**SET NO- 02**

| **Roll No** | | | | | | | |
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Candidates must write the Set No. on the title page of the answer book

# DAV PUBLIC SCHOOLS, ODISHA ZONE
# PRE-BOARD EXAMINATION (2023-24)

- Check that this question paper contains **8** printed pages.
- Set number given on the right hand side of the question paper should be written on the title page of the answer book by the candidate.
- Check that this question paper contains **33** questions
- Write down the Serial Number of the question in the left side of the margin before attempting it.
- 15 minutes time has been allotted to read this question paper. The question paper will be distributed 15 minutes prior to the commencement of the examination. The students will read the question paper only and will not write any answer on the answer script during this period.

## CLASS -XII

## SUB: PHYSICS

**Time Allowed: 3Hours** **Maximum 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.
(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. $\mu_0 = 4\pi \times 10^{-7}$ $Tm A^{-1}$

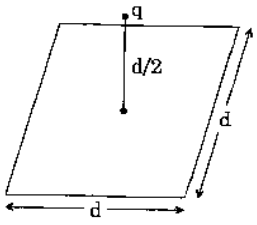
v. $h = 6.63 \times 10^{-34}$ Js

vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2 N^{-1} m^{-2}$

vii. Avogadro's number = $6.023 \times 10^{23}$ per gram mole

## SECTION A

**1.** A point charge q is at a distance of d/2 directly above the centre of a square of side d, as shown in figure. The electric flux through the square using gauss law is $\frac{q}{6\varepsilon_0}$ . If the point charge is now moved to distance ′d/3′ from the centre of the square, then the electric flux through the square will be

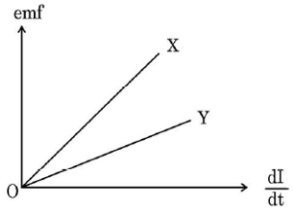



(a) same as $\frac{q}{6\varepsilon_0}$ (b) more than $\frac{q}{6\varepsilon_0}$ (c) less than $\frac{q}{6\varepsilon_0}$ (d) none of these

**2.** The potential on the surface of a charged metal sphere of radius 1m is 1000V, then potential at 1.5 m from the centre of the sphere is

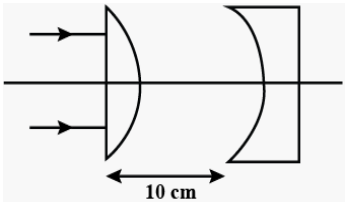
(a) 0 V (b) 666.6 V (c) 500 V (d) 1000 V

**3.** The figure shows the variation of induced emf as a function of rate of change of current for two identical solenoids X and Y. One is air cored and the other is iron cored. Which one of them is iron cored?




(a) X (b) Y (c) both X and Y (d) none of these

**4.** In the given figure, the radius of curvature of the curved surface of both the plano-convex and plano-concave lens is 10 cm and refractive index both is 1.5. The location of the final image after all the refractions through lenses is:




(a) 10 *cm* (b) 15 *cm* (c) 20 *cm* (d) 30 *cm*

**5.** The stopping potential when a metal with work function 0.6eV is illuminated with light of energy 2eV will be

(a) 1.4 eV (b) 1.4 V (c) 2.6 eV (d) 2.6 V

**6.** Under ideal conditions, consider two different sources of light producing identical waves that happen to be in phase with each other. The two sources are placed at the corners of a square. They broadcast waves uniformly in all directions. Which of the following locations of the two sources will ensure that the waves always produce constructive interference at the center of the square?

(a) any two corners of the square
(b) only the adjacent corners of the square
(c) only corners across the diagonal of the square
(d) one source at the corner and the other at the center

**7.** In single slit diffraction experiment, the width of slit is halved. The width of central maximum, in the diffraction pattern, will become

(a) half (b) four times (c) one - fourth (d) twice

**8.** Given below are two charged subatomic particles P and Q, that are accelerated through same potential difference V. Here, Masses: $m_P = m_Q$ Charges: $\frac{1}{2} q_P = q_Q$

Which of the two sub atomic particles will have longer de Broglie wavelength?

(a) Particle P, because it has the greater momentum

(b) Particle Q, because it has the greater momentum

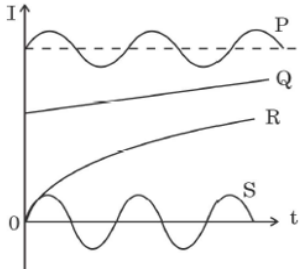
(c) Particle P, because it has the smaller momentum

(d) Particle Q, because it has the smaller momentum

**9.** The mass density of a nucleus of mass number A is :

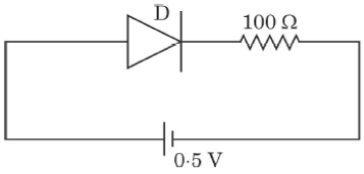
(a) proportional to $A^{1/3}$ (b) proportional to $A^{2/3}$ (c) proportional to $A^3$ (d) independent of A

**10.** The figure shows variation of current (I) with time (t) in four devices P, Q, R and S. The device in which an alternating current flows is




(a) P and S (b) P only (c) S only (d) Q and R

**11.** The threshold voltage for a p-n junction diode used in the circuit is 0.7V. The type of biasing and current in the circuit are




(a) Forward biasing, 0A (c) Reverse biasing, 0A

(b) Forward biasing, 5mA (d) Reverse biasing, 2mA

**12.** If the fundamental frequency in the ripple of the output of a full wave rectifier circuit is 60Hz, then the frequency of input ac mains will be

(a) 120 Hz (b) 60 Hz (c) 30 Hz (d) 25 Hz

**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) Both A and R are true and R is correct explanation of A.**

**(b) Both A and R are true and R is not the correct explanation of A.**

**(c) A is true but R is false.**

**(d) A is false and R is false.**

**13. ASSERTION (A):** When a conductor is placed in an external electrostatic field, the net electric field inside the conductor becomes zero after a small instant of time.

**REASON(R):** It is not possible to set up an electric field inside a conductor.

**14. ASSERTION (A):** In the phenomenon of mutual induction, self-induction of each of the coils persists.

**REASON(R):** Self-induction arises when strength of current in the same coil changes.

**15. ASSERTION (A):** In a purely inductive or capacitive circuit, the current is referred to as wattless current.

**REASON(R):** No power is dissipated in a purely inductive or capacitive circuit even though a current is flowing in the circuit.

**16.** **ASSERTION (A):** A photon has no rest mass, yet it carries definite momentum.
**REASON(R):** Momentum of photon is due to its energy and hence its equivalent mass.

## SECTION B

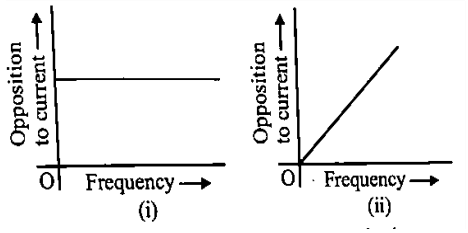
**17.** A particle of charge 2 μC and mass 1.6 g is moving with a velocity $4\ \hat{\imath}\ ms^{-1}$. At t = 0 the particle enters in a region having an electric field $\vec{E}\ (\text{in } NC^{-1}) = 80\,\hat{\imath} + 60\,\hat{\jmath}$. Find the velocity of the particle at t = 5 s.

**18.** A water molecule is placed in a uniform external electric field $\vec{E}$. Obtain the mathematical expression for the moment of couple experienced by the water molecule in vector form, if the electric dipole moment of water molecule is $\vec{\mu}$ and it is placed making an angle $\beta$ with $\vec{E}$.

**19.** (a) There is a pair of concentric and coplanar conducting loops of radii $R_1$ and $R_2$ such that $R_2 = 0.01\ R_1$. Find the mutual inductance M for this pair of loops?

**OR**

The graphs (i) and (ii) represent the variation of the opposition offered by the circuit element to the flow of alternating current with frequency of the applied emf.




Identify the circuit element and write the expression for current corresponding to each graph if the applied voltage is given by $V=V_0 \sin\omega t$

**20.** Draw a plot of the binding energy per nucleon as a function of mass number A of nuclei (30<A<238). Use this graph to explain the release of energy in nuclear fission.

**21.** (a) What do you understand by virtual value of ac?
(b) A voltage signal is described by

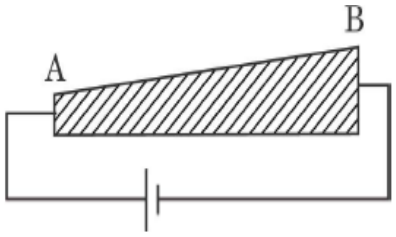
$$v = V_0 \quad \text{for } 0 \le t \le \frac{T}{2}$$

$$= 0 \quad \text{for } \frac{T}{2} \le t \le T$$

for a cycle.
(i) Plot the voltage ~ time graph for the complete cycle.
(ii) Find its rms value.

## SECTION C

**22.** (i) Define mobility of electrons. Give its SI units.
(ii) A steady current flows through a wire AB, as shown in the figure. What happens to the electric field and the average velocity of the free electrons along the wire? Justify your answer.




**23.** (a) What do you mean by resonance in RLC circuit.
(b) A 5 ohm resistor, a 5 mH inductor and a 5 μF capacitor, joined in series resonate with an ac source of frequency $\omega_o$. If only the resistance is changed to 10 ohm, the circuit resonates at a frequency $\omega_1$. If only the inductor is changed to 20 mH, the circuit resonates at a frequency $\omega_2$. Find the ratio $\omega_1/\omega_2$.

**24.** (a) An electromagnetic wave is travelling in a medium with a velocity $\vec{v} = v\hat{i}$. Draw a sketch showing the propagation of the electromagnetic wave, indicating the direction of the oscillating electric and magnetic fields.

(b) What is the phase difference between oscillating electric and magnetic field?

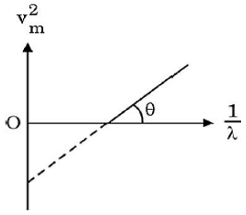
(c) Which constituent radiation of the electromagnetic spectrum is used

(i) in RADAR

(ii) to photograph internal parts of a human body

**25.** A beam of light consisting of two wavelengths 800 nm and 600 nm, is used to obtain the interference fringes in a Young's double slit experiment on a screen is placed 1.4 m away. If two slits are separated by 0.28 mm, calculate the least distance from the central bright maximum where the bright fringes of the two wavelengths coincide.

**26.** The figure shows $v^2_m$ versus $1/\lambda$ graph for photoelectrons emitted from a surface where $v_m$ is the maximum speed of electrons and $\lambda$ is the wavelength of incident radiation.




Using this graph and Einstein's photoelectric equation, obtain the expression for

(i) Planck's constant and

(ii) work function of the surface.

**OR**

(a) Give reason: A radiation of wavelength $\lambda < \lambda_{threshold}$ incident on a metal sphere placed on an insulated stand results in the emission of photoelectrons for some time and then stops.

(b) In the photoelectric experiment apparatus containing the collector and the emitter plate, a saturated photoelectric current is observed. If an external electric field is applied in the direction opposite to the motion of the photoelectrons, what is the change observed in each of the following? Give reasons.

i. The saturation value of the photocurrent

ii. The kinetic energy of the photoelectrons striking the collector plate

**27.** (a) The table below lists the different transitions of an electron in a hydrogen atom:

| | |
|---|---|
| i | $n_i = 4$ to $n_f = 2$ |
| ii | $n_i = 3$ to $n_f = 1$ |
| iii | $n_i = 2$ to $n_f = 3$ |
| iv | $n_i = 4$ to $n_f = 3$ |

Identify the transitions that give absorption spectra.

(b) In Geiger-Marsden experiment, show the variation of the number of particles scattered (N) with scattering angle ($\theta$). What is the main conclusion that can be inferred from this plot?

**28.** (a) Draw V I characteristics of a p-n junction diode. Explain how these characteristics make a diode suitable for rectification.

(b) Carbon and silicon have the same lattice structure. Then why is carbon an insulator but silicon a semiconductor?

## SECTION D

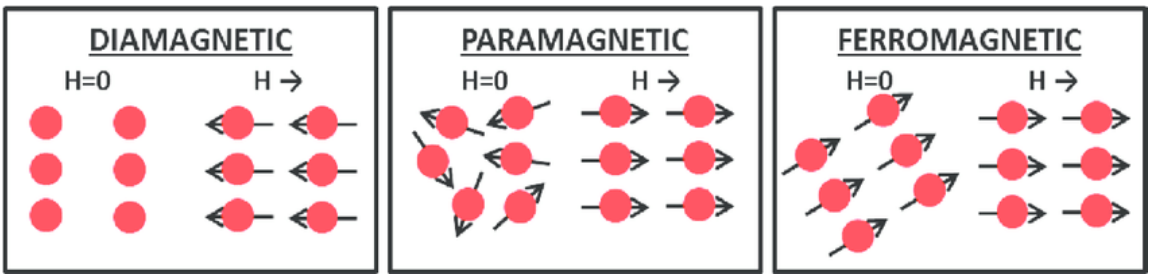
## Case Study Based Questions

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

When the atomic dipoles are aligned partially or fully, there is a net magnetic moment in the direction of the field in any small volume of the material. The actual magnetic field inside material placed in magnetic field is the sum of the applied magnetic field and the magnetic field due to magnetization. The magnetic intensity

$$H = \frac{B}{\mu_0} - M$$

Where M is the magnetization of the material. The measure that tells us how a magnetic material responds to an external field is given by a dimensionless quantity is called the magnetic susceptibility.




Different substances show different behaviors to the external magnetic field. Based upon their behaviors, they are classified as Diamagnetic, Paramagnetic and Ferromagnetic substances.

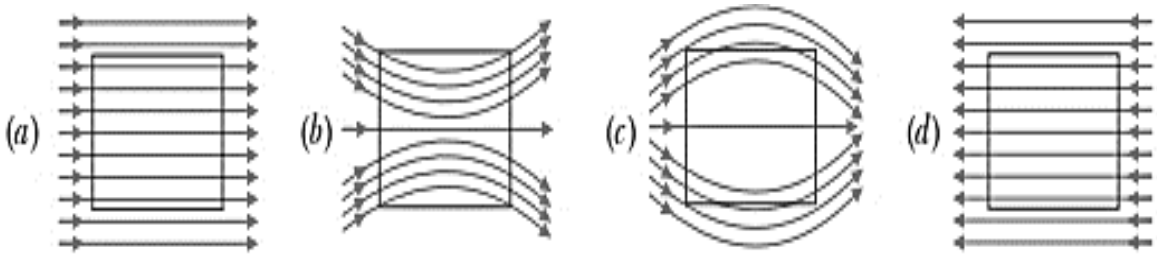
(i) If a diamagnetic substance is brought near the north or the south pole of a bar magnet, it is
(a) repelled by the north pole and attracted by the south pole
(b) attracted by the north pole and repelled by the south pole
(c) attracted by both the poles
(d) repelled by both the poles

(ii) Above Curie's temperature ferromagnetic substances becomes
(a) paramagnetic (b) diamagnetic (c) superconductor (d) no change

**OR**

The meniscus of a liquid contained in one of the limbs of a narrow U-tube is placed between the pole-pieces of an electromagnet with the meniscus in a line with the field. When the electromagnet is switched on, the liquid is seen to fall in the limb. This indicates that the liquid is
(a) ferromagnetic (b) paramagnetic (c) diamagnetic (d) non-magnetic

(iii) A uniform magnetic field exists in space in the plane of paper and is initially directed from left to right. When a bar of soft iron is placed in the field parallel to it, the lines of force passing through it will be represented by




(iv) The susceptibility of a paramagnetic material is $\chi$ at $27^0$C. At what temperature will its susceptibility be 0.25 $\chi$.
(a) $108^0$C (b) $327^0$C (c) $927^0$C (d) $237^0$C

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

The lens maker's formula is useful to design lenses of desired focal lengths using surfaces of suitable radii of curvature. The focal length also depends on the refractive index of the material of the lens and the surrounding medium. The refractive index depends on the wavelength of the light used. The power of a lens is related to its focal length.

Answer the following questions based on the above:

(a) If the wavelength of light decreases then the power of a lens will
(i) increase (ii) decrease (iii) remain unaffected (iv) increase first and then decrease

(b) The radius of curvature of two surfaces of a convex lens is 20cm each and the refractive index of the material of the lens is 1.5, then the focal length of the lens is

(i) 0 (ii) ∞ (iii) 20cm (iv) 10cm

(c) A thin convex lens of refractive index 1·5 has 20 cm focal length in air. If the lens is completely immersed in a liquid of refractive index 1.6, its focal length will be

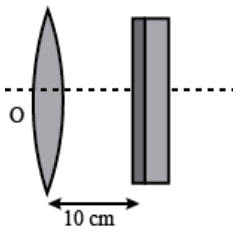
(i) 160cm (ii) -160cm (iii)10cm (iv)80cm

**OR**

An object is placed at the focus of a concave lens of focal length 9cm. The image of the object will be formed at

(i) ∞ (ii) 4.5cm (iii) 13.5cm (iv) 18cm

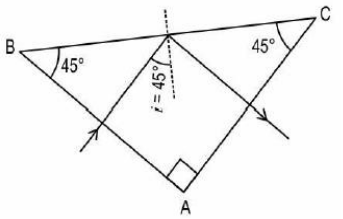
(d) The distance between a convex lens and a plane mirror is 10 cm. The parallel rays incident on the convex lens after reflection from the mirror forms image at the optical center of the lens. Focal length of lens will be




(i) 15 *cm* (ii) 30 *cm* (iii) 20 *cm* (iv) ∞

## SECTION E

**31.** (a) A ray of light of wavelength λ falls normally on a right-angled isosceles prism ABC of refractive index n.




Find the minimum value of refractive index n of the prism required for the total internal reflection of the light to occur on the face BC of the prism.

(b) For any given thin prism of small angle A, refractive index n, and an incident blue light, answer the following questions.

i. Write the formula for angle of minimum deviation for a thin prism. If the whole arrangement is immersed in a liquid of refractive index n' < n, how will the angle of minimum deviation change?

ii. For some angle of incidence on the second face of the prism, the incident blue light undergoes total internal reflection. However, a red incident light for the same angle of incidence on the second face of the prism does not undergo total internal reflection. Give reason.

**OR**

(a) Draw the labelled ray diagram for the formation of image by a simple microscope when the final image is formed at the near point.

(b) State its principle of working.

(c) Define magnifying power and derive an expression for it.

(d) A compound microscope used an objective lens of focal length 4 cm and eyepiece lens of focal length 10cm. An object is placed at 6cm from the objective lens. Calculate the magnifying power of the compound microscope, when the final image is formed at near point.

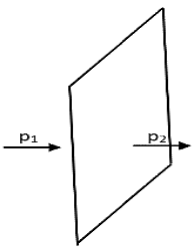
**32.** (a)Consider two identical point charges located at points (0.0) and (a,0).

(i) Is there a point on the line joining them at which the electric field is zero?

(ii) Is there a point on the line joining them at which the electric potential is zero?

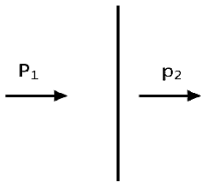
Justify your answer in each case.

(b) An electric dipole is kept first to the left and then to the right of a negatively charged infinite plane sheet having a uniform surface charge density. The arrows $p_1$ and $p_2$ show the directions of its electric dipole moment in the two cases.




Identify for each case, whether the dipole is in stable or unstable equilibrium. Justify each answer**.**

(c) Next, the dipole is kept in a similar way (as shown), near an infinitely long straight wire having uniform negative linear charge density.
Will the dipole be in equilibrium at these two positions? Justify your answer.

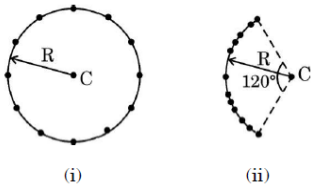



**OR**

(a) What do you understand by 'principle of superposition of electric potential'.

(b) Twelve negative charges of same magnitude are equally spaced and fixed on the circumference of a circle of radius R as shown in Fig. (i). Relative to potential being zero at infinity, find the electric potential and electric field at the centre C of the circle.

(c) If the charges are unequally spaced and fixed on an arc of 120 of radius R as shown in Fig. (ii), find electric potential at the centre C.




(i) (ii)

(d)What is the amount of work done in displacing a charge 'q' from the centre of the above arc to that of the circle if the distance between their centres is '$x'$.

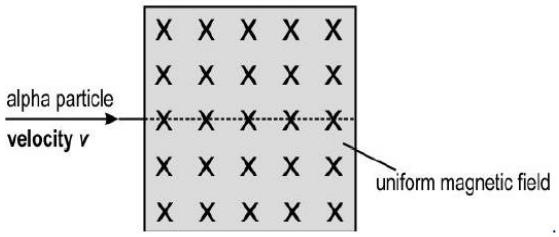
**33.** (a) A charge particle of charge $q$, mass m, moving with speed $v$ enters a uniform magnetic field $B$ making an angle $\theta$ with $B$.

(i) Draw the nature of path described by the charge particle.

(ii) Write the expression for the radius of the above path described

(b) An alpha particle is moving with a velocity $v$. It enters a magnetic field ($B$) as shown below. The magnetic field is perpendicular and into the plane of paper.

A uniform electric field is applied in the same region as the magnetic field so that the alpha particle passes undeviated through the combined fields.




(i) What should be the direction of the electric field?

(ii) Without any change in the electric and magnetic field, the alpha particle is replaced by the following particles:

(1) proton moving with a velocity $v$

(2) electron moving with a velocity $v/2$ Will there be any change a deviation in the path of the particles? Give a reason for your answer.

**OR**

(a) State the law which is used to find the magnetic field at a point due to a current element.

(b) Use it to obtain the magnetic field at an axial point, distant 'r' from the centre of a circular coil of radius 'a' carrying a current 'I'.

(c) A long straight wire carrying current $I_1$ is passing through the centre of the circular loop of radius $R$ carrying current $I_2$ perpendicular to the plane of the loop. Find the force on the circular loop by the straight wire.