Delhi Public School, Howrah

PERIODIC ASSESSMENT III (2024-2025)

Class-XII

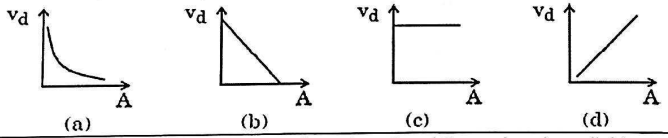
Care must be taken not to write anything on the question paper. All the questions must be attempted in the correct sequence.

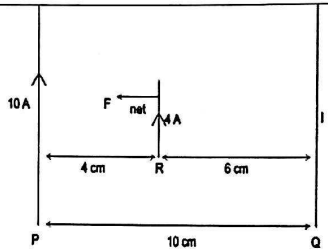
SUBJECT: PHYSICS (CODE- 042)

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. $m_e = 9.1 \times 10^{-31}$ 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

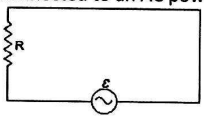
	SECTION - A	
1.	A point charge situated at a distance **'r'** from a short electric dipole on its axis, experiences a force $\vec{F}$. If the distance of the charge is **'2r'**, the force on the charge will be: (a) $\frac{\vec{F}}{16}$ (b) $\frac{\vec{F}}{8}$ (c) $\frac{\vec{F}}{4}$ (d) $\frac{\vec{F}}{2}$	1
2.	The potential difference across a cell in an open circuit is 8 V. It falls to 4 V when a current of 4 A is drawn from it. The internal resistance of the cell is: (a) 4Ω (b) 3Ω (c) 2Ω (d) 1Ω	1
3.	A steady current flows through a metallic wire whose area of cross-section **(A)** increases continuously from one end of the wire to the other. The magnitude of drift velocity (v_d) of the free electrons as a function of **A** can be represented by  (a) (b) (c) (d)	1
4.	Two long and straight current-carrying wires, P and Q are placed parallel to each other separated by a distance of 10 cm. A wire 'R' of length 8 cm and carrying a current of 4 A is placed between the two wires P and Q as shown in the diagram.	1



If the wire R, experiences a net force towards wire P, then which of the following is definitely **TRUE** about the current 'I' in wire Q?
(a) Current I cannot be in the upward direction.
(b) Current I can have any magnitude greater than 0 A in the upward direction.
(c) Current I cannot have a magnitude of more than 15 A in the upward direction.
(d) Current I cannot have a magnitude of more than 10 A in the upward direction.

5. The mass density of a nucleus of mass number A is: **1**
(a) proportional to $A^{1/3}$ (b) proportional to $A^{2/3}$ (c) proportional to A^3 (d) independent of A

6. A pure resistor is connected to an AC power source as shown below. **1**



Which of the following statement(s) is/are TRUE?
I: The average current flowing through the circuit during one full cycle is zero.
II: The current in the resistor leads the voltage by $\pi/2$.
III: The average power dissipated by the resistor is zero.
(a) only I
(b) only I and II
(c) only II and III
(d) all - I, II and III

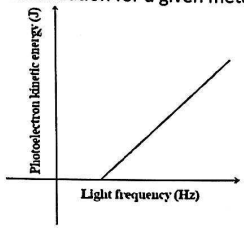
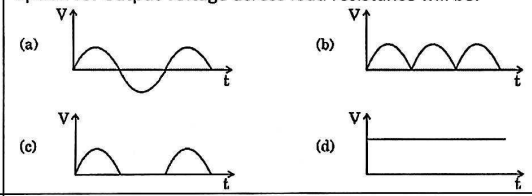
7. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of virtual image from the surface of the sphere is **1**
(a) 2 cm (b) 4 cm (c) 6 cm (d) 12 cm

8. A diamagnetic substance is brought near the north or south pole of a bar magnet. It will be: **1**
(a) repelled by both the poles.
(b) attracted by both the poles.
(c) repelled by the north pole and attracted by the south pole.
(d) attracted by the north pole and repelled by the south pole.

9. Three students construct a solenoid of length 35 cm. They are each given insulated copper wire of the same length. The table below lists some details about the solenoids made by them. **1**

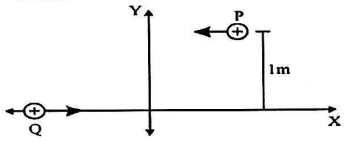
	Magnetic field produced	Radius of solenoid	Core of solenoid
Student 1	B_1	3 cm	air
Student 2	B_2	3 cm	iron
Student 3	B_3	6 cm	air

Compare the magnetic field produced by the solenoids made by the three students.
(a) $B_1=B_3<B_2$ (b) $B_3<B_1<B_2$ (c) $B_1<B_2<B_3$ (d) $B_1=B_2>B_3$

10.	The graph below shows the variation of the maximum kinetic energy of the emitted photoelectron with the frequency of the incident radiation for a given metal.  Which of the following gives the work function of the metal? (a) x-intercept (b) y-intercept (c) the slope of the graph (d) the area under the graph	1
11.	When an electron in an atom moves from the ground state to a higher energy level what happens to its kinetic and potential energies? <table><tr><td></td><td>kinetic energy</td><td>potential energy</td></tr><tr><td>(a)</td><td>increases</td><td>increases</td></tr><tr><td>(b)</td><td>increases</td><td>decreases</td></tr><tr><td>(c)</td><td>decreases</td><td>increases</td></tr><tr><td>(d)</td><td>decreases</td><td>decreases</td></tr></table>	1
12.	An ac source of voltage is connected in series with a p-n junction diode and a load resistor. The correct option for output voltage across load resistance will be:  	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):** The phase difference between any two points on a wave front is zero. **Reason(R):** All points on a wave front are at the same distance from the source and thus oscillate in the same phase.	1
14.	**Assertion (A):** Putting p type semiconductor slab directly in physical contact with n type semiconductor slab cannot form the p-n 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
15.	**Assertion (A):** When a bar of copper is placed in an external magnetic field, the field lines get concentrated inside the bar. **Reason(R):** Copper is a paramagnetic substance.	1
16.	**Assertion (A):** On increasing the current sensitivity of a galvanometer by increasing the number of turns may not necessarily increase its voltage sensitivity. **Reason (R):** The resistance of the coil of the galvanometer increases on increasing the number of turns.	1

Section-B

17. P and Q are two identical charged particles each of mass 4×10^{-26} kg and charge 4.8×10^{-19} C, each moving with the same speed of 2.4×10^{5} m/s as shown in the figure below. The two particles are equidistant (0.5 m) from the vertical Y -axis. At some instant, a magnetic field **B** is switched on so that the two particles undergo head-on collision. **2**



Find –

(a) the direction of the magnetic field, and

(b) the magnitude of the magnetic field applied in the region.

18. A proton and an α-particle have the same de Broglie wavelength. Determine the ratio of (i) their accelerating potentials and (ii) their speeds. **1+1**

Or

If light of wavelength 412.5 nm is incident on each of the metals given below, which ones will show Photoelectric emission and why? **2**

Metal	Work Function (eV)
Na	1.92
K	2.15
Ca	3.20
Mo	4.17

19. The ground state energy of hydrogen atom is -13.6 eV. What is the potential energy and kinetic energy of an electron in the third excited state? **1+1**

20. Two charges A (charge q) and B (charge 2q) are located at points (0, 0) and (a, a) respectively. Let $\hat{i}$ and $\hat{j}$ be the unit vectors along x-axis and y-axis respectively. Find the force exerted by A on B, in terms of $\hat{i}$ and $\hat{j}$. **2**

21. (a) Identify the part of the electromagnetic spectrum which: **1+1**

(i) Produces heating effect

(ii) Is absorbed by the ozone layer in the atmosphere

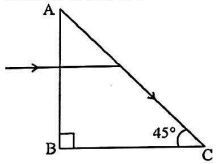
(b) Write any one method of the production of each of the above radiations.

Section-C

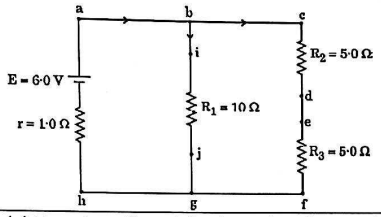
22. (a) Define mutual inductance and write its SI unit. **1+2**

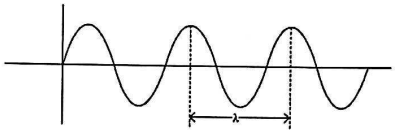
(b) Two circular loops, one of small radius *r* and other of larger radius R, such that R >> *r*, are placed coaxially with centres coinciding. Obtain the expression of mutual inductance of the arrangement.

23. (a) A light ray entering a right-angled prism undergoes refraction at the face AC as shown in the figure below. What is the refractive index of the material of the prism? **1+2**



(b) Two thin lenses of power +2.5 D and -0.5 D are placed in contact. Will the combination of lenses behave as a converging lens or diverging lens? Justify with proper reason.

24.	Use Biot-Savart law to obtain an expression for the magnetic field at the centre of a circular loop of radius 'a' and carrying a current 'I'. Draw magnetic field lines for a current loop indicating the direction of magnetic field.	2+1
25.	(a) State Kirchhoff's rules of electricity. (b) Observe the circuit diagram given below and answer the following questions. (i) What is the current through arm bg? (ii) Find the potential difference across resistance R_3.  	1+2
26.	(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.	2+1
27.	(a) Draw the energy level diagram for hydrogen atom. (b) The table below lists the different transitions of an electron in a hydrogen atom: A: $n_i = 4$ to $n_f = 2$ B: $n_i = 3$ to $n_f = 1$ C: $n_i = 2$ to $n_f = 3$ D: $n_i = 4$ to $n_f = 3$ Among these identify: (i) The transition that gives absorption spectra. (ii) The transition that gives Lyman spectral line, Balmer spectral line and Paschen spectral line.	3
28.	(a) Derive the relation between binding energy of a nucleus and the mass defect. (b) Binding energies of O_8^{16} and Cl_{17}^{35} are 127.35 MeV and 289.3 MeV respectively. Which one of the two nuclei are more stable and why? **Or,** (b) Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei and mention its two features. Why do lighter nuclei usually undergo nuclear fusion?	2+1 1+2
	Section-D **Case Study Based Questions** **Read the following paragraph and answer the questions that follow.**	
29.	**Read the passage carefully and answer the following questions:** According to de-Broglie, a moving material particle sometimes acts as a wave and sometimes as a particle or a wave associated with moving material particle which controls the particle in every respect. The wave associated with moving particle is called matter wave or de-Broglie wave where wavelength called de-Broglie wavelength, is given by $\lambda = h/mv$.	4



(i) If a proton and an electron have the same de Broglie wavelength, then
   a) kinetic energy of electron < kinetic energy of proton
   b) kinetic energy of electron = kinetic energy of proton
   c) momentum of electron = momentum of proton
   d) momentum of electron < momentum of proton

(ii) Which of these particles having the same kinetic energy has the largest de Broglie wavelength?
   a) Electron
   b) Alpha particle
   c) Proton
   d) Neutron

(iii) Two particles A_1 and A_2 of masses m_1, m_2 ($m_1 > m_2$) have the same de Broglie wavelength. Then
   a) their momenta are the same
   b) their energies are the same
   c) momentum of A_1 is less than the momentum of A_2
   d) energy of A_1 is more than the energy of A_2

(iv) When the velocity of an electron increases, its de Broglie wavelength
   a) increases
   b) decreases
   c) remains same
   d) may increase or decrease

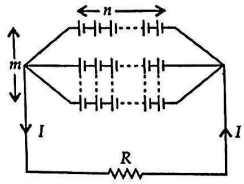
Or

(v) Proton and α-particle have the same de-Broglie wavelength. What is same for both of them?
   a) Time period
   b) Energy
   c) Frequency
   d) Momentum

30. A single cell provides a feeble current. In order to get a higher current in a circuit, we often use a combination of cells. A combination of cells is called a battery. Cells can be joined in series, parallel or in a mixed way. **4**

Two cells are said to be connected in series when negative terminal of one cell is connected to positive terminal of the other cell and so on.

Two cells are said to be connected in parallel if positive terminal of each cell is connected to one point and negative terminal of each cell connected to the other point. In mixed grouping of cells, a certain number of identical cells are joined in series, and all such rows are then connected in parallel with each other.



i) To draw the maximum current from a combination of cells, how should the cells be grouped?
a) Parallel
b) Series
c) Mixed grouping
d) Depends upon the relative values of internal and external resistances

ii) The total emf of the cells when n identical cells each of emf ε are connected in parallel is
a) nε
b) $n^2\varepsilon$
c) ε
d) ε/n

iii) 4 cells each of emf 2 V and internal resistance of 1 ohm are connected in parallel to a load resistor of 2 ohm. The the current through the load resistor is
a) 2 A
b) 1.5 A
c) 1A
d) 0.888 A

iv) If two cells out of n number of cells each of internal resistance 'r' are wrongly connected in series, then total resistance of the cell is
a) 2nr
b) nr-4r
c) nr
d) r

v) Two identical non-ideal batteries are connected in parallel. Identify the correct option based on the statements given below.
i. The equivalent emf is smaller than either of the two emfs.
ii. The equivalent internal resistance is smaller than either of the two internal resistances.

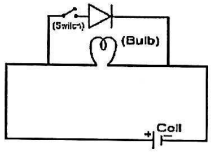
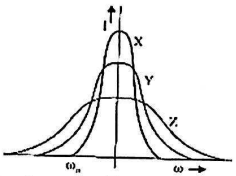
a) Both (i) and (ii) are correct.
b) (i) is correct but (ii) is wrong.
c) (ii) is correct but (i) is wrong.
d) Both (i) and (ii) are wrong.

Section-E

31. (a) Differentiate between intrinsic and extrinsic semiconductors. **1+3**
(b) Which device is used to convert an Alternating current (AC) into Direct current (DC)? State it's underlying principle and explain its working with a suitable diagram. **+1**
(c) If the frequency of input AC to this device is 50 Hz, then what will be frequency of the output of this device.

OR

(a) Draw the energy band diagram for P-type semiconductor at (i) T=0K and (ii) room temperature.
(b) Briefly explain how the diffusion and drift currents contribute to the formation of potential barrier in a p-n junction diode.

	(c) An ideal diode and a bulb are connected in an electric circuit as shown in the figure below. Identify the correct condition from the given cases in which the bulb will glow. **Case I:** when the switch is open, **Case II:** when the switch is closed. Also give reason for your answer.  	1+2 +2
32.	(a) Prove that the voltage and current always vary in the same phase in an AC circuit containing resistance only. Show this phase relationship graphically. (b) Three Students X, Y and Z performed an experiment for studying the variation of alternating current with angular frequency in a series LCR circuit and obtained the graph shown below. They all use AC sources of the same RMS value and inductance is of the same value.  What can we (qualitatively) conclude about the (i) Capacitance value, (ii) Resistance values- used by them? (iii) In which case will the quality factor be maximum? Justify your answer in each case. **Or** (a) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain. (b) A resistor of 30 Ω and a capacitor of $\frac{250}{\pi}\ \mu F$ are connected in series to a 200 V, 50 Hz ac source. Calculate (i) the current in the circuit, and (ii) voltage drops across the resistor and the capacitor. (iii) Is the algebraic sum of these voltages more than the source voltage? If yes, solve the paradox.	2+3 1+4
33.	(a) In a Young's double-slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. What will be the change in interference pattern? (b) What change in the interference pattern do you observe if the two slits are taken as point sources? (c) Plot a graph of intensity distribution vs. path difference in this experiment. Compare this with the intensity distribution of fringes due to diffraction at a single slit. (d) In a Young's double slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate: (i) The angular separation in radians between the central maximum and the adjacent maximum. (ii) The distance between these two maxima on a screen 50 cm from the slits. Or, (a) How would the angular width of central maximum of diffraction pattern be affected when (i) width of the slit is decreased and (ii) monochromatic light is replaced by polychromatic light? Justify your answers. (b) In what way is diffraction from each slit related to the interference pattern in a double-slit experiment? (c) A narrow slit illuminated by a parallel beam of monochromatic light of wavelength λ equals to 6000 Å and the angular width of the central maxima in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ′, the angular width decreases by 30%. Calculate the value of the wavelength λ′.	1+1 +1+ 2 2+1 +2