Physics (042)

CBSE Class 12 Board Examination 2027 – Practice Paper No. 1

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. An electric dipole is held in a uniform electric field with its dipole moment **p** pointing exactly opposite to the field **E**. Which of the following is correct for the dipole in this position?

(A) Net force zero, torque zero; equilibrium is stable
(B) Net force zero, torque zero; equilibrium is unstable
(C) Net force non-zero, torque zero
(D) Net force zero, torque maximum (= pE)

2. A parallel plate capacitor (air between the plates) is charged by a battery and then disconnected from it. Its stored energy is U. The gap is now completely filled with a dielectric slab of dielectric constant K = 4. The energy stored now is

(A) 4U
(B) U/4
(C) U
(D) 16U

3. A copper wire is connected across a constant potential difference V. It is replaced by another copper wire of the same cross-section but three times the length, connected across the same V. The drift speed of the free electrons becomes

(A) 3 times
(B) one-third
(C) unchanged
(D) one-ninth

4. An electron and a proton enter the same uniform magnetic field with equal speeds, both moving perpendicular to the field. The ratio of the radius of the electron's circular path to that of the proton ($r_e : r_p$) is

(A) $m_p : m_e$
(B) $m_e : m_p$
(C) 1 : 1
(D) $\sqrt{m_e} : \sqrt{m_p}$

5. A small bar of a material whose magnetic susceptibility is $\chi = -1.5 \times 10^{-5}$ is placed near one pole of a strong electromagnet (non-uniform field). The bar will

(A) move towards the stronger field; the field inside it is enhanced

(B) move towards the weaker field; the field inside it is slightly reduced

(C) be strongly attracted and remain magnetised after the current is switched off

(D) remain completely unaffected

6. An air-cored solenoid has self-inductance 2 mH. If the number of turns is doubled while its length and area of cross-section are kept the same, its self-inductance becomes

(A) 4 mH

(B) 8 mH

(C) 1 mH

(D) 16 mH

7. An ideal capacitor is connected to an ac source of fixed rms voltage and frequency 50 Hz; the rms current is 0.4 A. If the frequency of the source is changed to 200 Hz (same rms voltage), the rms current will be

(A) 0.1 A

(B) 0.4 A

(C) 0.8 A

(D) 1.6 A

8. Which part of the electromagnetic spectrum is used in LASIK eye surgery and is largely absorbed by the ozone layer of the atmosphere?

(A) Infrared

(B) Ultraviolet

(C) Microwaves

(D) Radio waves

9. A thin convex lens of focal length 25 cm is placed in contact with a thin concave lens of focal length 40 cm. The power of the combination and its nature are

(A) +1.5 D, converging

(B) –1.5 D, diverging

(C) +6.5 D, converging

(D) –6.5 D, diverging

10. In a single-slit diffraction set-up, the slit width is halved and the light is changed from 600 nm to 450 nm. The angular width of the central maximum becomes

(A) 0.75 times

(B) 1.5 times

(C) 2 times

(D) 3 times

11. An electron and an α-particle have the same de Broglie wavelength. Which of them has the greater kinetic energy?

(A) The electron

(B) The α-particle

(C) Both have equal kinetic energy

(D) It depends on the sign of their charges

12. A pure silicon crystal is doped with a small amount of indium (a trivalent element). The doped crystal is

(A) n-type and negatively charged

(B) p-type and positively charged

(C) p-type and electrically neutral

(D) n-type and electrically neutral

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): Energy is released when two light nuclei such as deuterium nuclei fuse to form a heavier nucleus.
Reason (R): The binding energy per nucleon of the nucleus formed is greater than that of the fusing light nuclei.
(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):** A hydrogen atom in its ground state can absorb a photon of energy 10.2 eV.
Reason (R): A hydrogen atom in its ground state can absorb a photon of any energy greater than 10.2 eV.
(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):** The focal length of a concave mirror does not change when the mirror is immersed in water.
Reason (R): The speed of light in water is less than its speed in air.
(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 work done in moving a charge between two points on an equipotential surface depends on the path followed.
Reason (R): Electric field lines are always parallel to an equipotential surface.
(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. A long, thin, straight wire carries a uniform linear charge density. The electric field at a point 25 cm from the wire is 7.2×10^4 N C^{-1}, directed away from the wire.
(i) Find the linear charge density λ of the wire.
(ii) What is the electric field at a point 75 cm from the wire?
(Take $1/4\pi\varepsilon_0 = 9 \times 10^9$ N m^2 C^{-2}.)

18. Two cells of emf 1.5 V and 2.0 V, with internal resistances 0.5 Ω and 1.0 Ω respectively, are connected in parallel (positive terminal to positive terminal). This combination is connected across an external resistor of 3 Ω. Find
(i) the current through the 3 Ω resistor, and
(ii) the current through the 1.5 V cell.

19. (A) A rod of a certain material has relative magnetic permeability $\mu_r = 1.0006$. It is placed in a uniform magnetising field of magnetic intensity $H = 5000$ A m^{-1}.

(i) Find the magnetic susceptibility χ and name the type of magnetic material.

(ii) Find the magnetisation M of the rod and the magnetic field B inside it. ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})

OR

(B) State any two differences between the electric field lines of an electric dipole and the magnetic field lines of a bar magnet. Why can two magnetic field lines never intersect?

20. Draw the I–V characteristic of a silicon p-n junction diode for both forward and reverse bias. Mark the knee (threshold) voltage and the breakdown voltage. Why does the current under reverse bias remain almost constant as the reverse voltage is increased (up to breakdown)?

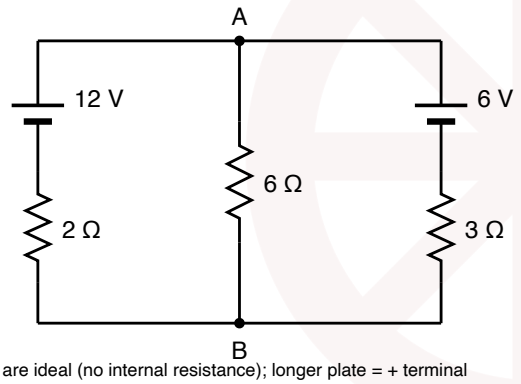
21. (A) Light of wavelength 414 nm falls on a metal surface whose work function is 2.0 eV. Calculate (i) the maximum kinetic energy of the emitted photoelectrons in eV, and (ii) the stopping potential.

OR

(B) An electron, initially at rest, is accelerated through a potential difference of 150 V. Calculate its de Broglie wavelength. How would the de Broglie wavelength of a proton accelerated through the same potential difference compare with it?

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

22. In the circuit shown, the cells are ideal. Using Kirchhoff's rules, find (i) the current in each branch, stating its direction, and (ii) the potential difference $V_A - V_B$.



Cells are ideal (no internal resistance); longer plate = + terminal

For visually impaired candidates: Three branches are connected in parallel between two points A and B. Branch 1: an ideal 12 V cell (positive terminal towards A) in series with a 2 Ω resistor. Branch 2: a 6 Ω resistor only. Branch 3: an ideal 6 V cell (positive terminal towards A) in series with a 3 Ω resistor. Using Kirchhoff's rules, find the current in each branch (with direction) and $V_A - V_B$.

23. (A) A moving coil galvanometer has a coil of resistance 99 Ω and gives full-scale deflection for a current of 10 mA.

(i) What shunt resistance is needed to convert it into an ammeter of range 0–1 A?

(ii) What resistance is needed, and how is it connected, to convert it into a voltmeter of range 0–5 V?

(iii) What is the resistance of the ammeter so formed?

OR

(B) Two long, straight, parallel wires 6 cm apart in air carry currents of 4 A and 9 A in opposite directions.

(i) Find the magnitude of the force per unit length between them and state whether it is attractive or repulsive.

(ii) Locate the point on the line joining the wires (in the plane of the wires) where the net magnetic field due to the two currents is zero. ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})

24. A rectangular coil of size 12 cm × 5 cm has 400 turns and a total resistance of 8 Ω. It is placed with its plane perpendicular to a uniform magnetic field directed into the plane of the page. The field decreases uniformly from 0.9 T to 0.3 T in 0.12 s. Find
(i) the magnitude of the induced emf,
(ii) the induced current and the total charge that flows through the coil, and
(iii) the direction of the induced current as seen by an observer looking at the page (field pointing away from the observer).

25. The magnetic field of a plane electromagnetic wave in vacuum is
$B_y = 2.0 \times 10^{-8} \sin (400\pi x - 1.2\pi \times 10^{11} t)$ T, with x in metre and t in second.
(i) Find the wavelength and frequency of the wave.
(ii) Find the amplitude of the electric field and state the axis along which the electric field oscillates.
(iii) Name the part of the electromagnetic spectrum to which the wave belongs and give one use of this radiation.

26. A ray of monochromatic light passes through a glass prism of angle A. Draw a ray diagram showing the passage of the ray when the prism is in the position of minimum deviation, and derive the relation between the refractive index n of the glass, A and the angle of minimum deviation D_m.
A ray of light falls on one face of an equilateral glass prism at an angle of incidence of 45° and passes through the prism symmetrically (the emergent ray also makes 45° with the normal to the second face). Find the refractive index of the glass and the angle of minimum deviation.

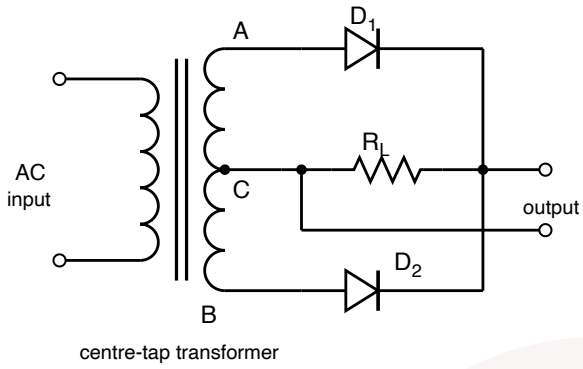
27. In a Young's double-slit experiment, the slits are 0.30 mm apart and the screen is 1.5 m from the slits. Light of wavelength 600 nm is used.
(i) Find the fringe width.
(ii) Find the distance between the second bright fringe on one side of the central bright fringe and the third dark fringe on the other side.
(iii) What will the fringe width be if the entire apparatus is immersed in water of refractive index 4/3?

28. In a hydrogen atom, the electron makes a transition from the orbit n = 4 to the orbit n = 2.
(i) Calculate the energy of the emitted photon in eV.
(ii) Calculate the wavelength of the emitted radiation and state the region of the spectrum.
(iii) Using Bohr's model, find the ratio of the radii and the ratio of the speeds of the electron in these two orbits ($r_4 : r_2$ and $v_4 : v_2$).
($E_n = -13.6/n^2$ eV)

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.

Almost every phone charger, LED bulb driver and inverter in Indian homes converts the 230 V, 50 Hz ac mains into a low dc voltage. Inside, a step-down transformer is followed by a rectifier made of p-n junction diodes. A common design is the full-wave rectifier using a centre-tap transformer shown in the figure: the ends A and B of the secondary are connected to diodes D_1 and D_2, and the load R_L is connected between the joined diode outputs and the centre tap C. The rectified output is pulsating, so a large capacitor is connected across R_L to smooth it before it reaches the phone battery.



(i) During the half-cycle in which end A of the secondary is positive with respect to the centre tap C,

(A) D_1 is reverse biased and D_2 is forward biased

(B) D_1 is forward biased and D_2 is reverse biased

(C) both D_1 and D_2 are forward biased

(D) both D_1 and D_2 are reverse biased

(ii) When the forward bias voltage across a p-n junction is increased, the depletion layer

(A) becomes wider and the barrier potential increases

(B) becomes wider and the barrier potential decreases

(C) becomes narrower and the barrier potential decreases

(D) remains unchanged

(iii) A large capacitor is connected across the load R_L because

(A) it blocks the dc and passes only the ripple to the load

(B) it charges to nearly the peak voltage and discharges only slowly through R_L

(C) it increases the peak value of the output voltage above the peak of the secondary voltage

(D) it makes the diodes conduct during both half-cycles

(iv) In a charger built with this circuit, diode D_2 burns out and becomes an open circuit. Describe the output across R_L (without the capacitor) and state the frequency of the output pulses when the input is 50 Hz.

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

The Tarapur Atomic Power Station in Palghar district, Maharashtra, was India's first nuclear power station. In its reactors, a slow neutron is absorbed by a uranium-235 nucleus, which splits into two medium-mass fragments (for example barium and krypton) and two or three neutrons. About 200 MeV of energy is released in each fission, mostly as kinetic energy of the fragments, and is finally converted into heat that produces steam to run the turbines. The neutrons released can cause further fissions, and the rate of fission in the reactor is kept under control. The nuclei involved are held together by the nuclear force, and their sizes follow $R = R_0 A^{1/3}$.

(i) How many fissions per second are needed to produce a thermal power of 160 MW, if each fission releases 200 MeV? (1 eV = 1.6×10^{-19} J)

(A) 5×10^{15}

(B) 5×10^{18}

(C) 8×10^{18}

(D) 2×10^{20}

(ii) Energy is released in the fission of a heavy nucleus like ^{235}U because

(A) the fragments have a larger binding energy per nucleon than the uranium nucleus

(B) the fragments have a smaller binding energy per nucleon than the uranium nucleus

(C) the total number of nucleons decreases in fission

(D) neutrons are converted completely into energy

(iii) Which of the following is **not** a property of the nuclear force?

(A) It is much stronger than the electrostatic force between protons at nuclear distances.

(B) It is short-ranged (a few femtometres).

(C) It acts only between protons and is absent between neutrons.

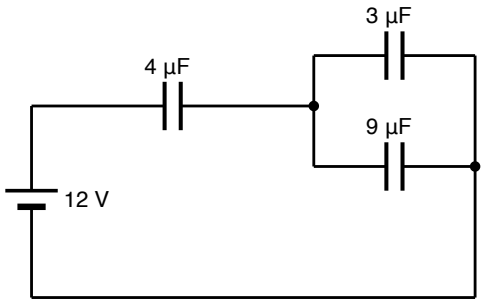
(D) It becomes repulsive when the nucleons are closer than about 0.8 fm.

(iv) What is the ratio of the nuclear mass densities of ^{235}U and a ^{92}Kr fragment? Give a reason.

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

31. (A) (i) Derive an expression for the electric potential at a point at distance r from the centre of a short electric dipole of dipole moment p, the line joining the point to the centre making an angle θ with the dipole axis ($r \gg a$). Hence write the potential at a point on (a) the axial line and (b) the equatorial line.

(ii) In the network shown in the figure below, a 4 μF capacitor is connected in series with a parallel combination of 3 μF and 9 μF capacitors across a 12 V battery. Find the equivalent capacitance of the network and the charge on the 9 μF capacitor.



OR

(B) (i) Using Gauss's law, obtain the expression for the electric field due to a uniformly charged thin spherical shell of radius R carrying charge q at a point (a) outside the shell and (b) inside the shell.

(ii) A thin spherical shell of radius 10 cm carries a charge of 4.0 nC uniformly distributed over it. Find the electric field at points 6 cm and 30 cm from its centre, and the electric potential at its centre. (Take $1/4\pi\varepsilon_0 = 9 \times 10^9$ N m^2 C^{-2}.)

32. (A) (i) A spherical refracting surface of radius of curvature R separates a rarer medium of refractive index n_1 from a denser medium of refractive index n_2. With a ray diagram, derive the relation $n_2/v - n_1/u = (n_2 - n_1)/R$ for a point object on the principal axis in the rarer medium forming a real image in the denser medium.

(ii) A thin biconvex lens of glass (refractive index 1.5) has radii of curvature 20 cm and 30 cm. Find its focal length in air and when it is completely immersed in a transparent liquid of refractive index 1.25. Does it remain a converging lens?

OR

(B) (i) Draw a labelled ray diagram of a refracting astronomical telescope in normal adjustment (final image at infinity) and obtain the expression for its magnifying power.

(ii) A small refracting telescope has an objective of focal length 120 cm and an eyepiece of focal length 4 cm. Find its magnifying power and the separation between the objective and the eyepiece in normal adjustment. If the Moon subtends an angle of 0.5° at the objective, what angle does its final image subtend at the eye?

33. (A) (i) A resistor R, an inductor L and a capacitor C are connected in series to an ac source $v = v_m \sin \omega t$. Draw the phasor diagram (take $V_L > V_C$) and obtain the expression for the impedance of the circuit and the phase difference between the voltage and the current.

(ii) A series circuit has R = 400 Ω, L = 0.4 H and C = 10 μF. It is connected to an ac source of rms voltage 250 V and angular frequency 1000 rad s^{-1}. Find the impedance, the rms current, the power factor, the average power consumed, and the angular frequency at which resonance would occur.

OR

(B) (i) State the principle of an ac generator. With a labelled diagram, explain its working and show that the emf induced in its coil is $e = NBA\omega \sin \omega t$.

(ii) A rectangular coil of 100 turns, each of area 0.05 m^2, rotates at 50 revolutions per second about an axis perpendicular to a uniform magnetic field of 0.07 T. Find the peak value and the rms value of the induced emf. (Take π = 22/7.)

All the best for your exam!