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Your JEE Guide

MP Board Class XII · Physics

Sample Question Paper 4 · 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:* A charged capacitor is disconnected from the battery and a dielectric slab is placed between its plates. The potential difference between the plates: (a) stays the same (b) decreases (c) becomes zero (d) increases	1
	(ii) Kirchhoff's loop rule is a consequence of the conservation of: (a) charge (b) mass (c) energy (d) momentum	1
	(iii) A current loop placed in a uniform magnetic field experiences: (a) a torque but no net force (b) neither a force nor a torque (c) both a net force and a torque (d) a net force but no torque	1
	(iv) In an LC oscillating circuit, energy is exchanged between: (a) the inductor and the resistor (b) heat and light (c) the capacitor and the source (d) the electric field of the capacitor and the magnetic field of the inductor	1

	(v) Which phenomenon shows that light waves are transverse? (a) interference (b) refraction (c) diffraction (d) polarisation	1
	(vi) Einstein's photoelectric equation is based on the conservation of: (a) mass (b) charge (c) energy (d) momentum	1
2.	**(i)** *Fill in the blanks:* One coulomb is the charge on about _____ electrons.	1
	(ii) Electrical conductivity is the reciprocal of _____.	1
	(iii) A galvanometer is converted into a voltmeter by connecting a _____ resistance in series with it.	1
	(iv) The SI unit of inductive reactance is the _____.	1
	(v) A concave lens always forms a _____, erect and diminished image of a real object.	1
	(vi) A _____ converts light energy directly into electrical energy.	1
3.	Match each device in column A with the principle on which it works in column B:	6

Column A	Column B
(i) Transformer	(a) torque on a current loop in a magnetic field
(ii) A.c. generator	(b) one-way conduction of a p-n junction
(iii) Optical fibre	(c) electromagnetic induction in a rotating coil
(iv) Moving-coil galvanometer	(d) photovoltaic effect
(v) Solar cell	(e) total internal reflection
(vi) Rectifier	(f) mutual induction

4.	**(i)** *Write True or False:* Like charges attract each other.	1
	(ii) Current density is a vector quantity.	1
	(iii) Isolated magnetic monopoles have been found to exist.	1
	(iv) The speed of light is the same in all media.	1
	(v) Nuclear forces are long-range forces.	1
5.	**(i)** *Answer in one word or one sentence:* What is the angle between the electric field and an equipotential surface?	1
	(ii) Name a material suitable for making permanent magnets.	1

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	(iii) Who first observed the photoelectric effect?	1
	(iv) Write the full form of LED.	1
	(v) What is 1 eV in joules?	1
6.	Capacitors of 4 μF and 12 μF are connected in series across a 60 V supply. Find the charge on each capacitor.	2
7.	Define the mobility of a charge carrier. Write its SI unit.	2
8.	State two differences between an ammeter and a voltmeter.	2
9.	Define magnetic susceptibility. What is its sign for diamagnetic and paramagnetic substances?	2
10.	A 100 Ω resistor is connected to a 220 V, 50 Hz a.c. supply. Find the rms and peak values of the current.	2
11.	What are coherent sources? Why can two separate bulbs not act as coherent sources?	2
12.	The threshold frequency of a metal is 5×10^{14} Hz. Find its work function in electron volts. ($h = 6.63 \times 10^{-34}$ J s)	2
13.	Derive the expression for the electric field at a point on the equatorial line of an electric dipole. **OR** What is electrostatic shielding? Why is it safer to stay inside a car than outside during a thunderstorm?	3
14.	Derive the expressions for the equivalent resistance of resistors connected (a) in series, (b) in parallel. **OR** Two bulbs rated 100 W, 220 V and 60 W, 220 V are connected in series across a 220 V supply. Which glows more brightly? Explain.	3
15.	An electron revolves round a nucleus in an orbit of radius r with speed v. Show that its magnetic moment is evr/2. **OR** Compare the magnetic field lines of a bar magnet with those of a current-carrying solenoid. What does this similarity show?	3
16.	For two thin lenses of focal lengths f_1 and f_2 placed in contact, show that the focal length F of the combination is given by $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$. **OR** Prove the law of reflection using Huygens' principle.	3

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17.	A slab of dielectric constant K and thickness t (t < d) is placed between the plates of a parallel-plate capacitor of plate area A and separation d. Derive the expression for its capacitance. **OR** What happens when a dielectric slab is placed in an electric field? Explain polarisation, and show how a dielectric increases the capacitance of a parallel-plate capacitor.	4
18.	A conducting rod of length l slides with velocity v on two parallel rails placed at right angles to a uniform magnetic field B. Derive the expression for the motional emf. If the circuit has resistance R, find the force needed to keep the rod moving. **OR** Derive the expression for the self-inductance of a long solenoid. Also derive the energy stored in an inductor carrying current I.	4
19.	Derive the lens maker's formula for a thin double-convex lens. **OR** Explain the formation of the image of a star by an astronomical telescope in normal adjustment, with a ray diagram, and state two ways of increasing its magnifying power.	4
20.	Distinguish between nuclear fission and nuclear fusion, with one example of each. Why is fusion difficult to achieve on earth? **OR** Draw the circuit of a half-wave rectifier and explain its working with input and output waveforms.	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) **(b)** decreases. *Working:* The charge stays the same and C increases K times, so V = Q/C falls.

(ii) **(c)** energy. *Working:* The net change in potential energy of a charge taken round a closed loop is zero.

(iii) **(a)** a torque but no net force. *Working:* Forces on opposite sides are equal and opposite, but in general they do not act along the same line.

(iv) **(d)** the electric field of the capacitor and the magnetic field of the inductor. *Working:* With no resistance, the total energy stays constant and moves back and forth.

(v) **(d)** polarisation. *Working:* Only transverse waves can be polarised.

(vi) **(c)** energy. *Working:* $h\nu = \phi_0 + K_{max}$: the photon's energy is shared between the work function and the kinetic energy.

Question 2

(i) 6.25×10^{18}.

(ii) resistivity.

(iii) high.

(iv) ohm.

(v) virtual.

(vi) solar cell.

3. (i) – (f) mutual induction; (ii) – (c) electromagnetic induction in a rotating coil; (iii) – (e) total internal reflection; (iv) – (a) torque on a current loop in a magnetic field; (v) – (d) photovoltaic effect; (vi) – (b) one-way conduction of a p-n junction

Question 4

(i) False: like charges repel.

(ii) True.

(iii) False: magnetic poles always occur in pairs.

(iv) False: it is greatest in vacuum and less in denser media.

(v) False: they act only over a few femtometres.

Question 5

(i) 90°.

(ii) Steel (or alnico).

(iii) Heinrich Hertz.

(iv) Light emitting diode.

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(v) 1.6×10^{-19} J.

6. 1/C = 1/4 + 1/12 = 1/3, C = 3 μF (1). In series each carries the same charge Q = CV = $3 \times 10^{-6} \times 60 = 1.8 \times 10^{-4}$ C (1).

7. The drift velocity per unit electric field, $\mu = v_d/E$ (1). SI unit: $m^2 V^{-1} s^{-1}$ (1).

8. An ammeter measures current and is connected in series; a voltmeter measures potential difference and is connected in parallel (1). An ideal ammeter has zero resistance and an ideal voltmeter infinite resistance (1).

9. The ratio of the magnetisation to the magnetising field intensity, $\chi = M/H$ (1). Negative for diamagnetic and small positive for paramagnetic substances (1).

10. $I_{rms} = 220/100 = 2.2$ A (1). $I_0 = \sqrt{2} \times 2.2 \approx 3.11$ A (1).

11. Sources that emit light of the same frequency with a constant phase difference (1). In separate bulbs the atoms emit randomly, so the phase difference changes rapidly and no steady pattern forms (1).

12. $\phi_0 = hv_0 = 6.63 \times 10^{-34} \times 5 \times 10^{14} = 3.3 \times 10^{-19}$ J (1) ≈ 2.07 eV (1).

13. The point is at distance $\sqrt{(r^2 + a^2)}$ from each charge, and the two fields have equal magnitude $\frac{q}{4\pi\varepsilon_0(r^2+a^2)}$ (1). Their components along the equatorial line cancel and those parallel to the axis add (1): $E = \frac{2qa}{4\pi\varepsilon_0(r^2+a^2)^{3/2}} = \frac{p}{4\pi\varepsilon_0(r^2+a^2)^{3/2}}$, directed opposite to p; $\approx \frac{p}{4\pi\varepsilon_0 r^3}$ for $r \gg a$ (1).

OR The electric field inside a cavity in a conductor is zero, whatever the charges and fields outside (1½). A car body acts as a closed conductor, so any charge from lightning stays on its outer surface and the field inside remains zero (1½).

14. (a) The same current flows through all; $V = V_1 + V_2 + V_3 = I(R_1 + R_2 + R_3)$, so $R = R_1 + R_2 + R_3$ (1½). (b) The same voltage is across all; $I = I_1 + I_2 + I_3 = V(1/R_1 + 1/R_2 + 1/R_3)$, so $1/R = 1/R_1 + 1/R_2 + 1/R_3$ (1½).

OR $R = V^2/P$: $R_{100} = 484\ \Omega$, $R_{60} \approx 807\ \Omega$ (1). In series the current is the same, so the power I^2R is greater in the bulb with the larger resistance (1). The 60 W bulb glows more brightly (1).

15. The revolving electron is equivalent to a current $I = e/T = ev/(2\pi r)$ (1). The area of the orbit is πr^2 (1). $\mu = IA = \frac{ev}{2\pi r} \times \pi r^2 = \frac{evr}{2}$ (1).

OR Outside, both have field lines leaving one end and entering the other, like those of a dipole (1). A solenoid has one end behaving as a north pole and the other as a south pole (1). So a bar magnet can be thought of as an equivalent solenoid, with its magnetism due to circulating currents (1).

16. The first lens forms an image at v_1: $\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1}$ (1). This image acts as the object for the second lens: $\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2}$ (1). Adding, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2}$, which is the lens formula for a single lens with $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ (1).

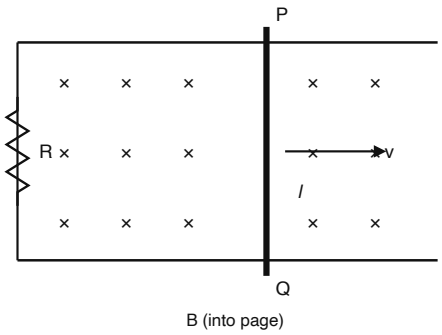
OR A plane wavefront AB meets a reflecting surface; while the disturbance at B travels BC = vt to the surface, the wavelet from A travels a distance vt after reflection (1). The reflected wavefront is the tangent CE from C to this wavelet (1). Triangles ABC and AEC are congruent (right-angled, common hypotenuse AC, BC = AE), so the angle of incidence equals the angle of reflection (1).

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17. With charge Q, the field in the air gap is $E_0 = Q/(\varepsilon_0 A)$ and in the slab E_0/K (1). $V = E_0(d - t) + (E_0/K)t$ (1) = $\frac{Q}{\varepsilon_0 A}\left(d - t + \frac{t}{K}\right)$ (1). So $C = \frac{\varepsilon_0 A}{d - t + t/K}$; for t = d this gives $K\varepsilon_0 A/d$ (1).

OR The field induces dipole moments in the molecules of the dielectric (or aligns permanent dipoles): the dielectric is polarised (1). Surface charges appear on the faces of the slab, which set up a field opposite to the applied one (1). The net field and so the potential difference fall for the same charge (1). C = Q/V therefore increases, to $K\varepsilon_0 A/d$ when the dielectric fills the gap (1).

18. Diagram (1):

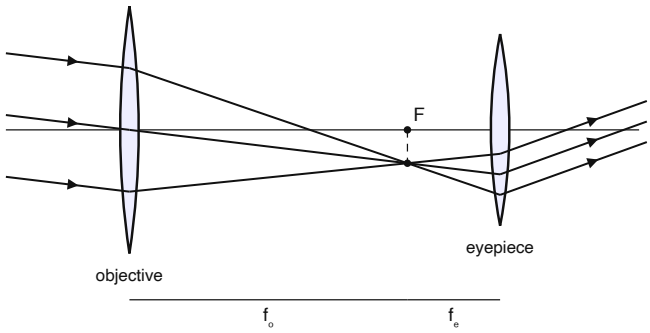


The flux through the circuit is Blx; $\varepsilon = -d\Phi/dt = Blv$ (1). Current $I = Blv/R$ (1). The magnetic force on the rod, $IlB = B^2l^2v/R$, opposes the motion, so an equal external force is needed (1).

OR $B = \mu_0 nI$ inside; total flux linkage $N\Phi = (nl)(\mu_0 nI)A$ (1). $L = N\Phi/I = \mu_0 n^2 Al$ (1). Work against the back emf to raise the current: $dW = LI\,dI$ (1). $U = \int_0^I LI\,dI = \frac{1}{2}LI^2$ (1).

19. Refraction at the first surface: $\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1}$ (1). Refraction at the second surface, the first image acting as object: $\frac{n_1}{v} - \frac{n_2}{v_1} = \frac{n_1 - n_2}{R_2}$ (1). Adding: $\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (1). For an object at infinity v = f, giving $\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (1).

OR Ray diagram (2):

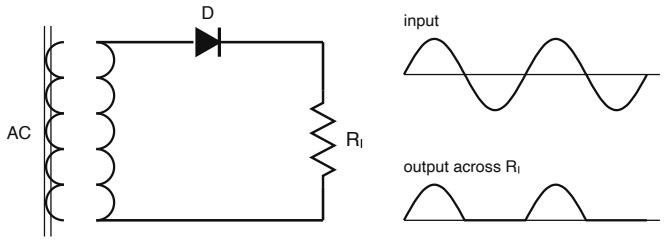


The objective forms a real image of the distant object at its focus, which is also the focus of the eyepiece, so the final image is at infinity (1). $m = -f_o/f_e$: use an objective of longer focal length or an eyepiece of shorter focal length (1).

20. Fission: a heavy nucleus splits into two lighter nuclei with release of energy, e.g. $^{235}U + n \rightarrow {}^{141}Ba + {}^{92}Kr + 3n$ (1½). Fusion: light nuclei join to form a heavier one with release of energy, e.g. hydrogen nuclei forming helium in the sun (1½). Fusion needs extremely high temperatures, millions of kelvin, to overcome the repulsion between the nuclei (1).

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OR Circuit and waveforms (2):



During the positive half-cycle the diode is forward biased and current flows through the load (1). During the negative half-cycle it is reverse biased and no current flows, so the output has only the positive halves (1).

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