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Your JEE Guide

MP Board Class XII · Physics

Sample Question Paper 6 · Session 2026-27

Time allowed: 3 hours **Maximum marks: 70**

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This is an original practice paper written to the MPBSE 2027 sample question paper pattern; it is not issued by MPBSE.

General instructions:

1. All questions are compulsory.
2. Questions 1 to 5 are objective questions (28 in all): choose the correct option, fill in the blanks, true/false, match the columns and answer in one word or sentence. Each sub-question carries 1 mark.
3. Questions 6 to 12 are very short answer questions of 2 marks each. Answer each in about 30 words.
4. Questions 13 to 16 are short answer questions of 3 marks each. Answer each in about 75 words.
5. Questions 17 to 20 are long answer questions of 4 marks each. Answer each in about 120 words.
6. Internal options are given in questions 13 to 20.
7. Draw neat and labelled diagrams wherever necessary.
8. The general meanings of the symbols in the question paper are according to the textbook.

1.	**(i)** *Choose the correct option and write it:* The electric field at a point inside a uniformly charged thin spherical shell is: (a) infinite (b) the same as at its surface (c) zero (d) maximum	1
	(ii) One kilowatt-hour is equal to: (a) 3600 J (b) 3.6×10^6 J (c) 1000 J (d) 3.6×10^3 J	1
	(iii) The magnetic field lines around a long straight current-carrying wire are: (a) ellipses (b) straight lines radiating from the wire (c) straight lines parallel to the wire (d) concentric circles round the wire	1
	(iv) The frequency of direct current is: (a) zero (b) 60 Hz (c) infinite (d) 50 Hz	1
	(v) The power of a convex lens of focal length 25 cm is: (a) +4 D (b) +25 D (c) –4 D (d) +0.25 D	1

	(vi) The nuclear force between two protons is: (a) repulsive and long-ranged (b) attractive and long-ranged (c) zero (d) attractive and short-ranged	1
2.	**(i)** *Fill in the blanks:* The force between two charges in a medium of dielectric constant K is _____ of the force between them in vacuum.	1
	(ii) The SI unit of current density is _____.	1
	(iii) A charged particle at rest in a magnetic field experiences _____ force.	1
	(iv) The emf induced in a coil because of a changing current in a neighbouring coil is due to _____.	1
	(v) The refractive index of a medium is the ratio of the speed of light in vacuum to its speed in the _____.	1
	(vi) At a p-n junction, the region with no free charge carriers is called the _____ layer.	1
3.	Match each kind of electromagnetic wave in column A with its use in column B:	6

Column A	Column B
(i) Radio waves	(a) radio and television broadcasting
(ii) Microwaves	(b) detecting bone fractures
(iii) Infrared waves	(c) radar
(iv) Visible light	(d) remote controls of TV sets
(v) Ultraviolet rays	(e) sterilising drinking water
(vi) X-rays	(f) seeing objects

4.	**(i)** *Write True or False:* The SI unit of electric charge is the ampere.	1
	(ii) Electric current is a scalar quantity.	1
	(iii) An induced current always helps the change that produces it.	1
	(iv) For an object at 2F in front of a convex lens, the image is formed at 2F on the other side.	1
	(v) A photon has momentum.	1
5.	**(i)** *Answer in one word or one sentence:* Write the value of the permittivity of free space.	1
	(ii) Name the rule used to find the direction of the force on a current-carrying conductor in a magnetic field.	1

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	(iii) What is the phase difference between the voltage and the current in a pure resistor?	1
	(iv) What kind of wavefront reaches us from a very distant point source?	1
	(v) Name the particle that has no charge and almost the same mass as a proton.	1
6.	Write two basic properties of electric charge.	2
7.	Find the electric field 30 cm from a point charge of 3×10^{-9} C in air. ($k = 9 \times 10^9$ N m^2 C^{-2})	2
8.	Define relaxation time. How does it change when the temperature of a metal rises?	2
9.	A circular coil of 50 turns and radius 10 cm carries a current of 2 A. Find the magnetic field at its centre. ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})	2
10.	Define mutual inductance. Write its SI unit.	2
11.	Why are microwaves suitable for radar systems?	2
12.	Write two differences between a photon and an electron.	2
13.	Derive the relation between electric field and electric potential, $E = -dV/dr$. What does the negative sign show? **OR** Charges of +4 μC and −1 μC are placed at x = 0 and x = 15 cm. Find the points on the x-axis where the electric potential is zero.	3
14.	A bulb is rated 60 W, 220 V. Find its resistance, the current through it and the electrical energy it uses in 5 hours. **OR** Why is the terminal voltage of a cell less than its emf when it supplies a current? A cell of emf 1.5 V and internal resistance 0.5 Ω supplies a current of 1 A. Find its terminal voltage.	3
15.	Starting from the force on a moving charge, derive the expression for the force on a straight conductor of length l carrying a current I in a uniform magnetic field B. **OR** Define magnetisation and magnetic intensity. Write the relation between B, H and M.	3
16.	An alternating voltage $v = v_0 \sin \omega t$ is applied to a pure inductor. Show that the current lags the voltage by π/2 and write the inductive reactance. **OR** Explain the oscillation of energy in an LC circuit. Write the frequency of the oscillations.	3

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17.	Two large, thin, parallel plane sheets carry uniform surface charge densities +σ and −σ. Using Gauss's law, find the electric field (a) between the sheets, (b) outside them. **OR** State four properties of a conductor in electrostatic equilibrium.	4
18.	Derive the expressions for the torque on a magnetic dipole in a uniform magnetic field and its potential energy. When is the dipole in stable equilibrium? **OR** Define the current sensitivity and the voltage sensitivity of a moving-coil galvanometer. Does increasing the current sensitivity always increase the voltage sensitivity? Explain.	4
19.	Derive the relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ for refraction at a convex spherical surface separating media of refractive indices n_1 and n_2. **OR** Explain how a simple microscope gives a magnified image, with a ray diagram, and derive its magnifying power when the image is at the near point.	4
20.	Draw graphs of photoelectric current against anode potential (a) for different intensities of light of the same frequency, (b) for different frequencies of light of the same intensity. What does each graph show? **OR** Calculate the binding energy and the binding energy per nucleon of the helium nucleus $^{4}_{2}\mathrm{He}$. (mass of hydrogen atom = 1.00783 u, neutron = 1.00867 u, helium atom = 4.00260 u, 1 u = 931.5 MeV)	4

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Answers and Marking Scheme

Marks for each step are shown in brackets. Any correct alternative method gets full credit.

Question 1

(i) **(c)** zero. *Working:* A Gaussian surface inside encloses no charge.

(ii) **(b)** 3.6×10^6 J. *Working:* 1000 W × 3600 s.

(iii) **(d)** concentric circles round the wire. *Working:* The right-hand thumb rule gives their direction.

(iv) **(a)** zero. *Working:* Direct current does not change direction.

(v) **(a)** +4 D. *Working:* P = 1/f = 1/0.25 m.

(vi) **(d)** attractive and short-ranged. *Working:* At about 1 fm the strong attraction greatly exceeds their electrostatic repulsion.

Question 2

(i) 1/K times.

(ii) A m^{-2}.

(iii) no (zero).

(iv) mutual induction.

(v) medium.

(vi) depletion.

3. (i) – (a) radio and television broadcasting; (ii) – (c) radar; (iii) – (d) remote controls of TV sets; (iv) – (f) seeing objects; (v) – (e) sterilising drinking water; (vi) – (b) detecting bone fractures

Question 4

(i) False: it is the coulomb.

(ii) True: it has a direction but does not add by vector rules.

(iii) False: it opposes the change (Lenz's law).

(iv) True.

(v) True: $p = h/\lambda$.

Question 5

(i) 8.854×10^{-12} C^2 N^{-1} m^{-2}.

(ii) Fleming's left-hand rule.

(iii) Zero.

(iv) A plane wavefront.

(v) The neutron.

6. Any two: charge is quantised (q = ne); it is conserved; it is additive (the total is the algebraic sum) (1 + 1).

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7. $E = kq/r^2$ (1) $= 9 \times 10^9 \times 3 \times 10^{-9}/0.09 = 300$ N C^{-1} (1).

8. The average time between successive collisions of a free electron with the ions (1). It decreases, because the ions vibrate more and collisions become more frequent (1).

9. $B = \mu_0 NI/(2R)$ (1) $= 4\pi \times 10^{-7} \times 50 \times 2/0.2 \approx 6.28 \times 10^{-4}$ T (1).

10. The magnetic flux linked with one coil per unit current in the other coil, $\Phi_2 = MI_1$ (or the emf in one per unit rate of change of current in the other) (1). SI unit: henry (1).

11. Their short wavelengths let them be sent out as narrow beams (1), and they are reflected well by aircraft and other objects, so their distance and direction can be found (1).

12. A photon has no rest mass and no charge; an electron has rest mass and a negative charge (1). A photon always travels at the speed of light in vacuum; an electron moves at less than that speed (1).

13. Moving a unit positive charge through dr against the field E needs work $-E\,dr$, which equals the change in potential dV (1). So $E = -dV/dr$ (1). The field points in the direction in which the potential decreases most rapidly (1).

OR Between the charges, at distance x from the origin: $4/x = 1/(15 - x)$, so x = 12 cm (1½). Beyond the −1 μC charge: $4/x = 1/(x - 15)$, so x = 20 cm (1½).

14. $R = V^2/P = 48400/60 \approx 807\ \Omega$ (1). $I = P/V \approx 0.27$ A (1). Energy = 0.060 kW × 5 h = 0.3 kWh (1).

OR Part of the emf is used to drive the current through the internal resistance of the cell (1). $V = \varepsilon - Ir$ (1) $= 1.5 - 1 \times 0.5 = 1.0$ V (1).

15. Each charge carrier experiences $q\vec{v}_d \times \vec{B}$ (1). The number of carriers in the conductor is nAl, so $\vec{F} = nAl\,q\,\vec{v}_d \times \vec{B}$ (1). Since $I = nqAv_d$, $\vec{F} = I\vec{l} \times \vec{B}$, of magnitude BIl sin θ (1).

OR Magnetisation M is the net magnetic moment per unit volume of a material (1). Magnetic intensity H is defined by $H = B_0/\mu_0$, where B_0 is the field of the external current (1). $B = \mu_0(H + M)$ (1).

16. $v = L\,di/dt$, so $di = (v_0/L) \sin \omega t\,dt$ (1). $i = -(v_0/\omega L) \cos \omega t = i_0 \sin(\omega t - \pi/2)$: the current lags by π/2 (1). $i_0 = v_0/(\omega L)$, so $X_L = \omega L$ (1).

OR A charged capacitor discharges through the inductor; its electric energy becomes magnetic energy of the current (1). The current then charges the capacitor in the opposite direction, and the process repeats (1). Frequency $\nu = 1/(2\pi\sqrt{(LC)})$ (1).

17. One sheet alone gives $E = \sigma/(2\varepsilon_0)$, directed away from a positive sheet and towards a negative one (1½). (a) Between the sheets the two fields are in the same direction: $E = \sigma/\varepsilon_0$, from the positive to the negative sheet (1½). (b) Outside, they are equal and opposite: E = 0 (1).

OR The electric field inside the conductor is zero (1). Any excess charge resides on the outer surface (1). The field just outside the surface is normal to it (1). The whole conductor is at the same potential (1).

18. Forces on the two poles form a couple: τ = mB sin θ, i.e. $\vec{\tau} = \vec{m} \times \vec{B}$ (1½). Work done in turning it: $U = -\int mB \sin\theta\,d\theta$, taking zero at θ = 90°, gives $U = -mB \cos\theta = -\vec{m} \cdot \vec{B}$ (1½). Stable equilibrium is at θ = 0, where U is least (1).

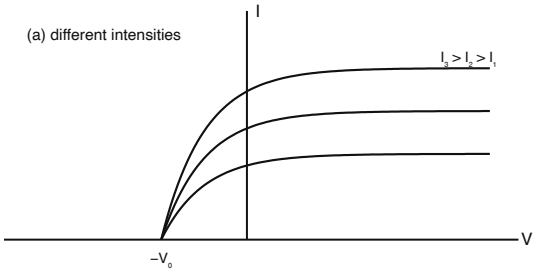
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OR Current sensitivity: deflection per unit current, $\phi/I = NAB/k$ (1). Voltage sensitivity: deflection per unit voltage, $\phi/V = NAB/(kR)$ (1). Doubling N doubles the current sensitivity (1), but it also doubles the coil's resistance R, so the voltage sensitivity stays the same (1).

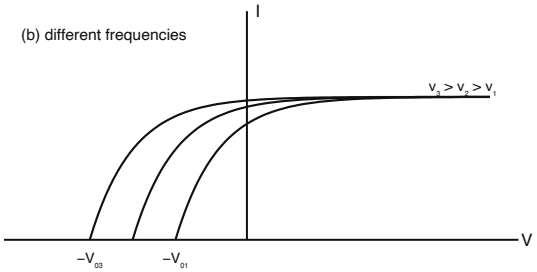
19. Ray diagram: a ray from O on the axis meets the surface at N and is refracted towards I; C is the centre of curvature (1). For small angles, $i = \alpha + \gamma$ and $r = \gamma - \beta$, where α, β and γ are the angles at O, I and C (1). Snell's law for small angles: $n_1 i = n_2 r$, so $n_1(\alpha + \gamma) = n_2(\gamma - \beta)$ (1). Using $\alpha = MN/OM$, $\beta = MN/MI$, $\gamma = MN/MC$ and the sign convention gives the result (1).

OR An object placed inside the focus of a convex lens gives an erect, magnified, virtual image (1). Ray diagram (1). Image at the near point, $v = -D$: from the lens formula, $m = v/u = 1 - v/f$ (1) $= 1 + D/f$ (1).

20. (a) Graph (1):



The saturation current increases with intensity but the stopping potential is the same (1). (b) Graph (1):



The stopping potential is larger for higher frequency, while the saturation current is the same (1).

OR Mass defect $\Delta m = 2(1.00783) + 2(1.00867) - 4.00260$ (1) $= 0.03040$ u (1). Binding energy $= 0.03040 \times 931.5 \approx 28.3$ MeV (1). Per nucleon ≈ 7.07 MeV (1).

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