# SUBJECT: PHYSICS (THEORY)
# CLASS: XII
# SESSION: 2024-25

**Maximum Marks: 70** **Time Allowed: 3 hours.**

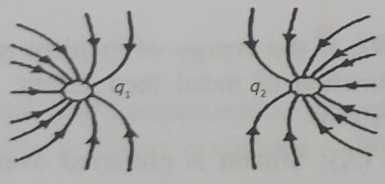
**General Instructions:**

(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) $\mu_0 = 4\pi \times 10^{-7}$ TmA$^{-1}$
(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

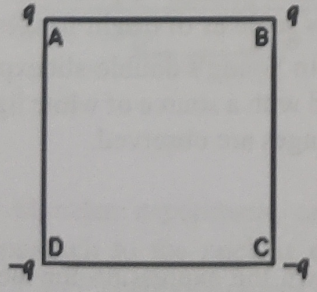
**1.** Figure shows electric lines of force due to two charges $q_1$ and $q_2$. **(1)**




What are the signs of two charges?

(a) Both are positive (b) $q_1$ negative, $q_2$ positive
(c) $q_1$ positive, $q_2$ negative (d) Both are negative

**2.** Charges are placed on the vertices of a square as shown. Let $E$ be the electric field and $V$ be the potential at the centre. If the charges on $A$ and $B$ are interchanged with those on $D$ and $C$ respectively, then: **(1)**




(a) $E$ changes, $V$ remains unchanged
(b) $E$ remains unchanged, $V$ remain changed
(c) Both $E$ and $V$ change
(d) E and $V$ remain unchanged

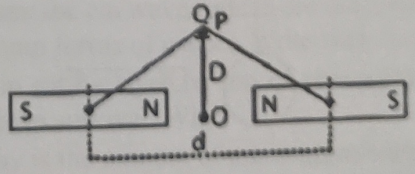
**3.** Light of wavelength 4000 Å is incident on a sodium surface for which the threshold wavelength of photo-electrons is 5420 Å. The work function of sodium is **(1)**

(a) 5 eV (b) 3 eV
(c) 2.29 eV (d) 0.57 eV

**4.** The size of nuclei (in metre) is of the order of **(1)**

(a) $10^{15}$ (b) $10^{-12}$
(c) $10^{-10}$ (d) $10^{-15}$

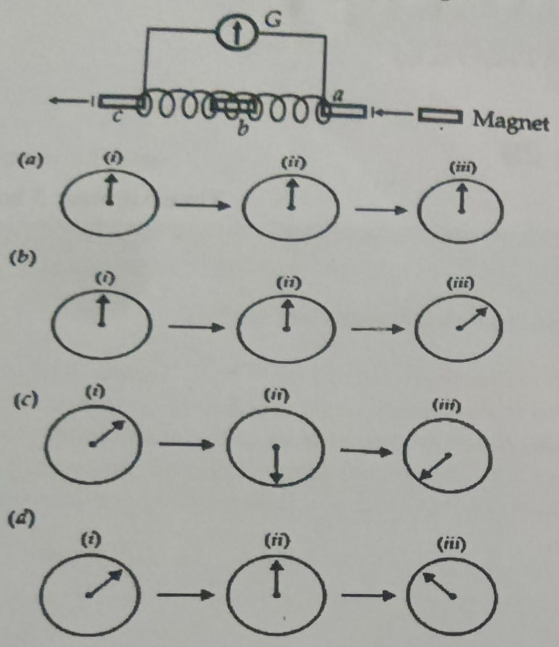
**5.** Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge $Q$ is placed at $P$ in between the gap of the two magnets at a distance $D$ from the centre $O$ as shown in the figure. The force on the charge $Q$ is **(1)**




(a) zero
(b) directed along $PO$
(c) directed along $OP$
(d) directed perpendicular to the plane of paper

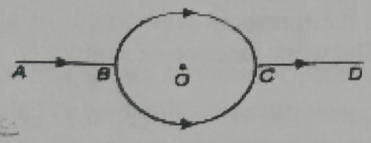
**6.** A small magnet is moved through a coil at constant speed from one end to the other. Which of the following series of observations will be seen in the galvanometer G attached to the coil? **(1)**

Three positions shown describe (*a*) magnet's entry (*b*) magnet is completely inside (*c*) magnet's exit.



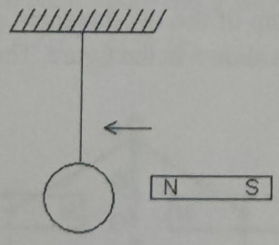

7. In the equation $AB = C$, $A$ is the current density, $C$ is the electric field, Then $B$ is (1)
   (*a*) resistivity (*b*) conductivity
   (*c*) potential difference (*d*) resistance

8. What is the magnetic field at point $O$ due to current carrying wires as shown in the figure? (1)




   (*a*) $0T$ (*b*) $4T$
   (*c*) $1T$ (*d*) cannot be determined

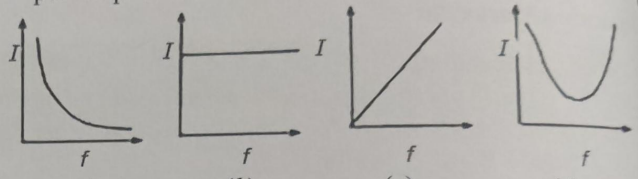
9. Give the direction in which induced current (as seen from magnet side) flows in the wire loop, when the magnet moves towards the loop as shown below: (1)




   (*a*) Anticlockwise
   (*b*) Clockwise
   (*c*) Irrespective of direction of motion of the magnet
   (*d*) None of these

10. In electromagnetic waves, the phase difference between electric field vector and magnetic field vector is (1)
    (*a*) zero (*b*) $\pi/2$ (*c*) $\pi$ (*d*) $\pi/3$

11. Which of the following graphs represent the variation of current ($I$) with frequency ($f$) in an $AC$ circuit containing a pure capacitor? (1)




12. If we consider electrons and photons of the same wavelength, then they will have the same (1)
    (*a*) Velocity (*b*) Angular momentum
    (*c*) Energy (*d*) momentum

**For questions 13 to 16, two statements are given-one labelled Assertion (*A*) and the other labelled Reason (*R*). Select the correct answer to this question from the codes (*a*), (*b*), (*c*) and (*d*) as given below.**

(*a*) *Both Assertion (A) and (Reason) R are true and (Reason) R is the correct explanation of Assertion (A).*
(*b*) *Both Assertion (A) and (Reason) R are true and (Reason) R is NOT the correct explanation of Assertion (A).*
(**c**) *Assertion (A) is true but (Reason) R is false.*
(*d*) *Assertion (A) is false and (Reason) R is also false.*

13. **Assertion (A):** Photoelectric effect will not be observed if energy of incident radiation is less than work function of metal. (1)
    **Reason (R):** If the energy of incident radiation is equal to work function of metal then kinetic energy of photo electrons is zero

14. **Assertion (A):** Silicon is preferred over germanium for making semiconductor devices. (1)
    **Reason (R):** The energy gap in germanium is more than the energy gap in silicon.

15. **Assertion (A):** Electrons move away from a region of lower potential to a region of higher potential. (1)
    **Reason (R):** Since electron has a negative charge.

16. **Assertion (A):** In Young's experiment, the fringe width for dark fringes is same as of bright fringes. (1)
    **Reason (R):** In Young's double-slit experiment, the fringes are performed with a source of white light , then only black and bright fringes are observed.

## SECTION-B

17. The oscillating magnetic field in a plane electromagnetic wave is given by (1+1)
    $B_y = (8 \times 10^{-6}) \sin [2 \times 10^{11} t + 300 \pi x]$ Tesla
    (*i*) Calculate the wavelength of the electromagnetic wave.
    (*ii*) Write down the expression for the oscillating electric field.

18. An electron and alpha particle have the same de- Broglie wavelength associated with them. How are their kinetic energies related to each other? (2)

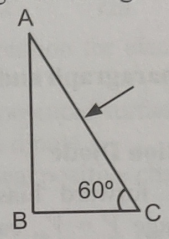
19. Draw a labeled diagram of a compound microscope when the final image is at the least distance of distinct vision. Write the expression for its magnifying power. **(2)**

20. Four identical cells, each of emf 8 *V* and internal resistance 2.5 Ω are connected in series and charged by a100 *V DC* supply, using a 24Ω resistor in series. Calculate the following : **(2)**
   (*i*) Charging current in the circuit.
   (*ii*) Potential difference across the cells during recharging.

21. A convex lens made up of glass of refractive index 1.5 is dipped in turn in **(2)**
   (*i*) A medium of refractive index 1.65
   (*ii*) A medium of refractive index 1.33
   Will it behave as a converging lens or a diverging lens in two cases?
   How will its focal length change in two media?

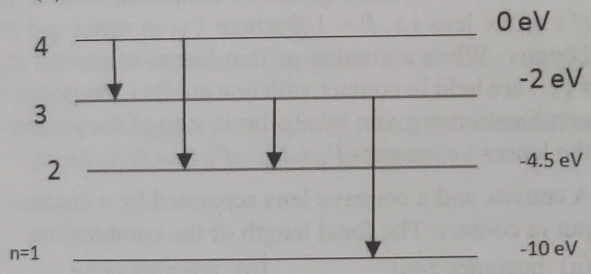
**OR**

Trace the path of the ray of light passing through a glass prism ABC. If refractive index of the glass is $\sqrt{3}$, find out the value of the angle of emergence from the prism. **(2)**

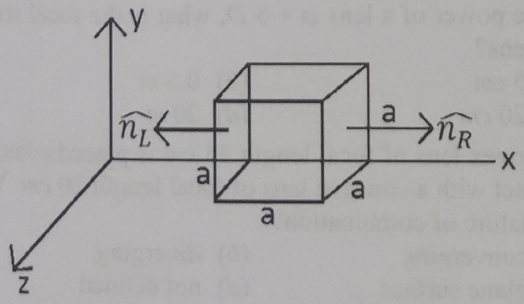



## SECTION-C

22. (*i*) The energy levels of an atom are as shown below. Which of them will result in the transition of a photon of wavelength 275 *nm*? **(2+1)**
   (*ii*) Which transition corresponds to emission of radiation of
   (*a*) maximum wavelength
   (*b*) minimum wavelength?

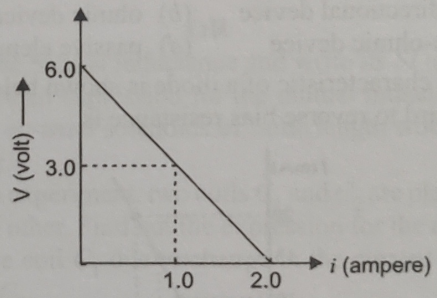



23. The electric field components in the following figure are $Ex = \alpha x$, $Ey = 0$, $Ez = 0$; in which $\alpha = 400\ N/C\ m$. Calculate **(1.5 + 1.5)**
   (*i*) the electric flux through the cube, and
   (*ii*) the charge within the cube, assume that $a = 0.1$m.




24. In a Geiger-Marsden experiment, calculate the distance of closest approach to the nucleus of $Z = 80$, when an α-particle of 8 *MeV* energy impinges on it before it comes momentarily to rest and reverses its direction. How will the distance of closest approach be affected when the kinetic energy of the α-particle is doubled? **(1.5 + 1.5)**

25. Four cells of identical emf *E*, internal resistance *r*, are connected in series to a variable resistor. The following graph shows the variation of terminal voltage of the combination with the current output. **(3)**




   (*i*) Find the emf of each cell.
   (*ii*) Calculate internal resistance of each cell.
   (*iii*) Calculate the value of current for maximum power dissipation.

26. (*i*) Derive the expression for the magnetic moment of an electron revolving at a speed *v* around an orbit of radius *r* in hydrogen atom. **(1+2)**
   (*ii*) Under what condition is the force acting on a charge moving through a uniform magnetic field, minimum.

27. Answer the following : **(1+1+1)**
   (*i*) Name the em waves which are used for the treatment of certain forms of cancer. Write their frequency range.
   (*ii*) Thin ozone layer on top of stratosphere is crucial for human survival. Why?
   (*iii*) Why is the amount of momentum transferred by an em wave incident on the surface so small?

28. (*i*) The current in a coil of self inductance $L = 40mH$ is to be increased uniformly from 1 *A* to 11 *A* in 4 milliseconds. What is the *e.m.f.* induced in the inductor during the process? **(3)**
   (*ii*) A magnetic field of $2 \times 10^{-2}\ T$ acts at right angles to a coil of area 100 $cm^2$ with 50 *turns*. The average *e.m.f.*

## SECTION-D

### CASE STUDY BASED QUESTIONS

**29. Read the following paragraph and answer the questions that follow.** (4)

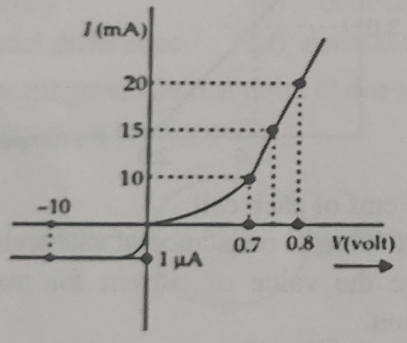
**Biasing of *p-n* Junction Diode**

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 p-n junction, the potential barrier is overcome and the current increases with forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current.

(*i*) Based on the *V-I* characteristics of the diodes, we can classify diode as

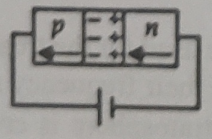
(*a*) bi-directional device (*b*) ohmic device
(*c*) non-ohmic device (*d*) passive element

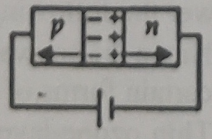
(*ii*) The *V-I* characteristic of a diode is shown below. The ratio of forward to reverse bias resistance is

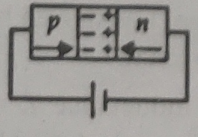


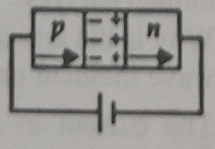

(*a*) 100 (*b*) $10^6$
(*c*) 10 (*d*) $10^{-6}$

(*iii*) In the case of forward biasing of a *p-n* junction diode, which one of the following figures correctly depicts the direction of conventional current (indicated by an arrow mark)?

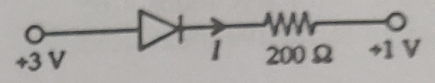
(a) 


(b) 


(c) 


(d) 


(*iv*) An ideal junction diode is connected as shown, what is the value of the current *I* ?




(*a*) 10*A* (*b*) 0 *A*
(*c*) 0.01*A* (*d*) 20*A*

**OR**

Which statement is true for p type?

(*a*) $n_e = n_h$ (*b*) $n_e > n_h$
(*c*) $n_e < n_h$ (*d*) $n_i^2 = n_e n_h$

**30. Read the following paragraph and answer the questions that follow.** (4)

**Power of A Lens**

Power (*P*) of a lens is given by reciprocal of focal length (*f*) of the lens i.e. $P = 1/f$, where f is in meter and *P* is in Dioptre. When a number of thin lenses of powers $P_1$, $P_2$, $P_3$ ... are held in contact with one another, the power of the combination is given by algebraic sum of the powers of all the lenses i.e. powers $P_1 + P_2 + P_3 + \ldots$

(*i*) A convex and a concave lens separated by a distance d are put in contact. The focal length of the combination

(*a*) becomes zero (*b*) remains same
(*c*) decreases (*d*) increases

(*ii*) If two lenses of power + 1.5 *D* and + 1.0 *D* are placed in contact, then the effective power of combination will be

(*a*) + 2.5 *D* (*b*) 1.5 *D*
(*c*) − 2.5 *D* (*d*) + 0.5 *D*

(*iii*) If the power of a lens is + 5 *D*, what is the focal length of the lens?

(*a*) 5 *cm* (*b*) 0.5 *m*
(*c*) 20 *cm* (*d*) 20 *m*

(*iv*) A convex lens of focal length 25 *cm* is placed coaxially in contact with a concave lens of focal length 20 *cm*. What is the nature of combination?

(*a*) converging (*b*) diverging
(*c*) plane surface (*d*) not defined

**OR**

Power of a diverging lens is

(*a*) positive (*b*) negative
(*c*) zero (*d*) infinite

## SECTION-E

31. (*i*) Explain the phenomenon of diffraction of light at a single slit in detail hence deduce the width of diffraction maximum in diffraction pattern obtained from it. **(2+3)**

(*ii*) Determine the angular width between central maximum and first order maximum of the diffraction pattern due to a single slit of width 0.25 *mm*, when light of wavelength 5890 Å is incident on it normally.

**OR**

(*i*) Draw a ray diagram for final image formed at infinity (under normal adjustment) of Astronomical Telescope and also deduce an expression for its magnifying power. **(3+2)**

(*ii*) An astronomical telescope of magnifying power 7 consists of two thin lenses 40 *cm* apart, in normal adjustment. Calculate the focal length of the lenses.

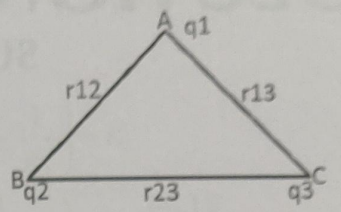
32. (*i*) Using Gauss's law, derive expression for intensity of electric field at any point near the infinitely long straight uniformly charged wire. **(3+2)**

(*ii*) Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.0\times10^{-22}\ C/m^2$. What is $E$: (*a*) in the outer region of the first plate. (*b*) between the plates?

**OR**

(*i*) Define electrostatic potential at a point. Write its *SI* unit. **(1+2+2)**

Three charges $q_1$ , $q_2$ and $q_3$ are kept respectively at points $A$, $B$ and $C$ as shown in figures.




Write the expression for electrostatic potential energy of the system.

(*ii*) Draw the equipotential surfaces due to

(*a*) an electric dipole

(*b*) two identical positive charges separated by a small distance.

33. (*i*) What is induced *emf*? Write Faraday's laws of electromagnetic induction. Express mathematically.

(*ii*) A conducting rod of length '*l*', with one end pivoted, is rotated with a uniform angular speed 'ω' in a vertical plane, normal to a uniform magnetic field '*B*'. Deduce an expression for the emf induced in this rod.

If resistance of rod is *R*, what is the current induced in it? **(2+3)**

**OR**

(*i*) Define mutual inductance and write its *SI* units.

(*ii*) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound over the other.

(*iii*) In an experiment, two coils $C_1$ and $C_2$ are placed close to each other. Find out the expression for the emf induced in the coil $C_1$ due to change in the current through the coil $C_2$. **(1+2+2)**

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