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Your JEE Guide

MP Board Class XII · Physics

Sample Question Paper 5 · 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 SI unit of the permittivity of free space, ε_0, is: (a) N m^2 C^{-2} (b) N C^{-1} (c) C^2 N^{-1} m^{-2} (d) C N^{-1} m^{-1}	1
	(ii) The resistance of an ideal voltmeter is: (a) infinite (b) about 1 Ω (c) zero (d) equal to that of the circuit	1
	(iii) The core of an electromagnet is made of: (a) steel (b) soft iron (c) copper (d) aluminium	1
	(iv) The peak value of a 220 V (rms) alternating voltage is about: (a) 440 V (b) 156 V (c) 220 V (d) 311 V	1
	(v) In Young's double-slit experiment, the separation between the slits is doubled. The fringe width: (a) is doubled (b) becomes four times (c) stays the same (d) is halved	1

	(vi) For light of a fixed frequency above the threshold, the photoelectric current is proportional to the: (a) intensity of the light (b) stopping potential (c) work function of the metal (d) wavelength of the light	1
2.	**(i)** *Fill in the blanks:* Electric field lines start from _____ charges and end on negative charges.	1
	(ii) The SI unit of electrical conductivity is _____.	1
	(iii) The magnetic field of a long straight current-carrying wire at distance r is proportional to _____.	1
	(iv) The core of a transformer is laminated to reduce _____ losses.	1
	(v) Light travels faster in a medium of _____ refractive index.	1
	(vi) Silicon and germanium are _____ elements.	1
3.	Match each quantity in column A with the correct relation in column B:	6

Column A	Column B
(i) Current and drift velocity	(a) $E = mc^2$
(ii) Heat produced per second in a resistor	(b) $n_1 \sin i = n_2 \sin r$
(iii) Force on a current-carrying wire in a magnetic field	(c) $P = I^2 R$
(iv) Resonant frequency of an LCR circuit	(d) $F = BIl \sin\theta$
(v) Snell's law	(e) $I = neAv_d$
(vi) Mass–energy equivalence	(f) $\nu_0 = \frac{1}{2\pi\sqrt{LC}}$

4.	**(i)** *Write True or False:* Electric charge is quantised.	1
	(ii) Ohm's law holds for all conductors.	1
	(iii) Soft iron is used to make permanent magnets.	1
	(iv) A concave mirror can form a virtual image.	1
	(v) Germanium is a trivalent element.	1
5.	**(i)** *Answer in one word or one sentence:* Name the device used to store electric charge.	1
	(ii) What happens to the resistance of a wire when its length is doubled, the area staying the same?	1
	(iii) Name the electromagnetic waves used in LASIK eye surgery.	1

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	(iv) What is the focal length of a plane mirror?	1
	(v) Which charge carriers are the minority carriers in an n-type semiconductor?	1
6.	Define electric dipole moment. Is it a scalar or a vector? Write its SI unit.	2
7.	A heater is rated 1100 W, 220 V. Find the current it draws and its resistance.	2
8.	Two long parallel wires 10 cm apart each carry a current of 5 A in the same direction. Find the force per metre between them and state whether it is attractive or repulsive.	2
9.	Define power factor. Why is the power factor of a pure inductor zero?	2
10.	Write two characteristics of electromagnetic waves.	2
11.	An object is placed 10 cm in front of a convex mirror of focal length 15 cm. Find the position and magnification of the image.	2
12.	State two differences between intrinsic and extrinsic semiconductors.	2
13.	State Gauss's law. A charge q is placed at the centre of a cube. Find the electric flux through the whole cube and through one face. **OR** Draw the equipotential surfaces for (a) a point charge, (b) a uniform electric field. Why do equipotential surfaces never intersect?	3
14.	Derive Ohm's law starting from the drift velocity of electrons, and express the conductivity in terms of the relaxation time. **OR** A copper wire 2.0 m long with a cross-sectional area of 1.0 mm^2 has a resistance of 0.034 Ω. Calculate the resistivity of copper.	3
15.	The magnetic flux through a coil varies with time as $\Phi = (3t^2 + 2t)$ Wb, where t is in seconds. Find the magnitude of the induced emf at t = 2 s. State the law you use. **OR** An alternating voltage $v = v_0 \sin \omega t$ is applied to a pure capacitor. Show that the current leads the voltage by π/2, and write the capacitive reactance.	3
16.	State three differences between the interference pattern of Young's double-slit experiment and the diffraction pattern of a single slit. **OR** A compound microscope has an objective of focal length 1 cm and an eyepiece of focal length 5 cm, with a tube length of 20 cm. Estimate its magnifying power when the final image is at the near point. (D = 25 cm)	3

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17.	Derive the expression for the electrostatic potential energy of a system of two point charges. Charges of +2 μC, −2 μC and +2 μC are placed at the corners of an equilateral triangle of side 30 cm. Find the potential energy of the system. **OR** Derive the expression for the torque on an electric dipole in a uniform electric field. When is the torque maximum?	4
18.	Use Ampere's circuital law to find the magnetic field inside a long solenoid. How does the field outside compare? **OR** A galvanometer of resistance 20 Ω shows full-scale deflection for 5 mA. What must be done to use it as a voltmeter reading up to 5 V? Draw the circuit.	4
19.	Derive the mirror equation for a concave mirror forming a real image. **OR** Two coherent waves of equal intensity I_0 meet with a phase difference ϕ. Show that the resultant intensity is $I = 4I_0 \cos^2(\phi/2)$. Write the conditions for constructive and destructive interference.	4
20.	Draw the energy level diagram of the hydrogen atom and show the transitions that give the Lyman, Balmer and Paschen series. In which region of the spectrum does each lie? **OR** State de Broglie's hypothesis. What did the Davisson–Germer experiment show? Why are de Broglie waves not noticed for everyday objects?	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)** $C^2\,N^{-1}\,m^{-2}$. *Working:* From $F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$, $\varepsilon_0 = q^2/(Fr^2)$.

(ii) **(a)** infinite. *Working:* It should draw no current from the circuit.

(iii) **(b)** soft iron. *Working:* Soft iron magnetises and demagnetises easily (low retentivity).

(iv) **(d)** 311 V. *Working:* $V_0 = \sqrt{2} \times 220$.

(v) **(d)** is halved. *Working:* $\beta = \lambda D/d$.

(vi) **(a)** intensity of the light. *Working:* More photons per second eject more electrons per second.

Question 2

(i) positive.

(ii) $S\,m^{-1}$ (siemens per metre).

(iii) 1/r.

(iv) eddy-current.

(v) lower.

(vi) tetravalent.

3. (i) – (e) $I = nAev_d$; (ii) – (c) $P = I^2R$; (iii) – (d) $F = BIl\sin\theta$; (iv) – (f) $\nu_0 = \frac{1}{2\pi\sqrt{LC}}$; (v) – (b) $n_1 \sin i = n_2 \sin r$; (vi) – (a) $E = mc^2$

Question 4

(i) True: every charge is a whole-number multiple of e.

(ii) False: it does not hold for devices such as diodes.

(iii) False: steel is used; soft iron loses its magnetism easily.

(iv) True: when the object is between the pole and the focus.

(v) False: it is tetravalent.

Question 5

(i) A capacitor.

(ii) It doubles.

(iii) Ultraviolet rays.

(iv) Infinite.

(v) Holes.

6. The product of either charge and the distance between the charges, $p = q \times 2a$, directed from $-q$ to $+q$ (1). It is a vector; SI unit C m (1).

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7. I = P/V = 5 A (1). R = V/I = 44 Ω (1).

8. $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d} = \frac{2\times10^{-7}\times25}{0.1}$ = 5 × 10^{-5} N m^{-1} (1). Currents in the same direction attract (1).

9. The cosine of the phase angle between voltage and current, cos ϕ (= R/Z) (1). In a pure inductor the current lags the voltage by 90°, so cos ϕ = 0 (1).

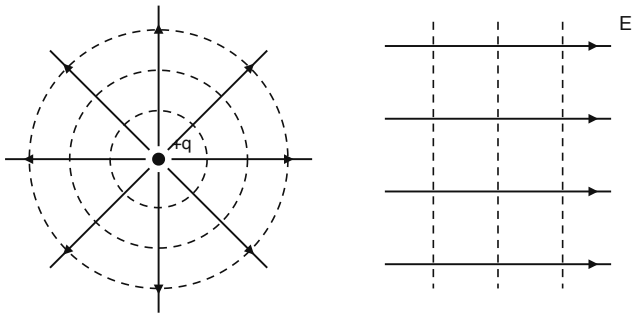
10. Any two: they are transverse; the electric and magnetic fields are at right angles to each other and to the direction of travel; they travel at 3 × 10^8 m s^{-1} in vacuum; they need no medium (1 + 1).

11. $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{15} + \frac{1}{10} = \frac{1}{6}$, v = +6 cm, behind the mirror (1). m = –v/u = 0.6: virtual, erect and diminished (1).

12. An intrinsic semiconductor is pure; an extrinsic one is doped with impurity (1). In an intrinsic semiconductor the numbers of electrons and holes are equal and conductivity is low; in an extrinsic one they are unequal and conductivity is much higher (1).

13. The total flux through a closed surface equals the enclosed charge divided by ε_0 (1). Through the cube: q/ε_0 (1). By symmetry, through each of the six faces: $q/(6\varepsilon_0)$ (1).

OR Diagrams (2):



(a) point charge (b) uniform field

solid lines: field lines; dashed lines: equipotential surfaces

At an intersection the potential would have two values, and the field two directions, which is impossible (1).

14. v_d = eEτ/m (1). I = neAv_d = $\frac{ne^2\tau A}{m}E$; with E = V/l, I = $\frac{ne^2\tau A}{ml}V$, so V ∝ I, which is Ohm's law (1). Conductivity σ = $ne^2\tau/m$, and J = σE (1).

OR ρ = RA/l (1) = 0.034 × 1.0 × 10^{-6} / 2.0 (1) = 1.7 × 10^{-8} Ω m (1).

15. Faraday's law: the induced emf equals the rate of change of magnetic flux, ε = –dΦ/dt (1). dΦ/dt = 6t + 2 (1). At t = 2 s, |ε| = 14 V (1).

OR q = Cv_0 sin ωt (1). i = dq/dt = ωCv_0 cos ωt = i_0 sin(ωt + π/2), so the current leads by π/2 (1). i_0 = v_0/(1/ωC), so X_C = 1/(ωC) (1).

16. Interference fringes are of equal width; in diffraction the central maximum is twice as wide as the others (1). In interference all bright fringes have about the same intensity; in diffraction the intensity falls off rapidly (1). Interference comes from two separate coherent sources; diffraction from wavelets of different parts of the same wavefront (1).

OR m ≈ $\frac{L}{f_o}\left(1 + \frac{D}{f_e}\right)$ (1) = 20 × (1 + 5) (1) = 120 (1).

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17. Bringing q_2 from infinity to distance r from q_1 needs work $q_2 \times \frac{q_1}{4\pi\varepsilon_0 r}$, so $U = \frac{q_1 q_2}{4\pi\varepsilon_0 r}$ (2). Sum over the three pairs: U = $\frac{k}{a}(-4 - 4 + 4) \times 10^{-12}$ = 9 × 10^9 × (–4 × 10^{-12})/0.3 (1) = –0.12 J (1).

OR The forces qE and –qE on the charges are equal and opposite, so the net force is zero (1). They form a couple of arm 2a sin θ (1). τ = qE × 2a sin θ = pE sin θ, i.e. $\vec{\tau} = \vec{p} \times \vec{E}$ (1). It is maximum, pE, when the dipole is at right angles to the field (1).

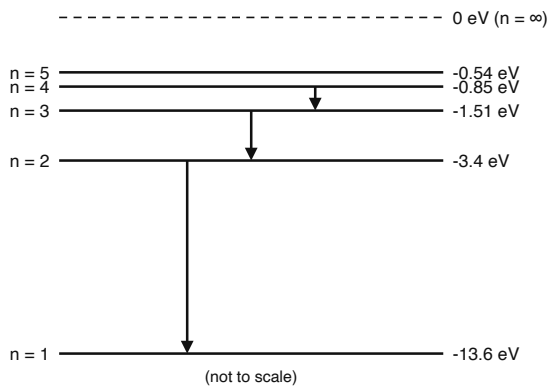
18. Take a rectangular loop with one side of length l inside the solenoid, parallel to its axis (1). Only that side contributes: Bl = μ_0(nl)I (1½). So B = μ_0nI, uniform inside (1). Outside, the field is nearly zero (½).

OR A high resistance R is connected in series (1). Total resistance needed = V/I_g = 5/0.005 = 1000 Ω (1). R = 1000 – 20 = 980 Ω (1). Circuit: the galvanometer in series with 980 Ω, connected across the points whose potential difference is measured (1).

19. Ray diagram with an object AB beyond C, the image A′B′, and the rays through the pole and parallel to the axis (1). Similar triangles A′B′P and ABP give A′B′/AB = PB′/PB (1). Similar triangles A′B′F and MPF (with MP ≈ AB for a small aperture) give A′B′/AB = B′F/FP (1). Equating and using sign conventions (PB′ = –v, PB = –u, FP = –f) gives $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ (1).

OR Displacements y_1 = a cos ωt and y_2 = a cos(ωt + ϕ) add to y = 2a cos(ϕ/2) cos(ωt + ϕ/2) (1). The amplitude is 2a cos(ϕ/2), so I ∝ 4a^2 $\cos^2$(ϕ/2), i.e. I = 4I_0 $\cos^2$(ϕ/2) (1). Constructive: ϕ = 2nπ (path difference nλ), I = 4I_0 (1). Destructive: ϕ = (2n + 1)π (path difference (n + ½)λ), I = 0 (1).

20. Energy level diagram with E_n = –13.6/n^2 eV (2):



Lyman: transitions to n = 1, ultraviolet; Balmer: to n = 2, visible; Paschen: to n = 3, infrared (2).

OR Moving matter has wave nature, with wavelength λ = h/p (1). Electrons scattered from a nickel crystal showed a strong peak at a particular angle, a diffraction effect (1), and the wavelength calculated from it agreed with h/p (1). For large objects p is so large that λ is far too small to detect (1).

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