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Your JEE Guide

MP Board Class XII · Physics

Sample Question Paper 2 · 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 potential due to a point charge at a distance r varies as: (a) $\frac{1}{r}$ (b) $\frac{1}{r^3}$ (c) r (d) $\frac{1}{r^2}$	1
	(ii) The SI unit of resistivity is: (a) S m^{-1} (b) Ω (c) Ω m (d) Ω m^{-1}	1
	(iii) The SI unit of magnetic field is the: (a) gauss (b) tesla (c) henry (d) weber	1
	(iv) The power factor of an a.c. circuit containing only a resistor is: (a) 0 (b) 0.5 (c) infinite (d) 1	1
	(v) When white light passes through a glass prism, the colour deviated most is: (a) yellow (b) violet (c) red (d) green	1

	(vi) The binding energy per nucleon is greatest for nuclei around: (a) helium (A = 4) (b) hydrogen (A = 1) (c) uranium (A = 238) (d) iron (A ≈ 56)	1
2.	**(i)** *Fill in the blanks:* The electric field inside a charged conductor in electrostatic equilibrium is _____.	1
	(ii) A charged particle moving at right angles to a uniform magnetic field follows a _____ path.	1
	(iii) The SI unit of magnetic dipole moment is _____.	1
	(iv) Electromagnetic waves are _____ in nature.	1
	(v) The superposition of light waves from two coherent sources to give bright and dark fringes is called _____.	1
	(vi) An n-type semiconductor is made by doping silicon with a _____ impurity.	1
3.	Match each quantity in column A with its SI unit in column B:	6

Column A	Column B
(i) Capacitance	(a) weber
(ii) Resistance	(b) ohm
(iii) Magnetic field	(c) farad
(iv) Self-inductance	(d) tesla
(v) Power of a lens	(e) dioptre
(vi) Magnetic flux	(f) henry

4.	**(i)** *Write True or False:* Electric potential is a vector quantity.	1
	(ii) A moving charge produces a magnetic field.	1
	(iii) Eddy currents are used to heat metals in an induction furnace.	1
	(iv) The focal length of a lens is the same for all colours of light.	1
	(v) A photodiode is operated in reverse bias.	1
5.	**(i)** *Answer in one word or one sentence:* Write the SI unit of electric field.	1
	(ii) Name the law that relates the induced emf to the rate of change of magnetic flux.	1
	(iii) Which electromagnetic waves are used in water purifiers to kill germs?	1

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	(iv) Write the magnitude of the charge on an electron.	1
	(v) What are the electrons emitted in the photoelectric effect called?	1
6.	Define the capacitance of a conductor. Write its SI unit.	2
7.	Two point charges of 2 μC and 4 μC are placed 30 cm apart in air. Calculate the force between them. ($k = 9 \times 10^9$ N m² C^{-2})	2
8.	Define resistivity. On what factors does the resistivity of a conductor depend?	2
9.	A straight wire 0.5 m long carries a current of 2 A at right angles to a uniform magnetic field of 0.4 T. Find the force on the wire.	2
10.	What are eddy currents? Give two uses of them.	2
11.	Two thin lenses of power +4 D and –2 D are placed in contact. Find the power and focal length of the combination.	2
12.	An electron starts from rest and is accelerated by 150 V. What is its de Broglie wavelength?	2
13.	Derive the expression for the electric potential at a distance r from a point charge q. **OR** Capacitors of 2 μF, 3 μF and 6 μF are connected (a) in series, (b) in parallel. Find the equivalent capacitance in each case. If the series combination is connected to 10 V, find the energy stored.	3
14.	Draw a Wheatstone bridge and derive its condition of balance. **OR** What is drift velocity? Derive the relation $I = neAv_d$.	3
15.	State the principle of an a.c. generator and show that the emf it produces is $\varepsilon = NBA\omega \sin \omega t$. **OR** State the principle of a transformer. Why is its core laminated?	3
16.	Light passes through a prism of angle A, and the angle of minimum deviation is D. Show that the refractive index is $n = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$. **OR** Use Huygens' principle to obtain the law of refraction.	3
17.	Derive the expression for the electric field at a point on the axial line of an electric dipole. How does it vary with distance at large distances? **OR** Show that the energy stored in a capacitor is $U = \frac{1}{2}CV^2$. Hence write the energy density of the electric field in a parallel-plate capacitor.	4

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18.	State Ampere's circuital law. Use it to find the magnetic field at a distance r from an infinitely long straight wire carrying a current I. **OR** Distinguish between diamagnetic, paramagnetic and ferromagnetic substances, giving one example of each, and describe how each behaves in an external magnetic field.	4
19.	In Young's double-slit experiment, write the conditions for bright and dark fringes and derive the expression for the fringe width. **OR** Explain the diffraction of light at a single slit. Write the condition for the minima and draw the intensity pattern.	4
20.	Describe the experimental observations on the photoelectric effect, and explain them using Einstein's photoelectric equation. **OR** Draw the energy band diagrams of a conductor, an insulator and a semiconductor, and use them to explain the difference in their electrical conductivity.	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) **(a)** $\frac{1}{r}$. *Working:* $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$.

(ii) **(c)** Ω m. *Working:* $\rho = \frac{RA}{l}$: Ω × m² / m.

(iii) **(b)** tesla. *Working:* 1 T = 1 N A^{-1} m^{-1}; the gauss is a non-SI unit.

(iv) **(d)** 1. *Working:* Voltage and current are in phase, so cos ϕ = 1.

(v) **(b)** violet. *Working:* The refractive index of glass is greatest for violet light.

(vi) **(d)** iron (A ≈ 56). *Working:* The binding-energy curve peaks near A = 56, which is why such nuclei are most stable.

Question 2

(i) zero.

(ii) circular.

(iii) A m² (or J T^{-1}).

(iv) transverse.

(v) interference.

(vi) pentavalent (e.g. phosphorus or arsenic).

3. (i) – (c) farad; (ii) – (b) ohm; (iii) – (d) tesla; (iv) – (f) henry; (v) – (e) dioptre; (vi) – (a) weber

Question 4

(i) False: it is a scalar.

(ii) True.

(iii) True.

(iv) False: it varies with colour because the refractive index does.

(v) True.

Question 5

(i) N C^{-1} (or V m^{-1}).

(ii) Faraday’s law of electromagnetic induction.

(iii) Ultraviolet rays.

(iv) 1.6 × 10^{-19} C.

(v) Photoelectrons.

6. The ratio of the charge given to the conductor to the rise in its potential, C = Q/V (1). SI unit: farad (F) (1).

7. $F = k\frac{q_1 q_2}{r^2} = \frac{9\times10^{9}\times8\times10^{-12}}{0.09}$ (1) = 0.8 N, repulsive (1).

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8. The resistance of a conductor of unit length and unit cross-sectional area (ρ = RA/l) (1). It depends on the material and the temperature, not on the dimensions (1).

9. F = BIl sin 90° (1) = 0.4 × 2 × 0.5 = 0.4 N (1).

10. Currents induced in the body of a conductor when the magnetic flux through it changes (1). Any two: magnetic braking in trains, electromagnetic damping in galvanometers, induction furnaces, electric power meters (1).

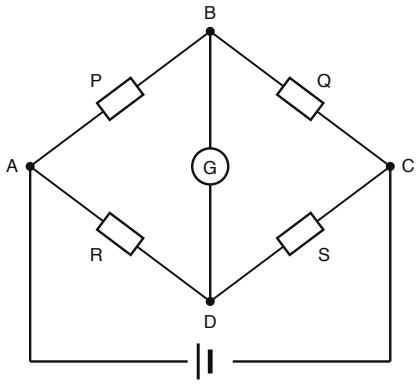
11. P = P_1 + P_2 = +2 D (1). f = 1/P = 0.5 m = 50 cm, a converging combination (1).

12. $\lambda = \frac{1.227}{\sqrt{V}}$ nm (1) $= \frac{1.227}{12.25} \approx 0.100$ nm (1).

13. The potential is the work done in bringing a unit positive charge from infinity to the point: $V = -\int_{\infty}^{r} \vec{E} \cdot d\vec{r}$ (1). With $E = \frac{q}{4\pi\varepsilon_0 r^2}$ (1), $V = -\int_{\infty}^{r} \frac{q}{4\pi\varepsilon_0 r^2} dr = \frac{q}{4\pi\varepsilon_0 r}$ (1).

OR (a) 1/C = 1/2 + 1/3 + 1/6 = 1, C = 1 μF (1). (b) C = 11 μF (1). U = ½CV² = ½ × 1 × 10^{-6} × 100 = 5 × 10^{-5} J (1).

14. Bridge diagram (1):

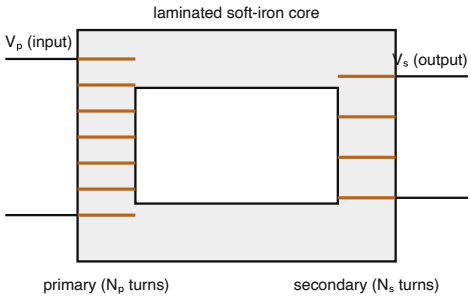


At balance no current flows through the galvanometer, so B and D are at the same potential (1). Applying Kirchhoff's loop rule to the two loops gives $I_1P = I_2R$ and $I_1Q = I_2S$, so P/Q = R/S (1).

OR The average velocity with which free electrons drift opposite to the applied field (1). In time Δt the electrons in a length $v_d\Delta t$ pass a cross-section: their number is $nAv_d\Delta t$ and charge $neAv_d\Delta t$ (1). I = charge/time = $neAv_d$ (1).

15. Principle: electromagnetic induction; a coil rotating in a magnetic field has a changing flux through it (1). Flux Φ = NBA cos ωt (1). ε = −dΦ/dt = NBAω sin ωt (1).

OR Mutual induction: an alternating current in the primary produces a changing flux that induces an emf in the secondary (1).

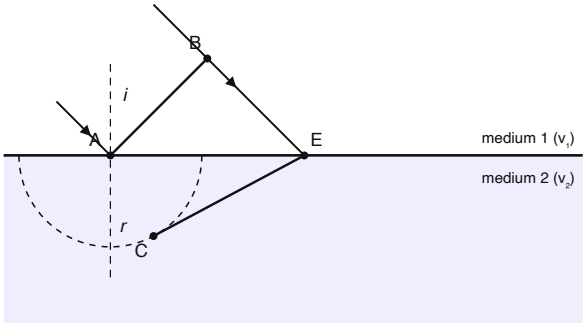


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$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (1). Lamination reduces eddy currents in the core and so reduces energy loss (1).

16. At minimum deviation the ray passes symmetrically: i = e and $r_1 = r_2 = r$ (1). Since $r_1 + r_2 = A$, r = A/2; and A + D = i + e = 2i, so i = (A + D)/2 (1). By Snell's law n = sin i / sin r gives the result (1).

OR Diagram (1):



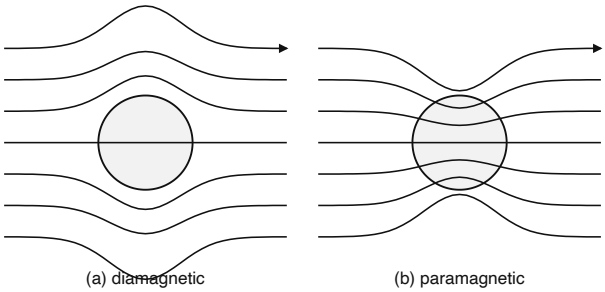
While the disturbance at one end of the incident wavefront travels BC = v_1t in medium 1, the secondary wavelet from A travels AE = v_2t in medium 2 (1). From the triangles, sin i = BC/AC and sin r = AE/AC, so sin i / sin r = $v_1/v_2 = n_{21}$, a constant (1).

17. For charges −q and +q at distance 2a and a point at distance r from the centre on the axis, $E_{+q} = \frac{q}{4\pi\varepsilon_0(r-a)^2}$ and $E_{-q} = \frac{q}{4\pi\varepsilon_0(r+a)^2}$ in opposite directions (1). $E = \frac{q}{4\pi\varepsilon_0} \cdot \frac{4ar}{(r^2-a^2)^2}$ (1) $= \frac{2pr}{4\pi\varepsilon_0(r^2-a^2)^2}$ (1). For r ≫ a, $E = \frac{2p}{4\pi\varepsilon_0 r^3}$: it falls as $1/r^3$ (1).

OR Work to move charge dq against potential q/C is dW = (q/C) dq (1). $U = \int_0^Q \frac{q}{C} dq = \frac{Q^2}{2C} = \frac{1}{2}CV^2$ (1). For a parallel-plate capacitor, C = $\varepsilon_0 A/d$ and V = Ed, so U = $\tfrac{1}{2}\varepsilon_0 E^2(Ad)$ (1). Energy density u = U/(Ad) = $\tfrac{1}{2}\varepsilon_0 E^2$ (1).

18. The line integral of the magnetic field around a closed loop equals μ_0 times the current threaded by the loop: $\oint \vec{B} \cdot d\vec{l} = \mu_0 I$ (1½). Take a circle of radius r centred on the wire; B is tangential and constant on it (1). B × 2πr = μ_0I, so $B = \frac{\mu_0 I}{2\pi r}$ (1½).

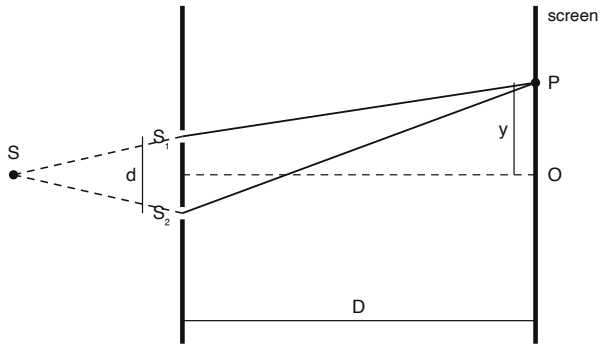
OR Diagram of field lines (1):



Diamagnetic substances are weakly repelled and push field lines out, e.g. bismuth, copper (1). Paramagnetic substances are weakly attracted and draw field lines in slightly, e.g. aluminium, sodium (1). Ferromagnetic substances are strongly attracted and concentrate the field lines, e.g. iron, cobalt, nickel (1).

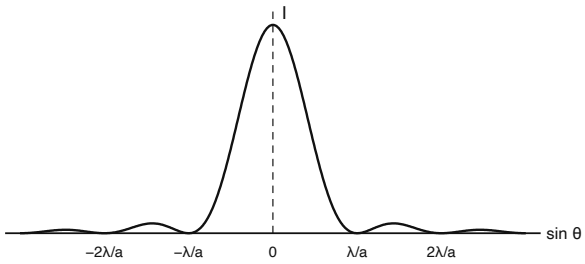
19. Diagram (1):

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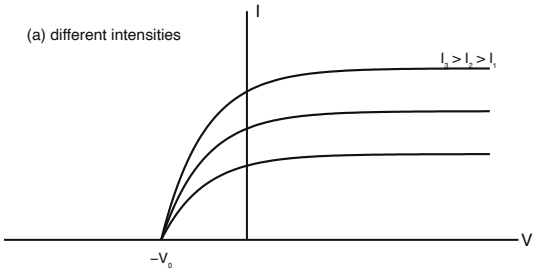
Path difference at a point y on the screen is $\frac{yd}{D}$ (1). Bright: $\frac{yd}{D} = n\lambda$, so $y_n = \frac{n\lambda D}{d}$; dark: $\frac{yd}{D} = (n + \frac{1}{2})\lambda$ (1). Fringe width $\beta = y_{n+1} - y_n = \frac{\lambda D}{d}$ (1).

OR Light from different parts of the slit reaches a point on the screen with different path differences (1). Minima occur where a sin θ = nλ (n = ±1, ±2, …) (1). The central maximum is bright and twice as wide as the others, which become fainter (1).



(diagram, 1)

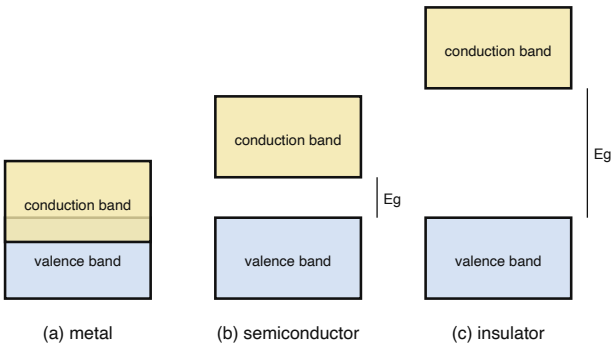
20. Graphs (1):



The photocurrent is proportional to the intensity; emission occurs only above a threshold frequency; the maximum kinetic energy depends on the frequency, not the intensity; emission is instantaneous (1½). Einstein: each photon of energy hv gives its energy to one electron, $K_{max} = hv - \phi_0$, so below $v_0 = \phi_0/h$ no electron escapes and K_{max} rises linearly with v (1½).

OR Diagrams (2):

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In a conductor the valence and conduction bands overlap, so many electrons are free to conduct (½). In an insulator the energy gap is large (more than about 3 eV) and no electron can reach the conduction band at room temperature (½). In a semiconductor the gap is small (about 1 eV), so some electrons are thermally excited to the conduction band and conductivity rises with temperature (1).

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