Aakash
Medical | IIT-JEE | Foundations

Corp. Office: Aakash Educational Services Limited, 3rd Floor, Incuspaze Campus- 2, Plot No. 13, Sector- 18, Udyog Vihar, Gurugram, Haryana - 122015

Time: 3 hrs. **Max. Marks: 70**

Mock Test Paper for Class-XII

PHYSICS (Code-A)

GENERAL INSTRUCTIONS

Read the following instructions carefully and follow them :

(i) This question paper contains **33** questions. All questions are compulsory.

(ii) This question paper is divided into **five** sections – **Sections A, B, C, D and E.**

(iii) In **Section A** Questions no. 1 to 16 are Multiple Choice type questions. Each question carries **1 mark**.

(iv) In **Section B** Questions no. 17 to 21 are Very Short Answer type questions. Each question carries **2 marks**.

(v) In **Section C** Questions no. 22 to 28 are Short Answer type questions. Each question carries **3 marks**.

(vi) In **Section D** Questions no. 29 and 30 are case study-based questions. Each question carries **4 marks**.

(vii) In **Section E** Questions no. 31 to 33 are Long Answer type questions. Each question carries **5 marks**.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A.

You may use the following values of physical constants wherever necessary:

$c = 3 \times 10^8$ m/s

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

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\mu_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) = 9.1×10^{-31} kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = 1.38×10^{-23} JK^{-1}

SECTION-A

1. The amount of charge flowing across a cross-section of a conductor, connected to a battery, in 4.0 s is 720 mC. The current in the circuit is

   (a) 0.18 A (b) 1.8 A

   (c) 18 mA (d) 18 A

2. In Young's double-slit experiment, the slit separation is made three times and the distance of the screen from the slits is doubled. The fringe width becomes

   (a) 6 times (b) $\frac{3}{2}$ times

   (c) $\frac{1}{6}$ times (d) $\frac{2}{3}$ times

3. The current sensitivity of a galvanometer does not depend on the

   (a) Magnetic field in which the coil is suspended

   (b) Current flowing in the coil

   (c) Torsional constant of the spring

   (d) Area of the coil

4. An inductor of resistance 5 Ω and self-inductance 25 mH is connected across an ac source of angular frequency 200 rad s^{-1}. The phase angle between the voltage and the current is

   (a) 30° (b) 45°

   (c) 60° (d) 90°

5. Two long straight parallel conductors carrying steady currents I_1 and I_2 in the same direction are separated by a distance d. The force exerted by one conductor on unit length of the other is

   (a) $\frac{\mu_0 I_1 I_2}{4\pi d}$, attractive (b) $\frac{\mu_0 I_1 I_2}{4\pi d}$, repulsive

   (c) $\frac{\mu_0 I_1 I_2}{2\pi d}$, attractive (d) $\frac{\mu_0 I_1 I_2}{2\pi d}$, repulsive

6. A thin concave lens of focal length $2f$ is put in contact with a thin convex lens of focal length f. The focal length of the combination will be

   (a) $2f$ (b) $\frac{f}{2}$

   (c) $-f$ (d) f

7. The magnetic field of an electromagnetic wave of wavelength λ is represented as $B_x = B_0 \sin(ky - \omega t)$. It means that the wave propagation direction and wave vector k are respectively

   (a) $+z$ axis, $\frac{2\pi}{\nu}$ (b) $-z$ axis, $\frac{2\pi}{T}$

   (c) $+y$ axis, $\frac{2\pi}{\lambda}$ (d) $-y$ axis, $\frac{\lambda}{2\pi}$

8. The minimum energy required to free the electron from the ground state of the hydrogen atom in Bohr model is 13.6 eV. The energy of the electron in its second orbit will be

   (a) –6.8 eV (b) 6.8 eV

   (c) –3.4 eV (d) 3.4 eV

9. The angular momentum of an electron in 3rd orbit of hydrogen atom is

(a) $\frac{h}{\pi}$ (b) $\frac{2h}{\pi}$

(c) $\frac{3h}{2\pi}$ (d) $\frac{h}{3\pi}$

10. The capacitance of a parallel plate capacitor is 10 μF when the distance between its plates is 8 cm. If the distance between the plates is halved, the capacitance will become

(a) 10 μF (b) 15 μF

(c) 20 μF (d) 40 μF

11. The electric flux through a Gaussian spherical surface enclosing a point charge q is ϕ. If the charge is replaced by an electric dipole, magnitude of its dipole moment being $2qa$, the flux through the surface will be

(a) 2ϕ (b) ϕ

(c) $\frac{\phi}{2}$ (d) Zero

12. Two circular loops of areas A and $4A$ carry currents $2I$ and I respectively. The magnetic fields at their centres will be in the ratio of

(a) 3 : 1 (b) 4 : 1

(c) 1 : 1 (d) 1 : 2

Questions numbers 13 to 16 are Assertion (A) and Reason (R) type questions. Two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer 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 the Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the 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) :** The electrostatic field $\vec{E}$ is a conservative field.

Reason (R) : Line integral of electrostatic field $\vec{E}$ around a closed path is zero.

14. **Assertion (A) :** The photoelectric current increases with increase in intensity of incident radiation, keeping the frequency of the incident radiation and the accelerating potential fixed.

Reason (R) : The number of photoelectrons emitted per second is directly proportional to the intensity of incident radiation.

15. **Assertion (A) :** The current density $\vec{J}$ at a point in a conducting wire is in the direction of electric field $\vec{E}$ at that point.

Reason (R) : A conducting wire do not obeys Ohm's law.

16. **Assertion (A) :** The torque acting on a current carrying coil is always zero.

Reason (R) : As force is zero, torque is also zero on coil.

SECTION-B

17. A point light source rests on the bottom of a bucket filled with a liquid of refractive index μ = 1.25 up to height of 10 cm. Calculate

(a) The critical angle for liquid-air interface.

(b) Radius of circular light patch formed on the surface by light emerging from the source.

18. State Huygens principle. Using it draw a diagram showing the details of passage of a plane wave from a denser into a rarer medium.

19. (a) Identify the part of electromagnetic spectrum which is
    (i) Suitable for radar systems.
    (ii) Sometimes referred to as 'heat waves'.
    Write their wavelength range.

    OR

    (b) Write two characteristic of electromagnetic waves. Name the radiation used to kill germs in water purifiers. Write the range of their frequency.

20. A closely wound coil having 1000 turns is placed in a region having magnetic field 1 T perpendicular to the plane of the coil. If the magnetic flux linked with coil is $\pi \times 10^{-5}$ Wb, find the radius of the coil.

21. Briefly explain how the valence band and conduction band are formed in a crystal.

SECTION-C

22. (a) A metallic rod of length 40 cm is rotated with a frequency of 300 rpm about a vertical axis passing through its centre. If a uniform magnetic field of 0.2 T acts vertically downward, find the emf induced between (i) the ends of the rod, and (ii) the centre and one end of the rod.

    OR

    (b) A square coil side 10 cm having 100 turns is suspended in a magnetic field of 100 mT so that its plane is normal to the field. The coil is rotated through 90° in 0.2 s. Calculate the average emf induced in it.

23. (a) Obtain the relationship between atomic mass unit (u) and electron volt (eV).
    (b) The mass of a ball is 0.5 kg. It is totally converted into energy. Calculate the energy output in eV.

24. In photoelectric effect experiment, show the variation of
    (a) Photocurrent with collector plate potential for a given surface for different intensities of incident radiation. Do the curves meet at any point? If so, why?
    (b) Photocurrent with intensity of radiation incident on a metal surface.

25. Two circular coils of radius R each and having equal number of turns N, carry equal currents I in the same direction. They are placed coaxially at a distance $2\sqrt{3}R$. Find the magnitude and direction of the net magnetic field produced at the midpoint of the line joining their centres.

26. Two point charges of 10 μC and 20 μC are located at points (–4 cm, 0, 0) and (5 cm, 0, 0) respectively, in a region with electric field $E = \frac{A}{r^2}$, where $A = 2 \times 10^6$ NC^{-1} m^2 and $\vec{r}$ is the position vector of the point under consideration. Calculate the electrostatic potential energy of the system.

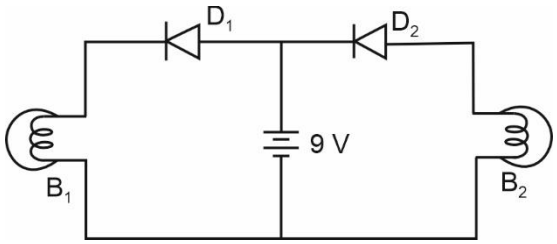
27. A particle of mass m and charge q is moving in a magnetic field $\vec{B}$ with a velocity $\vec{v}$. Discuss, giving reasons, the shape of its trajectory when the angle between $\vec{v}$ and $\vec{B}$ is
    (a) 0°
    (b) 90°
    (c) 120°

28. Write Einstein's photoelectric equation. Use it to
    (i) Explain the existence of threshold frequency for a given photosensitive surface.
    (ii) Shown that the stopping potential, V_0 varies linearly with the frequency ν of incident radiation.
    Explain how the value of Planck's constant can be found from the V_0 versus ν curve.

SECTION-D

29. The process of converting ac into dc is called rectification and the device used is called a rectifier. When ac signal is fed to a junction diode during positive half cycle, the diode is forward biased and current flows through it. During the negative half cycle, the diode is reverse biased and it does not conduct. Thus the ac signal is rectified. The p-n junction diodes can be used as half-wave and full-wave rectifiers.

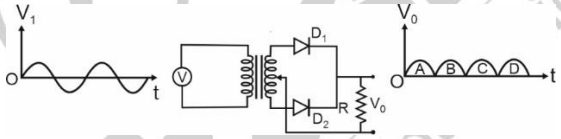
(i) Which bulb/bulbs will glow in the given circuit?



(a) B_1 only (b) B_2 only

(c) Both B_1 and B_2 (d) Neither B_1 nor B_2

(ii) A full-wave rectifier circuit is shown in the figure. The contribution in output waveform from junction diode D_1 is



(a) A, D (b) A, C

(c) A, B (d) B, C

OR

The output in a half-wave rectifier is

(a) Unidirectional without ripple (b) Steady and continuous

(c) Unidirectional with ripple but discontinuous (d) Steady but discontinuous

(iii) In a p-n junction diode, the majority charge carriers on p-side and on n-side are, respectively

(a) Electrons, electrons (b) Electrons, holes

(c) Holes, holes (d) Holes, electrons

(iv) If the frequency of the half-wave rectifier is 50 Hz, the frequency of full-wave rectifier is

(a) 25 Hz (b) 50 Hz

(c) 100 Hz (d) 200 Hz

30. Dipoles, whether electric or magnetic, are characterised by their dipole moments, which are vector quantities. Two equal and opposite charges separated by a small distance constitute an electric dipole create electric fields around them. Electric dipoles experience a torque when placed in an external electric field.

(i) Two identical electric dipoles, each consisting of charges $-q$ and $+q$ separated by distance d, are arranged in x-y plane such that their negative charges lie at the origin O and positive charges lie at points (d, 0) and (0, d) respectively. The net dipole moment of the system is

(a) $-qd(\hat{i}+\hat{j})$ (b) $qd(\hat{i}+\hat{j})$

(c) $qd(\hat{i}-\hat{j})$ (d) $qd(\hat{j}-\hat{i})$

(ii) E_1 and E_2 are magnitudes of electric field due to a dipole, consisting of charges $-q$ and $+q$ separated by distance $2a$, at distance r (>> a) (1) on its axis, and (2) on equatorial plane, respectively. Then $\left(\frac{E_1}{E_2}\right)$ is

(a) $\frac{1}{4}$ (b) $\frac{1}{2}$

(c) 2 (d) 4

(iii) An electric dipole of dipole moment 5.0×10^{-8} cm is placed in a region where an electric field of magnitude 1.0×10^3 N/C acts at a given instant. At that instant the electric field $\vec{E}$ is inclined at an angle of 30° to dipole moment $\vec{P}$. The magnitude of torque acting on the dipole, at that instant is

(a) 2.5×10^{-5} Nm (b) 5.0×10^{-5} Nm

(c) 1.0×10^{-4} Nm (d) 2.0×10^{-6} Nm

(iv) An electron is revolving with speed v around the proton in a hydrogen atom, in a circular orbit of radius r. The magnitude of magnetic dipole moment of the electron is

(a) $4evr$ (b) $2evr$

(c) $\frac{1}{2}evr$ (d) $\frac{1}{4}evr$

OR

A square loop of side 5.0 cm carries a current of 2.0 A. The magnitude of magnetic dipole moment associated with the loop is

(a) 1.0×10^{-3} Am^2 (b) 5.0×10^{-3} Am^2

(c) 1.0×10^{-2} Am^2 (d) 5.0×10^{-2} Am^2

SECTION-E

31. (i) Why do we use a small test charge to measure an electric field?

(ii) A small stationary positively charged particle is free to move in an electric field. In which direction will it begin to move?

(iii) Two point charges Q_1 (40 μC) and Q_2 (–16 μC) are placed along x-axis at 0 cm and 24 cm from the origin respectively. Calculate the net force on a third charge Q_3 (–2.5 μC) placed at x = 36 cm from the origin.

OR

(i) How will the capacitance of a parallel plate capacitor change if :

(1) The plates area is doubled?

(2) The separation between the plates is doubled?

(ii) The effective capacitance of three capacitors of the same capacitance connected in series is 1 μF. Find

(1) The effective capacitance if they are connected in parallel.

(2) The ratio of energy stored in the parallel combination of the capacitors to that in the series combination, if the combinations are connected to the same source one by one.

32. (a) (i) What are the two main considerations for designing the objective and eyepiece lenses of an astronomical telescope? Obtain the expression for magnifying power of the telescope when the final image is formed at infinity.

(ii) A ray of light is incident at an angle of 45° at one face of an equilateral triangular prism and passes symmetrically through the prism. Calculate :

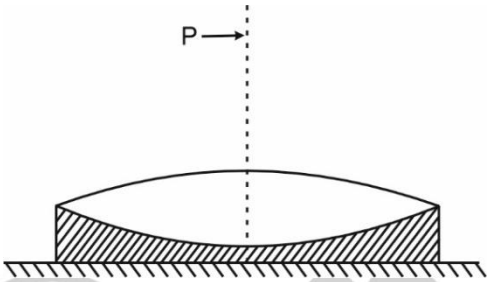
(1) The angle of deviation produced by the prism.

(2) The refractive index of the material of the prism.

OR

(b) (i) Describe a simple activity to observe diffraction pattern due to a single slit.

(ii) The figure below shows an equiconvex lens (of refractive index 1.50) in contact with a liquid layer on top of a plane mirror. A small needle on the principal axis is moved along the axis until its inverted image is found at the position of the needle. The distance of the needle from the lens is measured to be 45.0 cm. When the liquid is removed and the experiment is repeated, the new distance is 30.0 cm. Find the refractive index of the liquid.



33. (a) (i) A charged particle with speed v_0 enters a region in which a strong and non-uniform magnetic field exists everywhere. It comes out of the region following a complicated trajectory without suffering any collision in the region. Would its final speed v be equal to its initial speed v_0? Justify your answer.

(ii) In a region, a uniform magnetic field of 6×10^{-4} T is maintained. An electron enters the field with a speed of 3×10^6 ms^{-1} normal to the field. Find radius of its path. Also calculate its energy in eV.

OR

(b) (i) Derive an expression for the force acting on a conductor carrying current I in a magnetic field $\vec{B}$.

(ii) A long horizontal conductor carries a current of 30 A, in east to west direction. What are the magnitude and direction of the magnetic field due to the current 1.0 m below the conductor?

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