# Delhi Public School, Howrah

**PRE-BOARD EXAMINATION (2024-2025)**

**Class-XII**

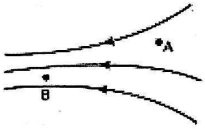
*Care must be taken not to write anything on the question paper. All the questions must be attempted in the correct sequence.*

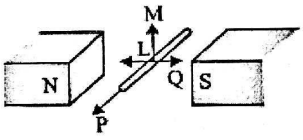
**SUBJECT: PHYSICS (CODE- 042)**

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

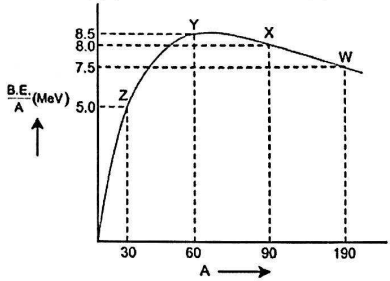
**General Instructions:**

(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 = $6.023 \times 10^{23}$ per gram mole

| | SECTION - A | |
|---|---|---|
| 1. | In the figure below, two points A and B are located in a region of electric field. The potential difference $V_B$-$V_A$ is:<br>  <br><br>a. Positive<br>b. negative<br>c. zero<br>d. Will change with respect to time | 1 |
| 2. | Two wires A and B of the same material have radii in the ratio 1:2 and carry currents in the ratio 4:1. The ratio of drift speed of electrons in A and B is-<br>a. 16:1<br>b. 1:16<br>c. 1:4<br>d. 4:1 | 1 |

| | | |
|---|---|---|
| 3. | If the speed of a charged particle moving in a uniform magnetic field is halved ( $v$ is perpendicular to B) then the radius of its path will-<br>a. not change<br>b. become two times<br>c. become one fourth<br>d. become half | 1 |
| 4. | What happens if a bar magnet is cut into two pieces along its length?<br>a. Both pieces will have the dipole moment equal to the original magnet<br>b. The pieces will have their magnetic moments equal to the half of the original magnet<br>c. The pieces will lose their magnetism<br>d. Both pieces will have the dipole moment equal to one fourth of the original magnet | 1 |
| 5. | The magnetic flux linked with the coil varies with time as $\phi = 3t^2 + 4t + 9$. The magnitude of induced EMF at t =2s is-<br>a. 9 V<br>b. 16 V<br>c. 3 V<br>d. 4 V | 1 |
| 6. | Which of the following statement is not true for electromagnetic wave?<br>a. They transport energy<br>b. They have momentum<br>c. They travel at different speed in air depending on their frequency<br>d. They travel at same speed in medium depending on their frequency | 1 |
| 7. | A double convex lens made of a material of refractive index 1.5 and having a focal length of 10 cm is immersed in liquid of refractive index 2.0. The lens will behave as -<br>a. converging lens of focal length 10 cm<br>b. Diverging lens of focal length 10/3 cm<br>c. Converging lens of focal length 10/3 am<br>d. Diverging lens of focal length 20 cm | 1 |
| 8. | If kinetic energy of a particle is increased by 16 times, the percentage change in the de Broglie wavelength of the particle is-<br>a. 25%<br>b. 75%<br>c. 60%<br>d. 50% | 1 |
| 9. | EMF will be induced between the ends of the conductor shown in the figure when conductor moves in the direction-<br>  <br><br>a. P<br>b. Q<br>c. L<br>d. M | 1 |
| 10. | Identify the correct statement/statements from the following given statements:<br>i) At greater distances nuclear forces are negligible<br>ii) Nuclear forces are charge dependent forces<br>iii) Nuclear forces are weakest in nature | 1 |

| | | |
|---|---|---|
| | iv) Nuclear forces are non-central forces<br>a. i, ii<br>b. ii, iii<br>c. iii, iv<br>d. i, iv | |
| 11. | In terms of Rydberg constant R, the shortest wavelength in Balmer series of hydrogen atom spectrum will have wavelength -<br>a. 1/R<br>b. 4/R<br>c. 3/2R<br>d. 9/R | 1 |
| 12. | The depletion layer of a p-n junction:<br>a. is depleted of ions<br>b. is of constant width irrespective of the bias<br>c. has a width that increases with an increase in forward bias<br>d. acts like an insulating zone under reverse bias | 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.**<br>**a) Both A and R are true and R is the correct explanation of the A.**<br>**b) Both A and R are true but R is NOT the correct explanation of A.**<br>**c) A is true but R is false.**<br>**d) Both A and R are false.** | |
| 13. | **Assertion(A):** The width of the central maxima of diffraction is two times as compared to other maxima.<br>**Reason(R):** Diffraction is superposition of a continuous family of waves originating from each point of a single slit | 1 |
| 14. | **Assertion (A):** A convex lens of focal length 30 cm cannot be used as a simple microscope in normal settings.<br>**Reason (R):** For normal setting the angular magnification of a simple microscope is $m = D/f$. | 1 |
| 15. | **Assertion (A):** In series LCR circuit, resonance occurs at a frequency called resonant frequency.<br>**Reason(R):** At resonant frequency, inductive reactance is equal to the capacitive reactance. | 1 |
| 16. | **Assertion (A):** An n-type semiconductor has a large number of electrons but still it is electrically neutral.<br>**Reason (R):** An n-type semiconductor is obtained by doping an intrinsic semiconductor with a pentavalent impurity. | 1 |
| | **Section-B** | |
| 17. | Photoelectric work function of a metal is 1 eV. Light of wavelength 3000 Å falls on it. What is the velocity of the ejected photo electron? | 2 |
| 18. | Identify the part of the electromagnetic spectrum used in i) radar and ii) eye surgery. Write their frequency range.<br>**Or**<br>Prove that the average energy density of the oscillating electric field is equal to that of the oscillating magnetic field. | 1+1<br><br>2 |
| 19. | The susceptibility of a given magnetic material is -0.085.<br>(a) Identify the magnetic type of the substance.<br>(b) A specimen of this material is kept in a uniform magnetic field. Draw the modified field patterns. | 1+1 |
| 20. | In Young's double-slit experiment using monochromatic light of wavelength $\lambda$, the intensities of two sources is $I_1$. What is the intensity of light at a point where path difference between wave front is $\lambda/3$? | 2 |

| | | |
|---|---|---|
| 21. | Binding energy per nucleon vs mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. Identify which of the following nuclei is most likely to undergo<br>(i) Nuclear Fission, (ii) Nuclear Fusion. Justify your answer.<br>  <br> | 1+1 |
| | **Section-C** | |
| 22. | A rectangular loop of area A having N turns and carrying a current I is held in a uniform magnetic field B.<br>(a) Find the expression for the maximum torque experienced by the loop.<br>(b) In which orientation will the loop be in stable equilibrium? | 2+1 |
| 23. | (a) Draw a ray diagram for the formation of image by a Cassegrain telescope.<br>(b) Why these types of telescopes are preferred over refracting type telescopes. (Write any 2 points) | 1+2 |
| 24. | (a) "The Lenz's law is a consequence of the law of conservation of energy"- Justify this statement.<br>(b) Deduce an expression for the self-inductance of a long solenoid of N turns having a core of relative permeability $\mu_r$ | 1+2 |
| 25. | When a circuit element 'X' is connected across an ac source, a current of √2 A flows through it and this current is in phase with the applied voltage. When another element 'Y' is connected across the same ac source, the same current flows in the circuit but it leads the voltage by $\pi/2$ radian.<br><br>(a) Name the circuit elements X and Y.<br>(b) Find the current that flows in the circuit when the series combination of X and Y is connected across the same ac voltage.<br>(c) Plot a graph showing variation of the net impedance of this series combination of X and Y as a function of the angular frequency ω of the applied voltage. | 1+2 |
| 26. | (a) Using the curve for the binding energy per nucleon as a function of mass number 'A', state clearly how the release of energy in the processes of nuclear fission and nuclear fusion can be explained.<br>(b) Calculate the binding energy (in MeV) of a helium nucleus ($^4_2He$). Given mass of $^4_2He$ = 4.0015 a.m.u., mass of a proton = 1.0073 a.m.u. and mass of a neutron = 1.0087 a.m.u. | 2+1 |
| 27. | (a) Using Bohr's postulates, obtain the expression for total energy of the electron in the $n^{th}$ orbit of a hydrogen atom.<br>(b) What is the significance of negative sign in the expression of energy? | 1+2 |
| 28. | Explain with proper circuit diagram and input-output waves, the working of a full-wave rectifier using two p-n junction diodes.<br><br>**Or,**<br><br>(a) Differentiate conductors, insulators and semi-conductors on the basis of their energy bands diagrams.<br>(b) Draw the circuit arrangement to study the I-V characteristics of a p-n junction diode in forward and reverse bias. Show the I-V characteristic curve for a silicon based p-n junction diode and indicate its breakdown region. | 1+1<br>+1<br><br>1+2 |

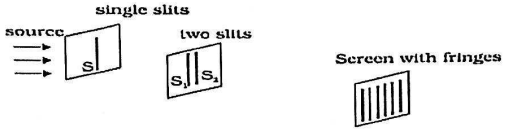
## Section-D

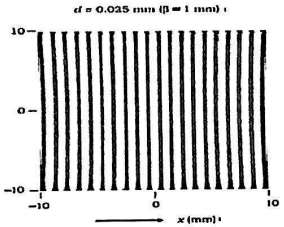
### Case Study Based Questions

**Read the following paragraph and answer the questions that follow.**

29. **Read the passage carefully and answer the following questions:** **4**

Young's double slit experiment uses two coherent sources of light placed at a small distance apart. Usually, only a few orders of magnitude greater than the wavelength of light are used. Young's double slit experiment helped in understanding the wavetheory of light, which is explained with the help of a diagram. As shown, a screen orphoto detector is placed at a large distance, 'D' away from the slits.




(i) What is the path difference between the two light waves coming from coherent sources, which produces 3rd maxima?

a. $\lambda$
b. $2\lambda$
c. $3\lambda$
d. 0

(ii) What is the correct expression for fringe width ($\beta$)?

a. $\lambda d/D$
b. $dD/\lambda$
c. $d/\lambda D$
d. $\lambda D/d$

(iii) what is the phase difference between two interfering waves producing 1st dark fringe?

a. $\pi$
b. $2\pi$
c. $3\pi$
d. $4\pi$

(iv) The ratio of the widths of two slits in Young's double slit experiment is 4: 1. Evaluate the ratio of intensities at maxima and minima in the interference pattern.

a. 1:1
b. 1:4
c. 3:1
d. 9:1

Or

(v) If the separation between the slits is 0.1 mm, the wavelength of light used is 600 nm and the interference pattern is observed on a screen 1m away, find the separation between bright fringes.

a. 6.6 mm
b. 6.0 mm
c. 6 m
d. 60cm

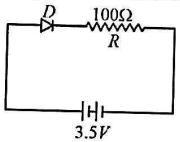
30. **Read the passage carefully and answer the following questions:** 4

When the diode is forward biased, it is found that beyond forward voltage $V = V_k$, called knee voltage, the conductivity is very high. At this value of battery biasing for the p-n junction, the potential barrier is overcome, and the current increases rapidly with an increase in forwarding voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current of about a few micro-amperes which almost remains constant with biasing voltage. This small current is called reverse saturation current.

(i) When p-n junction diode is forward biased then

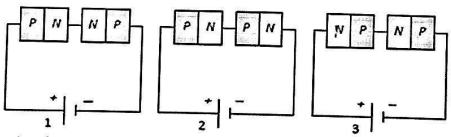
a. both the depletion region and barrier height are reduced
b. the depletion region is widened and barrier height is reduced
c. the depletion region is reduced and barrier height is increased
d. Both the depletion region and barrier height are increased

(ii) 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

(iii) Two identical *PN* junctions can be connected in series by three different methods as shown in the figure. If the potential difference in the junctions is the same, then the correct connections will be




a. in the circuits (1) and (2)
b. in the circuits (2) and (3)
c. in the circuits (1) and (3)
d. only in the circuit (1)

(iv) Barrier potential of a p-n junction diode does not depend on

a. doping density
b. diode design
c. temperature
d. forward bias

**Or**

(v) The resistance of a p-n junction diode in forward bias is
   a. Zero
   b. very low
   c. Infinity
   d. high

**Section-E**

31. (a) Using Gauss' law, obtain the expression for the electric field due to uniformly charged spherical shell of radius R at a point outside the shell and inside the shell. Draw a graph showing the variation of electric field with r, for r > R and r < R. **3+2**

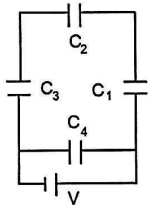
(b) A 500 μC charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 μC between two diagonally opposite points on the square. Show necessary steps.

**OR**

(a) Define the SI unit of capacitance. **1+2**

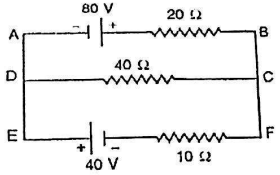
(b) Obtain the expression for the capacitance of a parallel plate capacitor. **+2**

(c) A network of four capacitors, each of capacitance 30 pF, is connected across a battery of 60 V as shown in the figure below. Find the net capacitance and the energy stored in the network of capacitors.

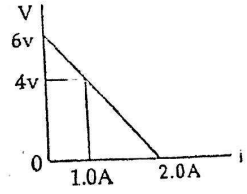



32. (a) Nichrome and copper wires of same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more? Justify your answer. **1+2**

(b) Using Kirchhoff's rules, calculate the current through the 40 Ω and 20 Ω resistors in the following circuit. **+2**




(c) The figure below shows a plot of terminal voltage 'V' versus the current 'i' of a given cell. Calculate from the graph (i) emf of the cell and (ii) internal resistance of the cell.



| | | |
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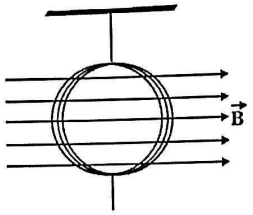
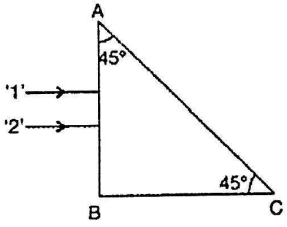
| | **Or**<br>(a) A circular coil of 30 turns and radius 8.0 cm carrying a current of 6.0 A is suspended vertically in a uniform horizontal magnetic field of magnitude 1.0 T. The field lines make an angle of 60° with the normal of the coil. Calculate the magnitude of the counter torque that must be applied to prevent the coil from turning.<br>  <br><br>(b) Two infinitely long straight parallel wires, '1' and '2', carrying steady currents $I_1$ and $I_2$ in the same direction are separated by a distance **d**. Obtain the expression with the help of a suitable diagram, the magnitude and direction of this force per unit length on wire '2' due to wire '1'. How does the nature of this force change if the currents are in opposite direction? | **2+3** |
| 33. | (a) Derive the lens makers formula.<br>(b) A convex lens made of glass of refractive index 1.5 is dipped in,<br>I: carbon di sulphide of refractive index 1.65.<br>II: Water of refractive index 1.33.<br>(i) State whether the lens will show converging or diverging action in the above two cases.<br>(ii) How will its focal length change in the two media?<br>**Or**<br>(a) A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. What is the area of the surface of water through which light from the bulb can emerge out? The refractive index of water is 1.33. (Consider the bulb to be a point source.)<br>(b) Two monochromatic rays of light are incident normally on the face AB of an isosceles right-angled prism ABC. The refractive indices of the glass prism for the two rays '1' and '2' are respectively 1.35 and 1.45. Trace the path of these rays entering through the prism.<br>  <br><br>(c) For the same value of angle of incidence, the angles of refraction in three media A,B and C are 15°, 25° and 35° respectively. In which medium would the velocity of light be minimum? Why? | **3+2**<br>**2+2 +1** |