Physics – Autumn Break Holiday Homework (Class XII)

Oct 13, 2026 · @VARAKUMAR G

Physics (Code 042) · Time: 3 hours · Maximum Marks: 70 · Syllabus: Chapters 1–12, Electric Charges and Fields to Atoms.

General Instructions

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: A, B, C, D and E.
3. Section A has sixteen questions of 1 mark each: twelve MCQs (Q1–12) and four assertion–reason questions (Q13–16). Section B has five questions of 2 marks each. Section C has seven questions of 3 marks each. Section D has two case-study questions of 4 marks each. Section E has three long-answer questions of 5 marks each.
4. There is no overall choice. Internal choice is given in two questions of Section B (Q20, Q21), one question of Section C (Q26) and all three questions of Section E. Attempt only one of the choices in such questions.
5. Use of calculators is not allowed.
6. You may use these values wherever necessary:

Constant	Value
Speed of light, c	3 × 10^8 m/s
Mass of electron, m_e	9.1 × 10^-31 kg
Mass of proton, m_p	1.7 × 10^-27 kg
Charge of electron, e	1.6 × 10^-19 C
Permeability of free space, μ0	4π × 10^-7 T m A^-1
Planck's constant, h	6.63 × 10^-34 J s
Permittivity of free space, ε0	8.854 × 10^-12 C^2 N^-1 m^-2
1/(4πε0)	9 × 10^9 N m^2 C^-2
hc	1240 eV nm
Ground-state energy of hydrogen	−13.6 eV

Section A – 16 × 1 = 16 marks

Q1–12 are multiple-choice questions. Choose the correct option.

1. The net electric flux through a closed spherical surface of radius R, enclosing an electric dipole of dipole moment p, is

(A) zero (B) p/ε_0 (C) $2p/\varepsilon_0$ (D) $p/(4\pi\varepsilon_0 R^2)$

2. A parallel-plate capacitor is charged by a battery and the battery is then disconnected. A dielectric slab of dielectric constant 4 is now inserted to fill the space between the plates. The energy stored in the capacitor

(A) becomes four times (B) becomes one-fourth (C) becomes one-half (D) remains the same

3. Two copper wires X and Y are connected in parallel across a battery. Wire Y is twice as long as wire X and has twice its radius. The ratio of the heat produced per second in X to that in Y is

(A) 1 : 2 (B) 2 : 1 (C) 1 : 4 (D) 4 : 1

4. A conductor of uniform cross-section carries a steady current. If the area of cross-section is halved (same material) and the same current is passed, the drift velocity of the electrons

(A) becomes half (B) becomes double (C) becomes four times (D) remains unchanged

5. A proton and an alpha particle enter a uniform magnetic field, perpendicular to it, with the same kinetic energy. The ratio of the radii of their circular paths, $r_p : r_\alpha$, is

(A) 1 : 2 (B) 2 : 1 (C) 1 : 1 (D) $1 : \sqrt{2}$

6. A radial magnetic field (concave pole pieces with a soft-iron core) is used in a moving-coil galvanometer so that

(A) the torque on the coil is zero in every position (B) the deflection of the coil is proportional to the current (C) the resistance of the coil decreases (D) the earth's magnetic field has no effect on the coil

7. Soft iron is preferred for the core of a transformer because it has

(A) high retentivity and high coercivity (B) low retentivity and low coercivity (C) high retentivity and low coercivity (D) low retentivity and high coercivity

8. A bar magnet is dropped from rest through a long vertical copper tube. As it falls, its speed

(A) increases uniformly with acceleration g (B) first increases and then becomes constant (C) decreases continuously to zero (D) first increases and then decreases to zero

9. A series LCR circuit has $R = 30\ \Omega$, $X_L = 60\ \Omega$ and $X_C = 20\ \Omega$. The power factor of the circuit is

(A) 0.4 (B) 0.6 (C) 0.8 (D) 1.0

10. A plane electromagnetic wave of intensity I is incident normally on a perfectly absorbing surface. The radiation pressure on the surface is

(A) I/c (B) $2I/c$ (C) Ic (D) I/c^2

11. An object is placed 30 cm in front of a convex lens of focal length 20 cm. The image formed is

(A) real, inverted and twice the size of the object (B) virtual, erect and twice the size of the object (C) real, inverted and half the size of the object (D) real, erect and of the same size

12. In Young's double-slit experiment, the intensity at a point where the path difference is λ/6 is K. The intensity at the central bright fringe is

(A) K (B) 4K/3 (C) 2K (D) 4K

For Q13–16, two statements are given: Assertion (A) and Reason (R). Select the correct answer from the options below.

(A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) Both A and R are false.

13. Assertion (A): Photoelectric emission from a metal surface takes place almost instantaneously when radiation of frequency above the threshold frequency falls on it, even if the intensity is very low. **Reason (R):** The energy of a photon is absorbed by a single electron in a one-to-one interaction, and this does not depend on the intensity of the radiation.

14. Assertion (A): An electron revolving in a stationary orbit of a hydrogen atom does not radiate energy. **Reason (R):** The angular momentum of an electron in a stationary orbit is an integral multiple of $h/2\pi$.

15. Assertion (A): The electric potential at any point on the equatorial line of an electric dipole is zero. **Reason (R):** The electric field at any point on the equatorial line of an electric dipole is zero.

16. Assertion (A): A diamagnetic substance is attracted towards the region of stronger field in a non-uniform magnetic field. **Reason (R):** Diamagnetic substances have a large positive magnetic susceptibility.

Section B – 5 × 2 = 10 marks

17. During a thunderstorm, people are advised to stay inside a car with a metal body rather than in an open field or under a tree. Explain, using the idea of electrostatic shielding, why the car is a safe place. [2]

18. Two point charges of +4 μC and −4 μC are placed 20 cm apart in air. Find (i) the electric potential and (ii) the magnitude and direction of the electric field at the midpoint of the line joining the charges. [2]

19. A student connects a cell to two different loads and records the terminal potential difference: it is 1.8 V when the cell delivers 1.0 A and 1.6 V when it delivers 2.0 A. Calculate the emf and the internal resistance of the cell. [2]

20. (a) Write the expression for the force per unit length between two long parallel straight conductors carrying currents I_1 and I_2 in the same direction, separated by a distance d. Hence define one ampere. [2]

OR

(b) A wire carrying a current of 10 A is bent into a circular loop of radius π cm. Find the magnetic field at the centre of the loop. [2]

21. (a) The ground-state energy of a hydrogen atom is −13.6 eV. Calculate the energy and the wavelength of the photon emitted when the electron jumps from the n = 3 orbit to the n = 2 orbit. Name the spectral series to which this line belongs. [2]

OR

(b) Light of wavelength 400 nm is incident on a metal surface of work function 2.0 eV. Calculate (i) the maximum kinetic energy of the emitted photoelectrons in eV and (ii) the stopping potential. [2]

Section C – 7 × 3 = 21 marks

22. Derive an expression for the energy stored in a parallel-plate capacitor of capacitance C charged to a potential difference V. Hence obtain the energy density of the electric field in terms of E. [3]

23. (a) Define drift velocity and relaxation time. (b) Using the free-electron model of a conductor, derive the expression for resistivity, $\rho = m/(ne^2\tau)$. [3]

24. A mass spectrometer uses a velocity selector in which a uniform electric field $E = 3 \times 10^4$ V/m and a uniform magnetic field B = 0.1 T act at right angles to each other and to the beam of singly charged ions. (i) Find the speed of the ions that pass through undeflected. (ii) An ion of speed 4×10^5 m/s enters the selector. Which force is greater on it, electric or magnetic? Hence state the direction in which it is deflected. (iii) Does the speed selected depend on the mass or the charge of the ion? Justify. [3]

25. Distinguish between diamagnetic, paramagnetic and ferromagnetic materials on the basis of (i) magnetic susceptibility, (ii) behaviour in a non-uniform magnetic field, and (iii) dependence on temperature. Give one example of each. [3]

26. (a) A conducting rod PQ of length 50 cm moves with a constant velocity of 4 m/s on two smooth parallel rails placed in a uniform magnetic field of 0.2 T perpendicular to the plane of the rails. The rails are joined by a resistor of 2 Ω; the resistance of the rod and the rails is negligible. Calculate (i) the emf induced, (ii) the force required to keep the rod moving at constant speed, and (iii) the power dissipated in the resistor. Show that the energy is conserved. [3]

OR

(b) A step-down transformer of 80% efficiency reduces 2200 V to 220 V and supplies 4.4 kW to a load. Calculate (i) the current in the secondary coil and (ii) the current in the primary coil. (iii) State any two causes of energy loss in a real transformer. [3]

27. A plane electromagnetic wave travelling along the +x direction in free space has the electric field $E = (30\ \text{V/m})\,\hat{j}\,\sin(2\pi x - 6\pi \times 10^8\, t)$, where x is in metres and t is in seconds. (i) Find the wavelength and the frequency of the wave. (ii) Find the amplitude of the magnetic field. (iii) Write the expression for the magnetic field, stating its direction of oscillation. [3]

28. State the postulates of Bohr's model of the hydrogen atom. Using them, show that the radius of the nth orbit is proportional to n^2. [3]

Section D – 2 × 4 = 8 marks

Q29 and Q30 are case-study based questions. Read the passage and answer the questions that follow.

29. Tuning a radio receiver. An AM radio receiver selects a station with a series LCR circuit called the tuner. The aerial picks up the signals of many stations at once, and each induces a small emf of its own frequency in the circuit. When the natural frequency of the circuit is adjusted to match one station, the

current for that station becomes very large and that for the others stays small: the circuit is said to be tuned. In one receiver the tuner has L = 100 μH, R = 10 Ω and a variable capacitor, which is initially set at C = 100 pF.

(i) The resonant angular frequency of the circuit is [1]

(A) 10^5 rad/s (B) 10^6 rad/s (C) 10^7 rad/s (D) 10^8 rad/s

(ii) To tune to a station whose frequency is twice the present resonant frequency, the capacitor should be set to [1]

(A) 200 pF (B) 50 pF (C) 25 pF (D) 400 pF

(iii) At resonance in a series LCR circuit, which statement is correct? [1]

(A) The current lags the applied voltage by 90°. (B) The potential differences across L and C are equal in magnitude and opposite in phase. (C) The impedance of the circuit is maximum. (D) The power factor of the circuit is zero.

(iv) The resistance of the tuner is doubled, with L and C unchanged. The quality factor and the sharpness of tuning will [1]

(A) double and become sharper (B) become half and become less sharp (C) remain unchanged (D) double and become less sharp

30. Photocell in an automatic street light. A photocell controls the street lamps of a colony: in daylight the photocurrent is amplified to switch the lamps off, and at dusk the current falls and the lamps switch on. The emitter of the photocell is a metal of work function 2.5 eV. (Use hc = 1240 eV nm.)

(i) Calculate the threshold wavelength of the emitter. [1]

(ii) Light of wavelength 310 nm falls on the emitter. Find the maximum kinetic energy of the photoelectrons and the stopping potential. [1]

(iii) The intensity of this 310 nm light is doubled, with everything else unchanged. State, with reason, how (a) the saturation photocurrent and (b) the stopping potential change. [2]

Section E – 3 × 5 = 15 marks

31. (a) (i) Using Gauss's law, derive the expression for the electric field due to a uniformly charged thin spherical shell at a point (A) outside the shell and (B) inside the shell. [3] (ii) A thin spherical shell of radius 10 cm carries a charge of 20 nC. Find the electric field at a point 20 cm from the centre and the potential at the surface of the shell. [2]

OR

(b) (i) Derive the expression for the capacitance of a parallel-plate capacitor of plate area A and separation d, when a dielectric slab of dielectric constant K and thickness t (t < d) is introduced between the plates. [3] (ii) A parallel-plate capacitor has capacitance 12 pF in air. A slab of thickness d/2 and dielectric constant 3 is inserted between its plates. Find the new capacitance and the energy stored when the capacitor is charged to 100 V. [2]

32. (a) (i) Use the Biot–Savart law to derive the expression for the magnetic field at a point on the axis of a circular current-carrying loop. [3] (ii) A circular coil of 100 turns and radius 3 cm carries a current of 0.5 A. Find the magnetic field at a point on its axis 4 cm from the centre. [2]

OR

(b) (i) Derive the expression for the torque on a rectangular current-carrying loop placed in a uniform magnetic field. Hence write the expression for its magnetic moment. [3] (ii) A rectangular coil of 50 turns and size 10 cm × 5 cm carries a current of 2 A in a uniform magnetic field of 0.4 T. The normal to the coil makes an angle of 30° with the field. Find the torque on the coil and the maximum torque it can experience. [2]

33. (a) (i) Derive the lens maker's formula for a thin convex lens, using refraction at spherical surfaces. [3] (ii) An equiconvex glass lens (refractive index 1.5) has both radii of curvature equal to 20 cm. Find its focal length in air. The lens is now immersed in a liquid of refractive index 1.6; find its new focal length and state the nature of the lens in the liquid. [2]

OR

(b) (i) Derive the expression for the fringe width in Young's double-slit experiment. [3] (ii) In a double-slit experiment the slits are 0.5 mm apart, the screen is 1 m away and the wavelength of light used is 500 nm. Find the fringe width and the distance of the third dark fringe from the central maximum. [2]

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