Delhi Public School, Howrah

PERIODIC TEST– II (2024-2025)

Class-XII

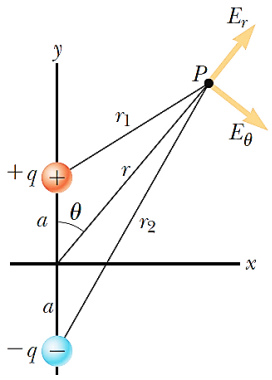
Care must be taken not to write anything on the question paper. All the questions must be attempted in the correct sequence.

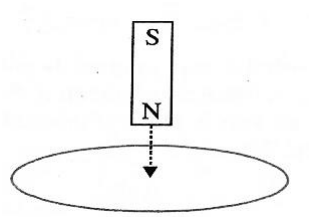
SUBJECT: PHYSICS (CODE- 042)

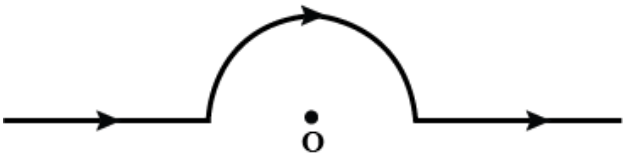
Time:-3 Hours **F.M.-70**

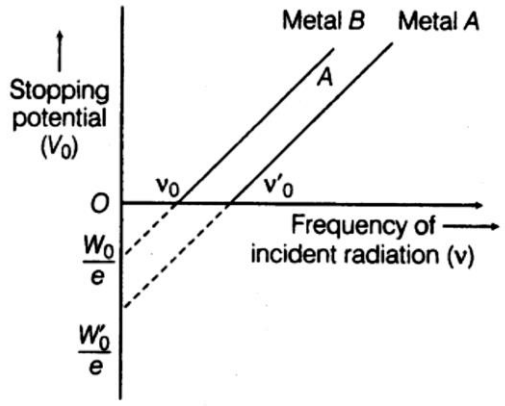
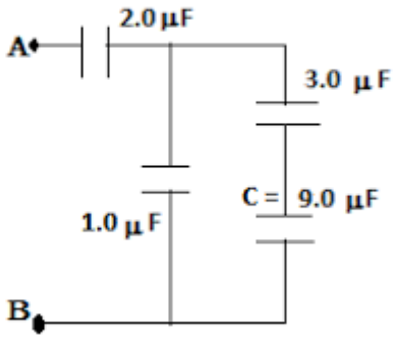
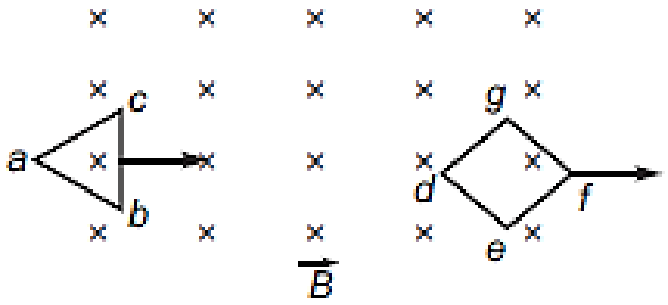
General Instructions:

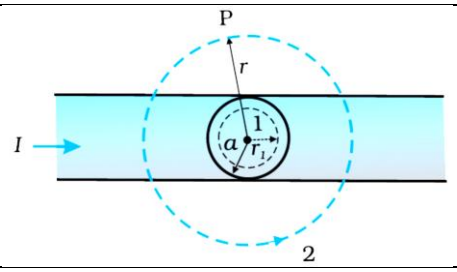
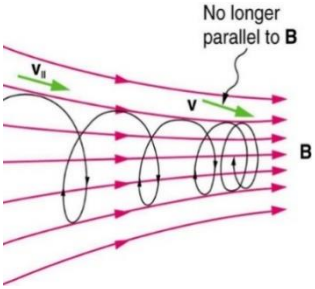
(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of one mark 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.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
ii. $m_e = 9.1$ x10-31 kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
v. $h = 6.63 \times 10^{-34}$ Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$
vii. Avogadro's number = 6.023×10^{23} per gram mole

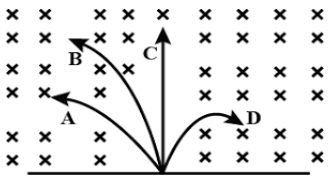
	SECTION - A	
1.	Based on the diagram given below, the magnitude of electric potential at point P is  (a) $\frac{p\cos\theta}{4\pi\varepsilon_o r^2}$ (b) $\frac{p\sin\theta}{4\pi\varepsilon_o r^2}$ (c) $\frac{p}{4\pi\varepsilon_o r^2}$ (d) $\frac{p}{4\pi\varepsilon_o r^3}$	**1**
2.	An electronic charge 'e' is revolving in a circular orbit of radius 'r' around a nucleus with speed 'v'. The equivalent current is _____. (a) $\frac{ev}{2\pi r}$ (b) $\frac{2ev}{\pi r}$ (c) $\frac{ev}{4\pi r}$ (d) none	**1**

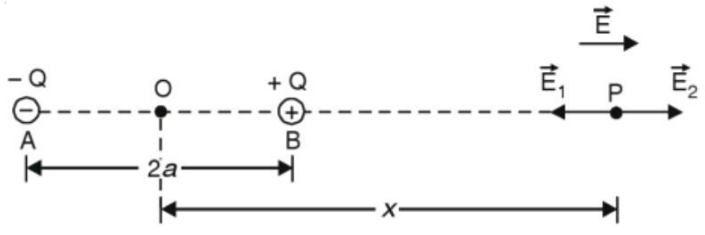
3.	A wire is placed parallel to the lines of force in a magnetic field and current flows in the wire. Then (a) the wire will experience a force in the direction of the magnetic field. (b) the wire will not experience any force at all. (c) the wire will experience a force in a direction opposite to the field. (d) the wire will experience a force in a direction perpendicular to lines of force.	**1**
4.	If N is the number of turns in a current carrying solenoid, the value of its self-inductance depends on N as (a) N^o (b) N (c) N^2 (d) $1/N^2$	**1**
5.	The fringe width in a Young's double slit experiment can be increased if we (a) decrease separation between slits. (b) decrease wavelength of light used. (c) decrease distance between slit and screen. (d) immerse the setup in a liquid.	**1**
6.	According to Einstein's photoelectric equation, graph of 'kinetic energy of emitted photo electrons from a metal surface' versus 'frequency of incident radiation' is linear. Its slope: (a) depends on type of metal used. (b) depends on intensity of radiation. (c) depends on both type of metal used and intensity of radiation. (d) is same for all metals and independent of intensity of incident radiation.	**1**
7.	What will be the ratio of the de-Broglie wavelength of proton and α particle if both have same energy? (a) 2:1 (b) 1:2 (c) 4:1 (d) 1:4	**1**
8.	A bar magnet is allowed to fall vertically through a copper coil placed in a horizontal plane. The magnet falls with a net acceleration—  (a) = g (b) zero (c) < g (d) > g	**1**
9.	The relative 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**
10.	An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is (a) 0.9 ohm (b) 0.09 ohm (c) 0.03 ohm (d) 0.3 ohm	**1**
11.	Which of the following is not the property of an equipotential surface? (a) They do not cross each other. (b) The work done in carrying a charge from one point to another on an equipotential surface is zero. (c) For a uniform electric field, they are concentric spheres. (d) They can be imaginary spheres.	**1**
12.	Which of the following characteristics of electrons determines the current in a conductor? (a) Drift velocity alone (b) Thermal velocity alone (c) Both drift velocity and thermal velocity (d) Neither drift nor thermal velocity	**1**

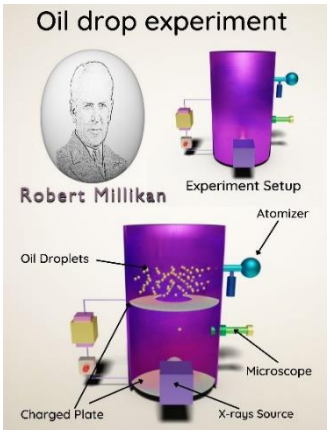
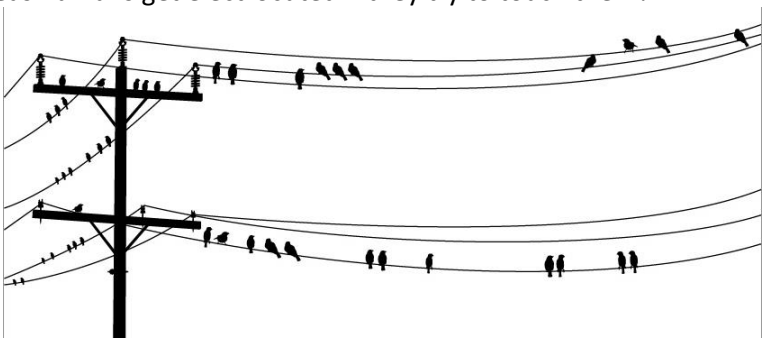
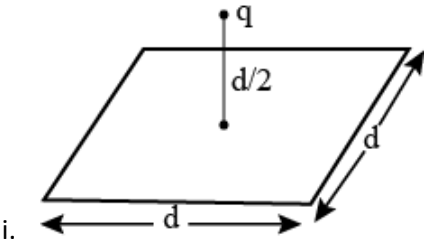
	For question numbers 13 to 16, two statements are given- one labeled as assertion (A) and the other labeled as reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below. **a) Both A and R are true and R is the correct explanation of the A.** **b) Both A and R are true but R is NOT the correct explanation of A.** **c) A is true but R is false.** **d) Both A and R are false.**	
13.	**Assertion (A):** In interference, all the fringes are of same width. **Reason(R):** In interference, fringe width is independent of the position of fringe.	**1**
14.	**Assertion (A):** The resistivity of a semi-conductor increases with temperature. **Reason (R):** The atoms of semi-conductor vibrate with large amplitude at high temperature thereby increasing its resistivity.	**1**
15.	**Assertion (A):** A magnetic dipole experiences maximum torque when it is placed normal to the magnetic field. **Reason(R):** The minimum potential energy of magnetic dipole is zero.	**1**
16.	**Assertion (A):** For the radiation of a frequency greater than the threshold frequency, photoelectric current is proportional to the intensity of the incident 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**
	Section-B	
17.	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.	**2**
18.	The magnetic field at the centre of a current carrying circular loop of radius **R** is $\mathbf{B_1}$. The magnetic field at a point on its axis at a distance **R** from the centre of the loop is $\mathbf{B_2}$. Find the ratio $\frac{B_1}{B_2}$ **.** **Or** A straight wire carrying a current of 12A is bent into a semi-circular arc of radius 2.0 cm as shown in the figure below. What is the magnetic field B at O due to (i) straight segments and (ii) the semi-circular arc?  	**2** **1+1**
19.	(i) How does a diamagnetic material behave when it is cooled to very low temperature? (ii) Why does a paramagnetic sample display greater magnetisation when cooled? Explain.	**1+1**
20.	(a) Draw a graph showing the variation of intensity of light against the position *x* on the screen in Young's double slit experiment. (b) State the essential conditions for which an interference pattern can be sustained.	**1+1**
21.	The graph shows the variation of stopping potential with frequency of incident radiation for two photosensitive metals A and B. Which one of the two has higher value of work-function? Justify your answer.	**1+1**

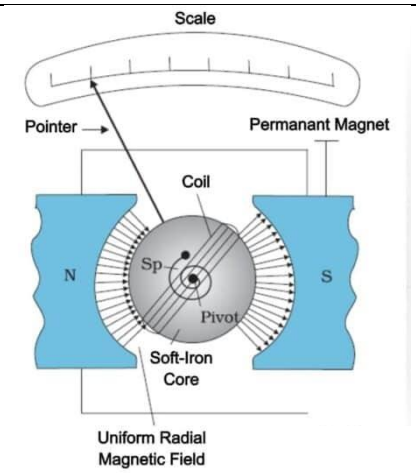
		
	Section-C	
22.	(a) Charges of magnitudes 2q and -q are located at points (a, 0, 0) and (4a, 0, 0). Find the ratio of the flux of electric field due to these charges through concentric spheres of radii 2a and 8a centered at the origin. (b) Find equivalent capacitance of the network shown below. 	**2+1**
23.	(a) Find an expression of drift velocity of electrons in a metal conductor in terms of number density of electrons, current density and charge of electron. (b) You are given n resistors each of resistance R, how will you combine them to get the (i) maximum and (ii) minimum effective resistance?	**1+2**
24.	(a) Two loops of different shapes are moved into a region of uniform magnetic field in the directions marked by arrows as shown in the figure. What is the direction of the induced current in each loop?  (b) A coil with an average diameter of 0.02 m is placed perpendicular to a magnetic field of 6000 T (tesla). If the induced emf is 11 V when the magnetic field is changed to 1000 T in 4 s, what is the number of turns in the coil?	**1+2**
25.	A long straight wire of a circular cross-section of radius a carries a steady current I. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point in the region for (i) r < a and (ii) r > a.	**1+2**

		
26.	(a) You are given two converging lenses of focal length 1.25 cm and 5 cm to design a compound microscope. If it is desired to have a magnification of 30, then find out the separation between the objective and eyepiece. (b) Draw a schematic diagram of image formation by this compound microscope when the final image is formed at least distance of distinct vision.	**2+1**
27.	(a) State Huygens' principle. (b) Using Huygens' principle, draw a ray diagram showing the propagation of a plane wave refracting at a plane surface separating two media. Also verify Snell's law of refraction.	**1+2**
28.	The work function of caesium metal is 2.14 eV. When light of wavelength 280 nm is incident on the metal surface, photoemission of electrons occurs. What is the (a) maximum kinetic energy of the emitted electrons? (b) Stopping potential? (c) maximum speed of the emitted photoelectrons? **Or** (a) How does Einstein's photoelectric equation explain the emission of electrons from a metal surface? Explain briefly. (b) Plot the variation of photocurrent with: (i) collector plate potential for different intensity of incident radiation and (ii) intensity of incident radiation.	**1+1** **+1** **2+1**
	Section-D **Case Study Based Questions** **Read the following paragraph and answer the questions that follow.**	
29.	**Bubble Chamber:** Trails of bubbles are produced by high-energy charged particles moving through the superheated liquid hydrogen in this artist's rendition of a bubble chamber. There is a strong magnetic field perpendicular to the page that causes the curved paths of the particles. The radius of the path can be used to find the mass, charge, and energy of the particle.   Magnetic forces can cause charged particles to move in circular or spiral paths. Particle accelerators keep protons following circular paths with magnetic force. Cosmic rays will follow spiral paths when encountering the magnetic field of astrophysical objects or planets (one example being Earth's magnetic field). The bubble chamber photograph in the figure below shows charged particles moving in such curved paths. The curved paths of charged particles in magnetic fields are the basis of a number of phenomena and can even be used analytically, such as in a mass spectrometer.	**4**

	(i) When a charged particle moves perpendicular to a uniform electric field, it follows- a. circular path b. parabolic path c. translational path d. helical path (ii) A charged particle moving with velocity v in X direction is subjected to a magnetic field B in negative X direction. As a result, the charge will a. retard along X-axis b. start moving in a circular path in YZ plane c. remains unaffected d. move in a helical path around X-axis (iii) An α- particle and proton having same momentum enter into a region of uniform magnetic field and move in a circular path. The ratio of the radii of curvature of their paths is a. 1:1 b. 1:4 c. 1:2 d. 4:1 (iv) A neutron, a proton, an electron and an α- particle enter in a region of uniform magnetic field with equal velocities. The magnetic field is perpendicular and directed into the paper. The tracks of the particles are shown in figure. The electron will follow the track-  a. A b. B c. C d. D **Or** (v) If magnetic force experienced by the charged particle is perpendicular to the velocity of the particle, then work done is- a. zero b. maximum c. minimum d. none of these	
30.	A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex lens is of three types: Double convex lens, Plano convex lens and Concavo-convex lens. Concave lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types: Double concave lens, Plano concave lens and Convexo-concave lens. When two thin lenses of focal lengths f_1 and f_2 are placed in contact with each other along their common principal axis, then the two-lens system is regarded as a single lens of focal length f and $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ If several thin lenses of focal length f_1, f_2, ... f_n are placed in contact, then the effective focal length of the combination is given by $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \cdots . + \frac{1}{f_n}$	**4**

	and in terms of power, we can write $P = P_1 + P_2 + ... + P_n$ The value of focal length and power of a lens must be used with proper sign consideration. (i) Two thin lenses are kept coaxially in contact with each other and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, the focal length of the other would be a. -26.7 cm b. 60 cm c. 80 cm d. 30 cm (ii) spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a a. converging lens b. diverging lens c. mirror d. thin plane sheet of glass (i) Lens generally used in magnifying glass is a. single concave lens b. single convex lens c. combination of convex lens of lower power and concave lens of lower focal length d. Planoconcave lens (i) The magnification of an image by a convex lens is positive only when the object is placed a. at its focus F b. between F and 2F c. at 2F d. between F and optical centre **Or** (i) A convex lens of 20 cm focal length forms a real image which is three times magnified. The distance of the object from the lens is a. 13.33 cm b. 14 cm c. 26.66 cm d. 25 cm	
	Section-E	
31.	(a) Derive the expression of electric field intensity due to an electric dipole at the point P as shown in the picture below. Also find the expression at the point P if it is far from the dipole.  	**2+3**

	(b) The oil drop experiment was performed by Robert A. Millikan and Harvey Fletcher in 1909 to measure the elementary electric charge. The experiment took place in the Ryerson Physical Laboratory at the University of Chicago. Millikan received the Nobel Prize in Physics in 1923.  Consider one such oil drop of mass m and charge - q to be held stationary in the gravitational field of the earth. What is the magnitude and direction of the electrostatic field required for this purpose? **Or** (a) We have seen birds sitting on high voltage power lines many a times. How can the birds safely sit on electrical wires whereas humans get electrocuted if they try to touch them?  (b) Draw a sketch of equipotential surfaces due to a single charge (- *q*), depicting the electric field lines due to the charge. (c) A point charge 'q' is at a distance of 'd/2' directly above the centre of a square ABCD of side 'd' as shown in figure below.  i. (i) Use Gauss' law to obtain the expression for the electric flux through the square. (ii) If we increase the side of the square to '2d', how the electric flux will be affected? Explain.	**1+1 +3**
32.	(a) Derive the expression of torque experienced by a current carrying coil placed in a uniform magnetic field. (b) Define magnetic moment of a current carrying coil. (c) Given below is a picture of a moving coil galvanometer. What is the importance of a radial magnetic field and the soft iron core used in a moving coil galvanometer?	**2+1 +2**

	 **Or** (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 inductance of the arrangement. (c) Lenz's law is a consequence of conservation of energy' – Justify the statement.	**2+2 +1**
33.	(a) Draw the ray diagram showing the refraction of light through a glass prism and hence obtain the relation between the refractive index of the prism, angle of prism and angle of minimum deviation. (b) Determine the value of the angle of incidence for a ray of light travelling from a medium of refractive index $\mu_1 = \sqrt{2}$ into the medium of refractive index μ_2 = 1, so that it just grazes along the surface of separation. **Or** (a) State the essential conditions for diffraction of light. (b) Explain diffraction of light due to a narrow single slit and the formation of pattern of fringes on the screen. (c) Find the relation for width of central maximum in terms of wavelength λ , width of slit *a* and separation between slit and screen *D*. (d) If the width of the slit is made double the original width, how does it affect the size and intensity of the central band?	**3+2** **1+1 +2+ 1**