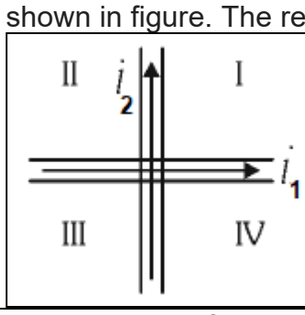
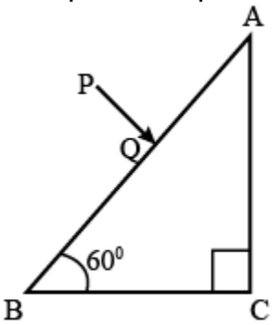
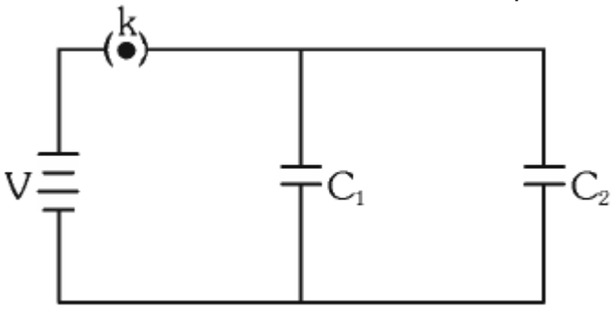
Pre-Board Examination 2024-25
Subject: Physics (042)
Class: XII

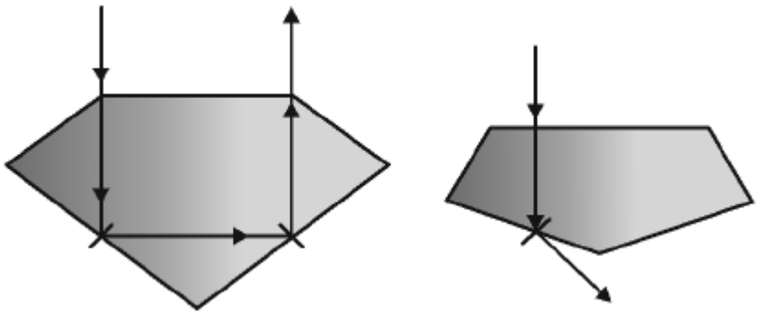
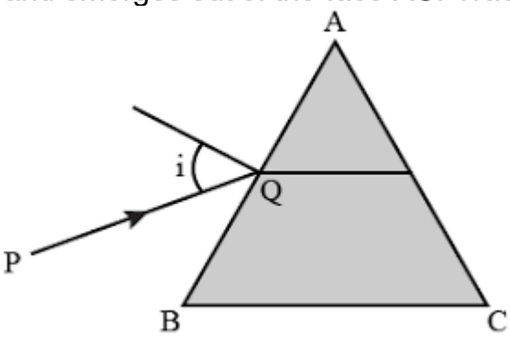
Time: 3 hrs Date: ---------- Max. Marks: 70

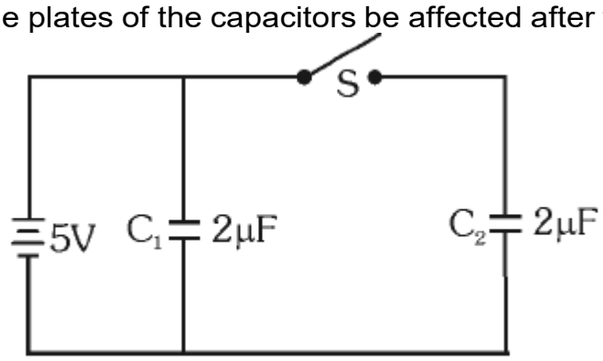
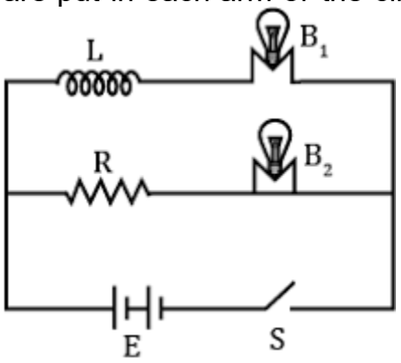
General Instructions:
(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based 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 two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

	Section-A	
1	A point charge q is placed at a distance a/2 directly, above the center of a square of side a. The electric flux through the square is. (a) q / ε0 (b) q / π ε0 (c) q / 4 ε0 (d) q / 6 ε0	1
2	The magnitude of electric field due to a point charge 2q, at distance r is E. Then the magnitude of electric field due to a point charge q at a distance r / 2 will be: (a) E / 4 (b) 0 (c) 2 E (d) 4 E	1
3	Photoelectric emission from a given surface of metal can take place when the value of a 'physical quantity' is less than the energy of incident photon. The physical quantity is. (a) threshold frequency (b) work function of surface (c) threshold wavelength (d) stopping potential	1
4	Angular momentum of an electron in the second excited state of hydrogen atom is. (a) h / π (b) 3 h / 2 π (c) 2 h / π (d) 0	1
5	Two wires of the same length are shaped into a square of side 'a' and a circle with radius 'r'. If they carry same current, the ratio of their magnetic moment is. (a) 2 : π (b) π : 2 (c) π : 4 (d) 4 : π	1
6	Which of the following is not correct about relative magnetic permeability(μ_r)? (a) For diamagnetic material $\mu_r < 1$ (b) For vacuum its value is one (c) For ferromagnetic materials $\mu_r >> 1$ (d) For paramagnetic materials $\mu_r < 1$	1
7	Two wires carrying currents i1 and i2 lie, one slightly above the other, in a horizontal plane as shown in figure. The region of vertically upward strongest magnetic field  (a) I (b) II (c) III (d) IV	1
8	A circular coil of N turns and diameter 'd' carries a current 'I'. It is unwound and rewound to make another coil of diameter '2d', current 'I' remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil is. (a) 1 : 2 (b) 2 : 1 (c) 1 : 4 (d) 4 : 1	1
9	A 0.1 m long conductor carrying a current of 50 A is held perpendicular to a magnetic field of 1.25 mT. The mechanical power required to move the conductor with a speed of 1m/s is. (a) 62.5 mW (b) 625 mW (c) 6.25 mW (d) 12.5 mW	1
10	A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9:3 V / m. The magnetic induction (B) along z-axis is. (a) 3.1×10^{-8} T (b) 3×10^{-5} T (c) 3×10^{-6} T (d) 9.3×10^{-6} T	1
11	An alternating voltage source of variable angular frequency 'ω' and fixed amplitude 'V' is connected in series with a capacitance C and electric bulb of resistance R (inductance zero). When ‘ω' is increased	1

	(a) the bulb glows dimmer. (b) the bulb glows brighter. (c) net impedance of the circuit remains unchanged. (d) total impedance of the circuit increases.	
12	In which of the following Bohr's orbit (n) a hydrogen atom emits the photons of lowest frequency: (a) n = 2 to n = 1 (b) n = 4 to n = 2 (c) n = 4 to n = 1 (d) n = 4 to n = 3	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: If intensity of incident light is doubled, the kinetic energy of photoelectron is also doubled. Reason: The kinetic energy of photoelectron is directly proportional to intensity of incident light.	1
14	Assertion: A semiconductor is virtually an insulator at absolute zero temperature. Reason: At absolute zero temperature, almost all the valence electrons are engaged in the formation of covalent bond.	1
15	Assertion: Balmer series lies in the visible region of electromagnetic spectrum. Reason: Wavelength of emitted radiation in given by $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$..... where n = 3, 4, 5, …… which lies in 4000 A^0 - 7000 A^0 range.	1
16	Assertion: The frequencies of incident, reflected and refracted beam of monochromatic light passing from one medium to another are the same. Reason: The incident, the reflected and refracted rays are coplanar.	1
	Section-B	
17	Write the two processes that take place in the formation of a p-n junction. Explain with the help of a diagram, the formation of depletion region and barrier potential in a p-n junction.	2
18	The wavelength λ of a photon and the de Broglie wavelength of an electron have the same value. Show that energy of a photon is (2λmc / h) times the kinetic energy of electron, where m, c and h have their usual meaning.	2
	OR	
	A proton and a deuteron are accelerated through the same accelerating potential. Which one of the two has: (a) greater value of de-Broglie wavelength associated with it, and (b) less momentum? Give reasons to justify your answer.	
19	A ray PQ incident normally on the refracting face BA is refracted in the prism BAC made of material of refractive index 1.5. From which face will the ray emerge? Justify your answer. Complete the path of ray through the prism. $Sin^{-1}(2/3) = 42^0$. 	2
20	(a) Two conducting wires X and Y of same diameter but different materials are joined in series across a battery. If the number density of electrons in X is twice that in Y, find the ratio of drift velocity of electrons in the two wires. (b) Two cells of emf E_1 and E_2 have their internal resistances r1 and r2 respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across an external resistance R. Assume that the two cells are supporting each other. (c) In case the two cells are identical, each of emf E = 5V and internal resistance r = 2 Ω, calculate voltage across the external resistance R = 10 Ω.	2
21	In a single slit diffraction experiment first minimum for λ_1 = 660 nm coincides with first maxima for wavelength λ_2. Calculate λ_2.	2

	Section-C	
22	(a) The radius of a spherical nucleus as measured by electron scattering is 3.6 fm. What is the likely mass number of the nucleus? (b) A nucleus with mass number A = 240 and BE/A = 7.6 MeV breaks into two fragments each of A=120 with BE /A = 8.5 MeV. Calculate the released energy.	3
23	Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 3C_2$ are connected across a battery of V volts as shown in the figure. Initially the key(k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates.  Find the ratio of (i) the net capacitance and (ii) the energies stored in the combination, before and after the introduction of the dielectric slab.	3
	OR	
	An electric dipole is held in a uniform electric field. Using suitable diagram, show that (i) it does not undergo any translatory motion, and (ii) derive an expression for the torque acting on it and specify its direction.	
24	State Bohr's postulate to define stable orbits in hydrogen atom. How does de-Broglie's hypothesis explain the stability of these orbits?	3
25	(a) Derive an expression for the current through a conductor in terms of the drift speed of electrons. (b) The resistance of the platinum wire of a platinum resistance thermometer at the ice point is 5 Ω and at steam point is 5.23 Ω. When the thermometer is inserted in a hot bath, the resistance of the platinum inserted in a hot bath, the resistance of the platinum wire is 5.795 Ω. Calculate the temperature of the bath.	3
	Haifa, Israel. The first traffic light in South India was installed at Egmore junction, Chennai in 1953. Several companies manufacture traffic signal using LEDs. The usual strategy with these signals is to package hundreds of LEDs together with reflectors or lenses to create the high-luminance signal face that is required by specifications of the Institute for Transportation Engineers (ITE). The solid state LED sources are known as p-n semiconductor devices. By doping substrate material with different material, a p-n junction is formed within the semiconductor crystal. The dopant in the n region provides mobile negative charge carries (e^-) while the dopant in the p region provides mobile positive charge carriers (holes). Within a semiconductor crystal, when a forward voltage is applied to the p-n junction from the p-region to the n region, the charge carriers inject across the junction into a zone where thy recombine and convert their excess energy into light. The materials used at the junction determine the wavelength of the	

	emitted light. A clear or diffuse epoxy lens covers the semiconductor chip and seals the LED. It also provides some optical control to the emitted light (i) Why cannot we use Si and Ge in fabrication of visible LEDs? (ii) LEDs have advantages over conventional incandescent low power lamps, why? (iii) The electrical conductivity of a semi-conductor increases when electromagnetic radiation of wavelength shorter than 2480 nm is incident on it. Find band gap in (eV) for the semiconductor. OR A light emitting diode (LED) has a voltage drop of 2V across it and passes a current of 10 mA when it operates with a 6V battery through a limiting resistor R. Calculate the value of R.	
30	Case Study Based Questions Read the following paragraph and answer the questions that follow. The total internal reflection of the light is used in polishing diamonds to create a sparking brilliance. By polishing the diamond with specific cuts, it is adjusted so that the most of the light rays approaching the surface are incident with an angle of incidence more than critical angle. Hence, they suffer multiple reflections and ultimately come out of diamond from the top. This gives the diamond a sparking brilliance. (i) Why can light not easily escape a diamond without multiple internal reflections? (ii) The critical angle for a diamond is 24^0. Calculate its refractive index. [sin $24^0 = 0.40$] (iii) What is the basic reason for the extraordinary sparkle of suitable cut diamond. OR The following diagram shows same diamond cut in two different shapes.  How will the brilliance of diamond in the second diamond vary with respect to first?	4
	Section-E	
31	(a) Draw a ray diagram for the formation of image of a distant object by an astronomical telescope in normal adjustment position. (b) Deduce the expression for its magnifying power. (c) The sum of focal lengths of the two lenses of a refracting telescope is 105 cm. The focal length of one lens is 20 times that of the other. Determine the total magnification of the telescope when the final image is formed at infinity.	5
	OR	
	(a) A ray 'PQ' of light is incident on the face AB of a glass prism ABC (as shown in the figure) and emerges out of the face AC. Trace the path of the ray. Derive the prism equation.  Plot a graph showing the variation of the angle of deviation as a function of angle of incidence. State the condition under which angle of deviation is minimum. (b) Find out the relation between the refractive index (μ) of the glass prism and angle A for the case when the angle of prism (A) is equal to the angle of minimum deviation. Hence obtain the value of the refractive index for angle of prism A = 60^0.	5
32	(a) A dielectric slab of thickness t is kept between the plates of a parallel plate capacitor separated by distance d. Derive the expression for the capacitance of the capacitor for t << d. (b) A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness d/2, where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.	5

	OR	
	(a) A Parallel plate capacitor is charged by a battery. After sometime, the battery is disconnected and a dielectric slab of dielectric constant K is inserted between the plates. How would (i) the capacitances (ii) the electric field between the plates (iii) the energy stored in the capacitor be affected? Justify your answer. (b) Figure shows two identical capacitors C_1 and C_2, each of 2 μF capacitance, connected to a battery of 5 V. Initially switch 'S' is closed. After some time, S is left open and dielectric slabs of dielectric constant K = 5 are inserted to fill completely the space between the plates of the two capacitors. How will the (i) charge and (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?  	5
33	(a) An ac voltage $e = e_0 \sin \omega t$ is applied across a pure inductor of inductance L. Find an expression for the current i, flowing in the circuit and show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of π / 2. Also draw its (i) phasor diagram (ii) graphs showing variation of V and i with time t. (b) Explain the term inductive reactance. Show graphically the variation of inductive reactance with frequency of the applied alternating voltage.	5
	OR	
	(a) Derive an expression for mutual inductance of two co-axial solenoids. (b) Figure shows an inductor L and a resistor R connected in parallel to a battery through a switch. The resistance of R is the same as that of the coil that makes L. Two identical bulbs are put in each arm of the circuit.  (i) Which of the bulbs lights up bright when S is closed? (ii) Will the two bulbs be equally bright after some time? Give reason for your answer	5