Physics (042)

CBSE Class 12 Board Examination 2027 – Practice Paper No. 2

Practice Question Paper

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

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(3) Section A contains sixteen questions, twelve MCQ and four Assertion–Reasoning based, of 1 mark each; Section B contains five questions of two marks each; Section C contains seven questions of three marks each; Section D contains two case study based questions of four marks each; and Section E contains three long answer questions of five marks each.

(4) There is no overall choice. However, an internal choice has been provided in two questions in Section B, one question in Section C and all three questions in Section E. You have to attempt only one of the choices in such questions.

(5) Use of calculators is not allowed.

(6) You may use the following values of physical constants wherever necessary: $c = 3 \times 10^8$ m s^{-1}; $m_e = 9.1 \times 10^{-31}$ kg; $m_p = 1.7 \times 10^{-27}$ kg; $e = 1.6 \times 10^{-19}$ C; $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}; $h = 6.63 \times 10^{-34}$ J s; $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}; Avogadro's number = 6.023×10^{23} per gram mole.

SECTION A Questions 1 to 16 carry 1 mark each. (Q.1–12 multiple choice; Q.13–16 assertion–reason) **[16]**

1. Two identical small metal spheres carry charges +8 μC and –2 μC. When placed a distance d apart, they attract each other with a force F. They are touched together and then placed again at the same distance d. The force between them now is

(A) 9F/16, attractive
(B) 9F/16, repulsive
(C) 3F/8, repulsive
(D) F, repulsive

2. The electric potential along the x-axis in a region is $V = (5 - 3x^2)$ volt, where x is in metre. The electric field at x = 2 m is

(A) 12 V m^{-1} along +x
(B) 12 V m^{-1} along –x
(C) 7 V m^{-1} along –x
(D) 24 V m^{-1} along +x

3. The free electrons in a metal wire acquire a drift speed of 1.5×10^{-4} m s^{-1} when the electric field inside the wire is 0.3 V m^{-1}. The mobility of the electrons is

(A) 5×10^{-4} m^2 V^{-1} s^{-1}
(B) 2×10^3 m^2 V^{-1} s^{-1}
(C) 4.5×10^{-5} m^2 V^{-1} s^{-1}
(D) 5×10^{-5} m^2 V^{-1} s^{-1}

4. The current sensitivity of a moving coil galvanometer can be increased by

(A) increasing the number of turns N of the coil
(B) using a suspension (spring) of larger torsional constant k
(C) using a weaker radial magnetic field B
(D) reducing the area A of the coil

5. A piece of iron (a ferromagnetic material) is heated to a sufficiently high temperature. Which of the following then happens?

(A) It becomes diamagnetic.
(B) It becomes paramagnetic.
(C) Its domains grow larger and it becomes a stronger magnet.
(D) Its susceptibility becomes negative.

6. A straight metal rod of length 25 cm moves with a speed of 8 m s^{-1} perpendicular to its own length and perpendicular to a uniform magnetic field of 0.5 T. The emf induced between the ends of the rod is

(A) 0.1 V (B) 1.0 V

(C) 10 V (D) 100 V

7. A parallel plate capacitor is being charged. At an instant when the conduction current in the connecting wires is 0.8 A, the displacement current in the gap between the plates is

(A) zero (B) 0.8 A

(C) 0.8 ε_0 A (D) (0.8/ε_0) A

8. An object is placed 20 cm in front of a concave mirror of focal length 15 cm. The image is

(A) 60 cm in front of the mirror, real, inverted and three times the size of the object

(B) 60 cm behind the mirror, virtual, erect and three times the size

(C) 8.6 cm in front of the mirror, real, inverted and diminished

(D) 8.6 cm behind the mirror, virtual and erect

9. In a Young's double-slit experiment, the fringe width is β. The screen is moved from 1.0 m to 1.5 m from the slits and the slit separation is changed from 0.30 mm to 0.60 mm, the light remaining the same. The new fringe width is

(A) 0.75 β (B) 1.33 β

(C) 3 β (D) 0.25 β

10. The ratio of the momentum of a photon of violet light of wavelength 400 nm to that of a photon of red light of wavelength 700 nm is

(A) 4 : 7 (B) 7 : 4

(C) 16 : 49 (D) 1 : 1

11. The radius of a nucleus of mass number 64 is 4.8 fm. The radius of a nucleus of mass number 216 is

(A) 16.2 fm (B) 7.2 fm

(C) 3.2 fm (D) 10.8 fm

12. A silicon diode is connected in forward bias in series with a 200 Ω resistor across a 4.7 V battery. Taking the voltage drop across the conducting diode as a constant 0.7 V, the current in the circuit is

(A) 23.5 mA (B) 20 mA

(C) 3.5 mA (D) zero

13. For Questions 13 to 16, 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 Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Both Assertion (A) and Reason (R) are false.

Assertion (A): Heavy nuclei such as ^{235}U release energy when they undergo fission.
Reason (R): The nuclear force between two nucleons is nearly independent of their electric charge.

(A) Both A and R true; R explains A (B) Both A and R true; R does not explain A
(C) A true, R false (D) Both A and R false

14. **Assertion (A):** The total energy of the electron in a Bohr orbit of a hydrogen atom is negative.
Reason (R): The kinetic energy of the electron in the orbit is greater than the magnitude of its electrostatic potential energy.

(A) Both A and R true; R explains A (B) Both A and R true; R does not explain A
(C) A true, R false (D) Both A and R false

15. **Assertion (A):** A pure (intrinsic) semiconductor behaves like an insulator at T = 0 K.
Reason (R): At T = 0 K the valence band is completely filled and the conduction band is empty, and no electron has the thermal energy needed to cross the energy gap.

(A) Both A and R true; R explains A (B) Both A and R true; R does not explain A
(C) A true, R false (D) Both A and R false

16. **Assertion (A):** The capacitance of a parallel plate capacitor increases when the separation between its plates is decreased.
Reason (R): The capacitance of a capacitor depends on the charge given to it.

(A) Both A and R true; R explains A (B) Both A and R true; R does not explain A
(C) A true, R false (D) Both A and R false

SECTION B Questions 17 to 21 carry 2 marks each. **[10]**

17. An electric dipole consists of charges +5 nC and –5 nC separated by 4 mm. It is placed in a uniform electric field of 2×10^5 N C^{-1} with its dipole moment along the field.
(i) Find the dipole moment and the potential energy of the dipole in this position.
(ii) How much work must an external agent do to turn the dipole slowly so that its dipole moment points opposite to the field? What torque acts on the dipole when its dipole moment makes an angle of 30° with the field?

18. An aluminium wire of cross-sectional area 1.0 mm^2 carries a current of 3.6 A. The drift speed of the free electrons in it is 1.25×10^{-4} m s^{-1}.
(i) Find the number density of free electrons in the wire.
(ii) The number of aluminium atoms per cubic metre is 6.0×10^{28}. How many free electrons does each atom contribute, on average?

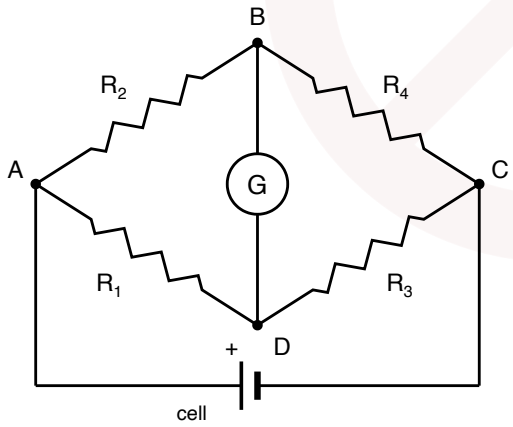
19. (A) The current in a coil changes uniformly from 6 A to 2 A in 0.05 s, and an average emf of 40 V is induced in it.
(i) Find the self-inductance of the coil.
(ii) By how much does the magnetic energy stored in the coil change?
OR
(B) Define mutual inductance and state its SI unit. When the current in coil P is increased steadily from 0 to 5 A in 0.02 s, an emf of 1.5 V is induced in a nearby coil S. Find the mutual inductance of the pair. What emf would be induced in P if the same change of current were made in S instead?

20. (A) A hydrogen atom is in the state n = 3.
(i) What minimum energy must be supplied to ionise it from this state?
(ii) How many different wavelengths can it emit while returning to the ground state? Which transition gives the longest wavelength?
OR
(B) Using Bohr's postulates, obtain the expression for the radius of the n^{th} orbit of the electron in a hydrogen atom.

21. With the help of a labelled diagram, explain how the depletion region and the barrier potential are formed at a p-n junction.

SECTION C Questions 22 to 28 carry 3 marks each. **[21]**

22. (i) In the Wheatstone bridge shown, a cell of negligible internal resistance is connected between A and C, and a galvanometer G between B and D. Using Kirchhoff's rules, obtain the condition for the bridge to be balanced (no current through G).
(ii) In such a bridge R_1 = 12 Ω (arm AD), R_2 = 18 Ω (arm AB), R_3 = 8 Ω (arm DC) and R_4 = 15 Ω (arm BC). The bridge is not balanced. What resistance must be connected in parallel with R_4 to balance it?



For visually impaired candidates: In the Wheatstone bridge ABCD, the cell is connected across A and C and the galvanometer across B and D; R_1 is in arm AD, R_2 in arm AB, R_3 in arm DC and R_4 in arm BC.

23. A coil draws a current of 2.0 A when connected to a 12 V dc supply. When the same coil is connected to a 12 V (rms), 50 Hz ac supply, it draws a current of 1.2 A (rms).
(i) Why does the coil draw a smaller current from the ac supply?
(ii) Find the resistance and the self-inductance of the coil.
(iii) Find the power factor and the average power consumed on the ac supply.

24. (i) Name the electromagnetic radiation that
(a) is produced when high-energy electrons strike a metal target,
(b) is emitted by hot bodies and is used in physical therapy,
(c) is used in radar systems for aircraft navigation.
Arrange these three radiations in increasing order of frequency.
(ii) A medium-wave radio station broadcasts at a frequency of 750 kHz. Find the wavelength of these waves.
(iii) At a certain place the amplitude of the electric field of these radio waves is 0.12 V m^{-1}. Find the amplitude of the magnetic field there.

25. A student shines a laser pointer of wavelength λ normally on a narrow single slit of width a and observes the diffraction pattern on a distant wall.
(i) Sketch the variation of intensity with the angle θ in this pattern, marking the angular positions of the first two minima on either side of the centre.
(ii) The student now replaces the single slit by two such slits close together. Describe how the pattern on the wall changes, and state the role played by single-slit diffraction in the new pattern.
(iii) The dark bands of the pattern receive almost no light. Does this mean that light energy is destroyed there? Explain.

26. (A) When ultraviolet light of wavelength 310 nm falls on a metal surface, the stopping potential of the emitted photoelectrons is found to be 1.8 V.
(i) Find the energy of each incident photon in eV and the work function of the metal.
(ii) Find the maximum speed of the photoelectrons.
(iii) Find the threshold wavelength of the metal. Will red light of wavelength 650 nm eject photoelectrons from it?

OR

(B) (i) Draw graphs showing the variation of photoelectric current with the collector plate (anode) potential for two radiations of frequencies ν_1 and ν_2 ($\nu_2 > \nu_1$) of the same intensity. Why is the stopping potential different for the two radiations?
(ii) Draw the graph of stopping potential V_0 against frequency ν for two metals A and B whose threshold frequencies are $\nu_{0A} < \nu_{0B}$. What does the slope of each line represent? Are the two lines parallel?

27. In a fusion reactor such as ITER (in which India is a partner), deuterium and tritium nuclei fuse:
$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + 17.6\ MeV$
Tritium is very scarce in nature, so fusion power plants are planned to produce ('breed') it in a 'blanket' containing lithium around the hot fuel, where the neutrons from fusion are absorbed by lithium-6:
$^{6}_{3}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{3}_{1}H$
(i) Calculate the energy released in one such lithium reaction.
(ii) Compare the energy released per nucleon taking part in the deuterium–tritium fusion reaction with that in the fission of ^{235}U (about 200 MeV per fission).
(iii) The deuterium–tritium fuel must be heated to an extremely high temperature for fusion to occur, but the lithium reaction needs no such heating. Explain why.
Given: m($^{6}_{3}Li$) = 6.015122 u, m($^{4}_{2}He$) = 4.002603 u, m($^{3}_{1}H$) = 3.016049 u, m_n = 1.008665 u, 1 u = 931.5 MeV/c^2.

28. (i) A crystal of pure germanium is doped with antimony (a pentavalent element). What type of extrinsic semiconductor is obtained? Draw its energy band diagram and mark the energy level introduced by the dopant.

(ii) In the doped crystal the concentration of antimony atoms is $4.8 \times 10^{22}\ m^{-3}$. The intrinsic carrier concentration of germanium at room temperature is $2.4 \times 10^{19}\ m^{-3}$. Find the electron and hole concentrations, assuming every antimony atom is ionised.

(iii) Why is the hole concentration in the doped crystal much smaller than the intrinsic carrier concentration of germanium?

SECTION D Questions 29 and 30 are case study based questions carrying 4 marks each. **[8]**

29. Read the following passage and answer the questions that follow.

The Koyna Hydroelectric Project in Satara district is one of the largest hydroelectric power stations in Maharashtra. Water from the Koyna dam flows down through tunnels and turns turbines, each coupled to an ac generator. In a generator, a coil and a magnetic field rotate relative to each other, so the magnetic flux linked with the coil changes continuously and an emf $e = NBA\omega \sin \omega t$ is induced, where ωt is the angle between the normal to the coil and the magnetic field. Suppose one generator gives an alternating voltage of rms value 11 kV at 50 Hz. The transformers have cores made of thin laminated sheets of soft iron. Before the power is sent over long transmission lines to cities such as Pune and Mumbai, transformers step this voltage up to 220 kV.

(i) The emf induced in the generator coil is maximum at the instant when

(A) the plane of the coil is perpendicular to the magnetic field

(B) the plane of the coil is parallel to the magnetic field

(C) the magnetic flux linked with the coil is maximum

(D) the coil is momentarily at rest

(ii) The core of a transformer is laminated mainly to

(A) reduce the flux leakage between the coils

(B) reduce the energy lost due to eddy currents in the core

(C) reduce the resistance of the windings

(D) increase the magnetic flux produced by the primary

(iii) For an ideal transformer that steps 11 kV up to 220 kV, the ratio of the number of turns N_s/N_p and the ratio of the currents I_s/I_p are respectively

(A) 20 and 1/20

(B) 20 and 20

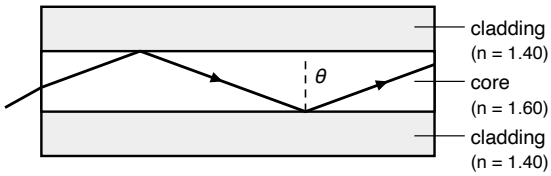
(C) 1/20 and 20

(D) 1/20 and 1/20

(iv) The same electrical power is sent through the same transmission line, once at 11 kV and once at 220 kV. Find the ratio of the power lost as heat in the line at 220 kV to that at 11 kV.

30. Read the following passage and answer the questions that follow.

Under the BharatNet project, optical fibre cables are being laid to bring high-speed internet to gram panchayats across India, including villages in Maharashtra. An optical fibre has a thin glass core surrounded by a cladding of slightly lower refractive index. Light entering one end strikes the core–cladding boundary at an angle larger than the critical angle, is totally internally reflected again and again, and so travels along the fibre with very little loss, even when the fibre is gently bent. In the fibre shown in the figure, the core has refractive index 1.60 and the cladding 1.40.



θ > C at every reflection (not to scale)

(i) For total internal reflection to take place at the core–cladding boundary, light must travel

(A) from the cladding to the core, with angle of incidence greater than the critical angle

(B) from the core to the cladding, with angle of incidence greater than the critical angle

(C) from the core to the cladding, with angle of incidence less than the critical angle

(D) from the cladding to the core, with angle of incidence less than the critical angle

(ii) The critical angle C at the core–cladding boundary is given by

(A) sin C = 7/8

(B) sin C = 8/7

(C) sin C = 5/8

(D) sin C = 1/1.60

(iii) The speed of light in the core is

(A) 1.875×10^8 m s^{-1}

(B) 2.14×10^8 m s^{-1}

(C) 4.8×10^8 m s^{-1}

(D) 3.0×10^8 m s^{-1}

(iv) A ray travelling in the core strikes the core–cladding boundary at an angle of incidence of 55°. Will it be totally internally reflected? Justify. (sin 55° = 0.82)

For visually impaired candidates: the figure shows a ray zig-zagging along the core of a fibre, reflected at the core–cladding boundary; the core (n = 1.60) is surrounded by the cladding (n = 1.40).

SECTION E Questions 31 to 33 carry 5 marks each. **[15]**

31. (A) (i) State Gauss's law in electrostatics. Using it, derive an expression for the electric field due to a uniformly charged infinite plane sheet of surface charge density σ.

(ii) Two large, thin, parallel plane sheets A and B are placed in air, with A to the left of B. Sheet A carries a uniform surface charge density of +17.7 nC m^{-2} and sheet B carries –8.85 nC m^{-2}. Find the magnitude and direction of the electric field (a) to the left of A, (b) between the sheets and (c) to the right of B. ($\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2})

OR

(B) (i) Derive an expression for the electric potential at a distance r from a point charge q. Draw graphs showing how the potential V and the field E vary with r for a positive point charge.

(ii) Point charges +2 μC and –3 μC are held fixed at points P and Q, 30 cm apart, in air.

(a) Find the electrostatic potential energy of this system of two charges.

(b) How much work must an external agent do to bring a third charge of +4 μC from infinity to the point R such that PQR is an equilateral triangle of side 30 cm?

(c) What is the total potential energy of the three-charge system? How much work is needed to separate all three charges to infinity?

(Take $1/4\pi\varepsilon_0 = 9 \times 10^9$ N m^2 C^{-2}.)

32. (A) (i) Using the Biot–Savart law, derive an expression for the magnetic field at a point on the axis of a circular loop of radius R carrying a current I, at a distance x from its centre. Hence write the field at the centre of the loop.

(ii) A circular coil of 20 turns and radius 4.0 cm carries a current of 1.5 A. Find the magnetic field (a) at its centre and (b) at a point on its axis 3.0 cm from the centre.

OR

(B) (i) State Ampere's circuital law. Using it, obtain the magnetic field at a distance r from an infinitely long straight wire carrying a steady current I.

(ii) A beam of protons moving with speed 4×10^5 m s^{-1} passes undeflected through a region in which a uniform magnetic field of 0.05 T and a uniform electric field are perpendicular to each other and to the beam.

(a) Find the magnitude of the electric field.

(b) If the electric field is switched off, find the radius of the circular path of the protons.

(c) Does the kinetic energy of the protons change while they move in the magnetic field alone? Give a reason.

33. (A) (i) With the help of a ray diagram, derive the mirror equation $1/v + 1/u = 1/f$ for a concave mirror forming a real image of an object placed beyond its centre of curvature.

(ii) A dentist holds a small concave mirror of focal length 2.0 cm at a distance of 1.5 cm from a tooth. Find the position, nature and magnification of the image.

OR

(B) (i) Two thin lenses of focal lengths f_1 and f_2 are placed in contact. Derive an expression for the focal length F of the combination and write the power of the combination in terms of the powers of the two lenses.

(ii) An object is placed 30 cm in front of a thin convex lens of focal length 20 cm.

(a) Find the position and magnification of the image.

(b) A second thin convex lens of focal length 60 cm is now placed in contact with the first lens. Find the focal length and power of the combination.

(c) Find the position and magnification of the image now formed by the combination.

All the best for your exam!