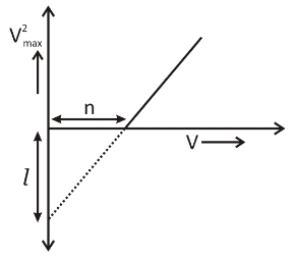
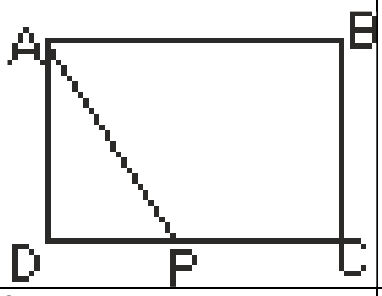
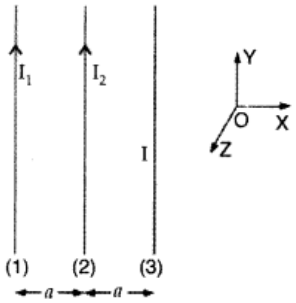
- There are 33 questions in all. All questions are compulsory.
- This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
- Section A contains sixteen MCQ of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
- There is no overall choice. However, an internal choice has been provided in section B, C,D & E. You have to attempt only one of the choices in such questions.
- Use of calculator is not allowed

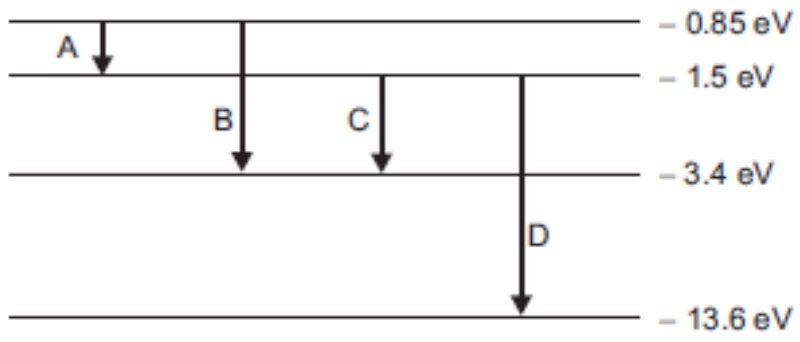
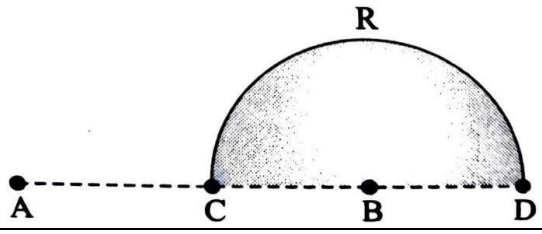
Q.No	SECTION A	
1	An electric dipole placed in an electric field of intensity 2×10^5 N/C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is (a) 7 μC (b) 8 mC (c) 2 mC (d) 5 mC	**1**
2	A cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by: (a)  (b)  (c)  (d) 	**1**

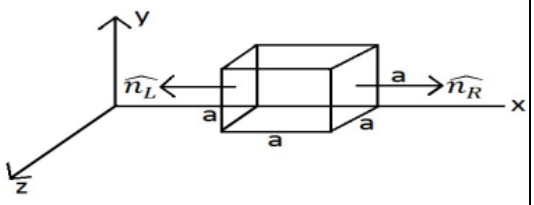
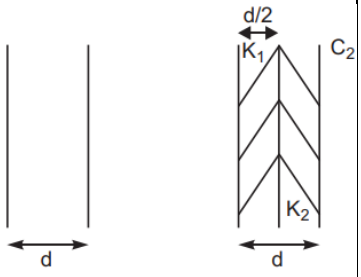
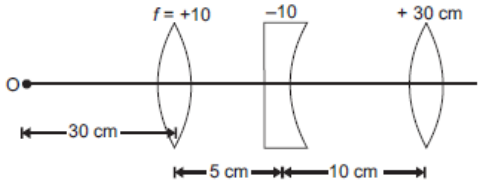
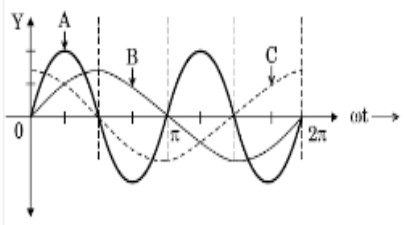
3	In a coil of resistance 100 Ω a current is induced by changing the magnetic flux through it. The variation of current with time is as shown in the figure. The magnitude of change in flux through coil is  (a) 200 Wb (b) 275 Wb (c) 225 Wb (d) 250 Wb	**1**
4	A proton and an α particle have the same de- Broglie wavelength. The ratio of their accelerating potential of proton to α particle is (a) 1:4 (b) 8:1 (c) 2:1 (d) 1:8	**1**
5	The type of extrinsic semiconductor, indicated on the energy band diagram is:  (a) N-type (b) P-type. (c) PN junction (d) none	**1**
6	The electrical field amplitude of an e.m. wave is E_0 = 120 N/C and its frequency γ = 50 MHz. The value of propagation constant k of the wave is (a) 1.5 m (b) 1.25 m (c) 0.15 m (d) 1.05 m	**1**
7	The relative magnetic permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then (a) X is paramagnetic and Y is ferromagnetic (b) X is diamagnetic and Y is ferromagnetic (c) X and Y both are paramagnetic (d) X is diamagnetic and Y is paramagnetic	**1**
8	An infinitely long positively charged straight wire has a linear charge density λ c m^{-1}. An electron is revolving around the wire as its center with a constant velocity in a circular plane perpendicular to the wire. The expression for the kinetic energy of the electron is:  (a) $e\lambda/2\pi\epsilon_0 r$ (b) $e\lambda/4\pi\epsilon_0$ (c) $e\lambda/2\pi\epsilon_0 r^2$ (d) $e\lambda/4\pi\epsilon_0 r^2$	**1**

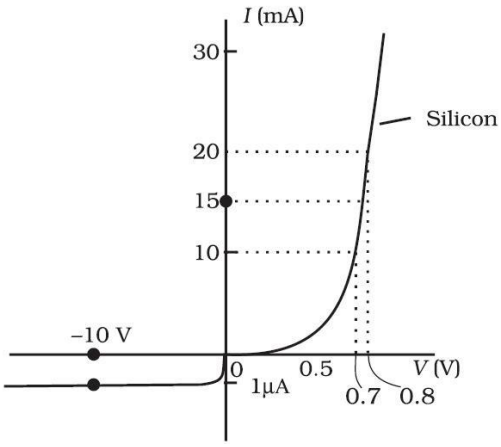
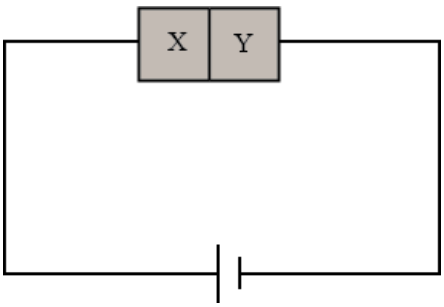
9	An inductor L, a capacitor C and ammeters **A1, A2** and **A3** are connected to an oscillator in the circuit as shown in the adjoining figure. When frequency of the oscillator is increased, then at resonant frequency, the ammeter reading is zero in the case of:  (a) A_1 (b) A_2 (c) A_3 (d) A_1, A_2,& A_3	**1**
10	An infinitely long straight conductor is bent into the shape as shown below. It carries a current of I ampere and the radius of the circular loop is R metre. Then, the magnitude of magnetic induction at the centre of the circular loop is:  . (a) Zero (b) Infinite (c) $\mu_0 I(\pi-1)/2\pi r$ (d) $\mu_0 I(\pi+1)/2\pi r$	**1**
11	To increase the current-sensitivity of a moving-coil galvanometer by 50%, its resistance is increased so that the new resistance becomes twice its initial resistance. By what percentage does its voltage-sensitivity change? (a) 75% (b) 15% (c) 25% (d) 50%	**1**
12	The longest wavelength that a photon can ionize a hydrogen atom in its ground state is (a) 1.210 A^0 (b) 0.1210 A^0 (c) 0.910 A^0 (d) 0.1210 nm	**1**
	For Questions 13 to 16, two statements are given – one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. a) If both Assertion and Reason are true and Reason is correct explanation of Assertion. b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion. c) If Assertion is true but Reason is false. d) If both Assertion and Reason are false	
13	**Assertion:** When radius of a circular loop carrying current is doubled, its magnetic moment becomes four times**.** **Reason:** Magnetic moment depends on area of the loop**.**	**1**

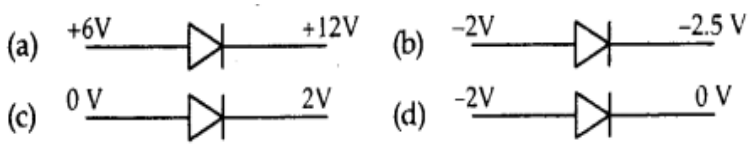
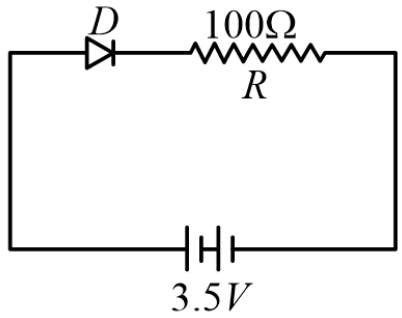
14	**Assertion** (A): For the radiation of a frequency greater than the threshold frequency, photoelectric current is proportional to the intensity of the radiation. **Reason (R)** : Greater the number of energy quanta available, greater is the number of electrons absorbing the energy quanta and greater is number of electrons coming out of the metal.	**1**
15	**Assertion (A) :** Putting P type semiconductor slab directly in physical contact with N type semiconductor slab cannot form the PN junction. **Reason (R):** The roughness at contact will be much more than inter atomic crystal spacing and continuous flow of charge carriers is not possible.	**1**
16	**Assertion (A) :** Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface. **Reason (R)**: Refractive index of the material of the cladding of the optical fibre is greater than that of the core.	**1**
	SECTION B	
17	The charges Q, +q and +q are placed at the vertices of an equilateral triangle of side l. If the net electrostatic energy of the system is zero, find the value of Q?  	**2**
18	The given figure shows a long straight wire of a circular cross-section (radius *a*) carrying steady current *I*. The current *I* is uniformly distributed across this cross-section. Calculate the magnetic field in the region $r < a$ and $r > a$.  	**2**

19	The wavelength λ of a photon and the de Broglie wavelength of an electron of mass m have the same value. Show that the energy of the photon is 2λmc/h times the kinetic energy of the electron, where c and h have their usual meanings. **OR** Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the regions in which nuclear force is (i) attractive (ii) repulsive. Write two important conclusions which you can draw regarding the nature of the nuclear forces	**2**
20	A ray of monochromatic light passes through an equilateral glass prism in such a way that the angle of incidence is equal to the angle of emergence and each of these angles is 3/4 times the angle of the prism. Determine the angle of deviation and the refractive index of the glass prism.	**2**
21	When a given photosensitive material is irradiated with light of frequency ν, the maximum speed of the emitted photoelectrons equals v_{max}. The square of v_{max}, is observed to vary with ν as per the graph shown below. Determine the Planck's constant in terms of m, *l*, and n?  	**2**
	SECTION C	
22	Derive an expression for the resistivity of a conductor in terms of number density of free electrons and relaxation time. **OR** A wire of uniform cross-section and resistance 4 ohm is bent in the shape of square ABCD. Point A is connected to a point P on DC by a wire AP of resistance 1 ohm. When a potential difference is applied between A and C, the points B and P are seen to be at the same potential. What is the resistance of the part DP?  	**3**
23	Three long straight parallel wires are kept as shown in the figure. The wire (3) carries a current I  (i) The direction of flow of current I in wire (3), is such that the net force, on wire (1), due to the other two wires, is zero. (ii) By reversing the direction of I, the net force, on wire (2), due to the other two wires, becomes zero. What will be the directions of current I, in the two cases? Also obtain the relation between the magnitudes of currents I_1 I_2 and I	**3**

24	The energy level diagram of an element is given below. Identify, by doing necessary calculations, which transition corresponds to the emission of a spectral line of wavelength 102.7 nm.  	**3**
25	Charges (+q) and (–q) are placed at the points A and B respectively which are a distance 2L apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD?  	**3**
26	(a) A parallel plate capacitor is being charged by a time varying current. Explain briefly how Ampere's circuital law is modified to incorporate the effect due to the displacement current. (b) Identify the part of the electromagnetic spectrum which: (i) is absorbed by the ozone layer in the atmosphere, (ii) is used for studying crystal structure.	**3**
27	A given coin has a mass of 3.0 g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of ${}_{29}Cu^{63}$ atoms (of mass 62.92960 u). Given m_p = 1.007825 u and m_n = 1.008665 u.	**3**
28	(a) Define mutual inductance and write its SI unit. (b) Two circular loops, one of small radius r and other of larger radius R, such that R >> r, are placed coaxially with centres coinciding. Obtain the mutual inductanc of this arrangement.	**3**

	SECTION D	
29	Define electric flux. Write its SI unit. State Gauss's theorem. Given the components of an electric field as $E_x = \alpha x$, $E_y = 0$ and $E_z = 0$, in which $\alpha = 400$ N/C and side of the cube is 10 cm. If the distance of the left face of the cube from origin is equal to the side of the cube, calculate the electric flux through each face of the cube of side 'a' as shown in the figure and the electric charge inside the cube?  **OR** (i) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' ($t < d$). Derive the expression for the capacitance of the capacitor. (ii) You are given an air filled parallel plate capacitor C1. The space between its plates is now filled with slabs of dielectric constants K_1 and K_2 as shown in C_2. Find the capacitances of the capacitor C_2 if area of the plates is A , distance between the plates is d.  	**5**
30	(i) Draw a ray diagram for the formation of image of a point object by a thin double convex lens having radii of curvature R_1 and R_2. Hence derive lens maker's formula. (ii) A converging lens has a focal length of 10 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, find its new focal length. **OR** (i) Derive the lens formula for a convex lens when virtual image is formed. (ii) Find the position of the image formed by the lens combination given in the figure  	**5**
31	Obtain the expression for the average power consumed in a series LCR circuit. And show that the average power consumed in a capacitor and an inductor is zero? Can the voltage drop across the inductor or capacitor in a series LCR circuit be greater than the applied voltage of the ac source? Justify your answer **OR** Device 'X' is connected to an ac source $V = V_o \sin\omega t$. The variation of voltage, current and power in one cycle is shown in the above graph: Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit .Obtain the expression for the current through 'X'. Draw its graphical representation and phasor diagram. Draw the variation of opposition to the flow of ac with frequency?  	**5**

	SECTION E	
32	**Case study :** **Read the following paragraph and answer the questions that follow.** A semiconductor diode is basically a PN junction with metallic contacts provided at the ends for the application of an external voltage. It is a two terminal device. When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal, it is said to be forward biased. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased. An ideal diode is one whose resistance in forward biasing is zero and the resistance is infinite in reverse biasing. When the diode is forward biased, it is found that beyond forward voltage called knee voltage, the conductivity is very high. When the biasing voltage is more than the knee voltage the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current.  (i) The V-I characteristic of a diode is shown in the figure. The ratio of the resistance of the diode at I = 15 mA to the resistance at V = -10 V is (a) 100 (b) 10^6 c) 10 (d) 10^{-6} (ii) A semiconductor X is made by doping a germanium crystal with arsenic Z = 33. A second semiconductor Y is made by doping germanium with indium Z = 49  (a) X is P type, Y is N type and the junction is forward biased (b) X is P type, Y is N type and the junction is reverse biased	**4**

	(c) X is P type, Y is N type and the junction is reverse biased (d) X is N type, Y is P type and the junction is reverse biased **OR** In which case is the junction diode forward biased.  (i) a (ii) c (iii) b (iv) a and c (iii) In the given figure, a diode *D* is connected to an external resistance $R = 100\ \Omega$ and an emf of 3.5 *V*. If the barrier potential developed across the diode is 0.5 *V*, the current in the circuit will be:  (a) 40 mA (b) 20 mA (c) 35 mA (d) 30 mA (iv) A semiconductor has equal electron and hole concentration of 6×10^{8} per m^{3}. On doping with certain impurity, electron concentration increases to 9×10^{12} per m^{3}. The new hole concentration is (a) $4 \times 10^{4}\ m^{-3}$ (b) $4.45 \times 10^{4}\ m^{-3}$ (c) $4.5 \times 10^{4}\ m^{-3}$ (d) $5.45 \times 10^{13}\ m^{-3}$	
33	**Case study :** **Read the following paragraph and answers the questions:** The spectral series of hydrogen atom were accounted for by Bohr using the relation	**4**

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

where, R=Rydberg constant = 1.097×10^7 m^{-1}.Lyman series is obtained when an electron jumps to first orbit from any subsequent orbit. Similarly, Balmer series is obtained when an electron jumps to 2^{nd} orbit from any subsequent orbit. Paschen series is obtained when an electron jumps to 3^{rd} orbit from any subsequent orbit. Whereas Lyman series in U.V. region, Balmer series is in visible region and Paschen series lies in infrared region. Series limit is obtained when $n_2=\infty$.

(i) The wavelength of first spectral line of Lyman series is
(a) 1215.4 A^0 (b) 1215.4 nm
(c) 1215.4 m (d) 1215. 4 mm

(ii) The wavelength limit of Lyman series is
(a) 1215.4 A^0 (b) 511.9 A^0
(c) 951.6 A^0 (d) 911.6 A^0

(iii) The frequency of first spectral line of Balmer series is
(a) 1.097×10^7 Hz (b) 4.57×10^{14} Hz
(c) 4.57×10^{15} Hz (d) 4.57×10^{16} Hz

(iv) Which of the following transitions in hydrogen atom emit photon of highest frequency?
(a) n=1 to n=2 (b) n=2 to n=6
(c) n=6 to n=2 (d) n=2 to n=1

OR

The ratio of minimum to maximum wavelength in Balmer series is
(a) 5 : 9 (b) 5 : 36 (c) 1 : 4 (d) 3 : 4