Previous Years' Paper

Common University Entrance Test for UG Programmes

CUET-UG - Physics

Entrance Exam, 2025

(After the list of questions, the solution will Start.)

Q1. If the protons and electrons are the only basic charges in the universe, all the observable charges have to be integral multiples of e. Thus, if an object contains x electrons and y protons, the net charge on the object will be

1. - (x + y) e

2. (x + y) e

3. (x - y) e

4. (y - x) e

Q2. A charge of magnitude 3 x 10^{-7} C is located at a distance of 0.09 m from a point P. Obtain the work done in bringing a charge of 2 x 10^{-9} C from infinity to the point P.

1. 6 x 10^{4} J

2. 6 x 10^{-2} J

3. 6 x 10^{-5} J

4. 6 x 10^{5} J

Q3. In a series combination of capacitors connected across a battery

1. each capacitor has an equal charge for certain values of capacitances only

2. each capacitor has different charge for a certain value of its capacitance

3. each capacitor has equal charge for any value of its capacitance

4. each capacitor has different charge for any value of its capacitance

Q4. Two point charges, 4 μC and -3 μC (with no external field) are placed at (-6 cm, 0, 0) and (6 cm, 0, 0), respectively. The amount of work required to separate the two charges infinitely away from each other will be

1. 0.9 J

2. 0.18 J

3. -0.9 J

4. -0.018 J

Q5. If the net flux through a cube is 1.05 N m^2 C^{-1}, what will be the total charge inside the cube? (Given: The permittivity of free space is 8.85 x 10^{-12} c^2 N^{-1} m^{-2}).

1. 9.29 x 10^{-11} C

2. 9.27 x 10^{-10} C

3. 9.22 x 10^{-6} C

4. 9.29 x 10^{-12} C

Q6. A parallel plate capacitor having plate area 200 cm^2 and separation 2.0 mm holds a charge of 0.06 μC on applying a potential difference of 60 V. The dielectric constant of the material filled in between the plates is.

1. 0.113

2. 1.13

3. 11.3

4. 113

Q7. The electric potential due to an electric dipole

(A) depends on r, where r is the magnitude of position vector $\vec{r}$

(B) depends on the angle between the position vector $\vec{r}$ and the dipole moment vector $\vec{p}$

(C) falls off at long distances, as $1/r^2$

(D) does not depend upon the distance separating the charges

Choose the correct answer from the options given below:

1. (A), (B) and (D) only

2. (A), (B) and (C) only

3. (A), (B), (C) and (D)

4. (B), (C) and (D) only

Q8. Two point charges placed a distance d apart in vacuum exert a force of magnitude F on each other. One of the two charges is doubled. To keep the magnitude of force same the separation between the charges should be changed to

1. 2d

2. d/2

3. $\sqrt{2}$ d

4. d/$\sqrt{2}$

Q9. Conductors develop electric currents in them

1. on applying electric field

2. on placing the conductor in the magnetic field

3. on applying gravitational field only

4. on applying the magnetic field and gravitational field

Q10. Resistivity of a conductor depends on

1. its material and the dimensions of the conductor

2. its material and temperature of the conductor

3. the dimensions of the conductor only

4. the temperature of the conductor only

Q11. In the (i) absence of electric field, and in the (ii) presence of electric field, the paths of electrons between successive collisions with the positive ions of the metal, are

1. (i) Straight line, (ii) straight line

2. (i) Curved, (ii) straight line

3. (i) Curved, (ii) curved

4. (i) Straight line, (ii) Curved in general

Q12. A resistor develops 800 J of thermal energy in 20 s on applying a potential difference of 20 V. Its resistance is

1. 20 Ω

2. 10 Ω

3. 40 Ω

4. 0.5 Ω

Q13. A wire of resistance 4 Ω is used to make a coil of radius 7 cm. The wire has a diameter of 1.4 mm and the resistivity of its material is 2 x 10^{-7} Ω m. The number of turns in the coil will be

1. 70

2. 40

3. 140

4. 20

Q14. A battery of emf 12 V and internal resistance 3 Ω is connected to an external resistor. If the current in the circuit is 0.6 A, the voltage across the external resistor will be

1. 10.2 V

2. 17.0 V

3. 12.0 V

4. 13.8 V

Q15. A uniform wire of resistance 12 Ω is cut into three pieces in the ratio of length 1: 2: 3. Now the three pieces are connected to form a triangle. A cell of emf 8 V and internal resistance 5 Ω is connected across the highest of the three resistors, The current through the circuit is:

1. 4 A

2. 2 A

3. 0.5 A

4. 1 A

Q16. A bar magnet of magnetic moment 5.0 A m^2 has poles 20 cm apart. The pole strength would be

1. 20 A m

2. 30 A m

3. 1 A m

4. 25 A m

Q17. Match List-I with List-II

List-I	List-II
Physical Quantity	**Units**
(A) Magnetic field	(I) $J\ T^{-1}$
(B) Magnetic moment	(II) $T\ m\ A^{-1}$
(C) Pole strength	(III) $J\ T^{-1}\ m^{-1}$
(D) Permeability of free space	(IV) $Wb\ m^{-2}$

Choose the correct answer from the options given below:

1. (A) – (IV), (B) – (II), (C) – (III), (D) – (I)

2. (A) – (IV), (B) – (I), (C) – (III), (D) – (II)

3. (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

4. (A) – (IV), (B) – (III), (C) – (I), (D) – (II)

Q18. A long wire with a small current element of length 1 cm is placed at the origin and carries a current of 10 A along the x-axis. The magnitude of the magnetic field, due to the element, on the y-axis at a distance 0.5 m from it, would be

1. 4×10^{-8} T

2. 5×10^{-8} T

3. 6×10^{-8} T

4. 2×10^{-8} T

Q19. A conductor is placed along z-axis carrying current in z direction in uniform magnetic field directed along y-axis. The magnetic force acting on the conductor is directed along:

1. positive x-axis

2. positive y-axis

3. positive z-axis

4. negative x-axis

Q20. A galvanometer of resistance 520 Ω is shunted with 20 Ω resistance to convert it into an ammeter. The resistance of the ammeter will be

1. 16.8 Ω

2. 540 Ω

3. 19.3 Ω

4. 18 Ω

Q21. The magnitude of magnetic field inside a solenoid of length 0.3 m having 800 turns carrying a current of 6 A is

1. 2.03 T

2. 60.3 mT

3. 20 mT

4. 6.03 T

Q22. A charged particle accelerated through a potential difference of V volts acquires a speed u. The particle is then made to enter perpendicularly in a uniform magnetic field B. The radius of the circular path followed by the charged particle will be proportional to

1. V/u

2. u/V

3. $V2/u^2$

4. u^2/V^2

Q23.

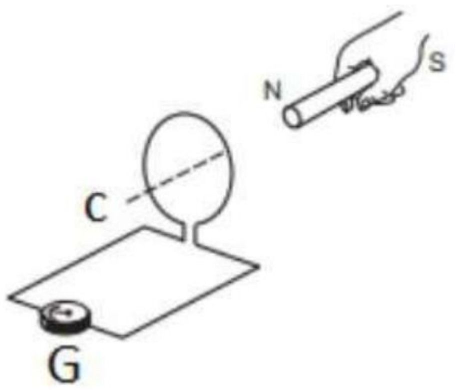

Figure shows a coil C connected to a galvanometer G. When the North-pole of a bar magnet is pushed towards the coil, the pointer in the galvanometer deflects. Regarding this set up, the following statements are given:

(A) It indicates the presence of electric current in the coil.

(B) The deflection is found to be smaller when the magnet is pushed towards the coil faster.

(C) There is repulsion in the moving magnet and the magnetic pole induced in the coil facing towards the N pole of the magnet.

(D) If the bar magnet does not move, there is no induced current in the coil.

Choose the correct answer from the options given below:

1. (A), (C) and (D) only

2. (A), (B) and (C) only

3. (A), (B), (C) and (D)

4. (B), (C) and (D) only

Q24.

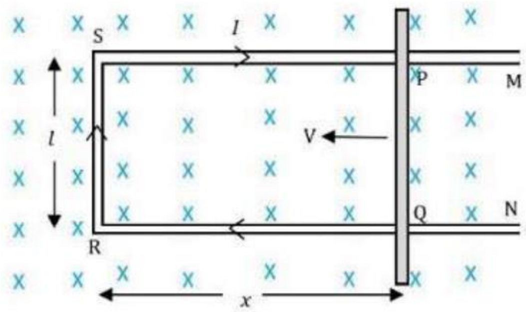

Figure shows a rectangular conductor PORS in which the conductor PO is free to move. The conductor PO is moved towards the left with a constant velocity V as shown in the figure. Assume that there is no loss of energy due to friction.

What will be the magnetic flux linked with the loop PQRS and the motional emf?

1. Magnetic $flux = Bl(xV)$; Motional $emf = Blx$

2. Magnetic $flux = Blx$; Motional $emf = (BlV)/t$

3. Magnetic $flux = Blx$; Motional $emf = BlV$

4. Magnetic $flux = B/(lx)$; Motional $emf = BlV$

Q25. The average emf induced in a coil is 2 V when current is changed in 0.4 s

(A) from 5 A to 2 A and the self-inductance of the coil is 0.266 mH

(B) from 4 A to 4 A in the opposite direction, the self-inductance of the coil is 0.10 mH

1. (A) is correct, (B) is incorrect

2. Both (A) and (B) are correct

3. (A) is incorrect, (B) is correct

4. Both (A) and (B) are incorrect

Q26. An inductor of 500 mH is in series with a resistance and a variable capacitor connected to a source of frequency 0.4 kHz. The value of capacitance of the capacitor to get a maximum current will be

1. 2.3 μF

2. 0.32 μF

3. 63 μF

4. 0.62 μF

Q27. A 12 V battery connected to a 6, 10 mH coil through a switch drives a constant current in the circuit. The switch is suddenly opened. Assuming that it took 1 ms to open the switch, the average emf induced across the coil would be

1. 10 V

2. 20 V

3. 200 V

4. 12 V

Q28. For an ac source rated at 220 V, 50 Hz, which of the following statements is correct?

1. The peak value over a period of (1/50) s is 220 V.

2. The average value over a period of (1/50) s is 220 V.

3. The average value over a period of (1/50) s is 0 V.

4. The average value over a period of (1/50) s is $220\sqrt{2}$ V.

Q29. Which of the following statements is not correct for electromagnetic induction?

1. The magnitude of induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit.

2. The magnitude of induced emf in a circuit is equal to the total change of magnetic flux through the circuit.

3. The induced emf can be increased by increasing the number of turns N of a closed coil.

4. The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it

Q30. Maxwell's displacement current is

1. due to flow of charges

2. due to changing gravitational field

3. due to changing electric field

4. **ϵ0** times the rate of change of magnetic flux

Q31. Match List-I with List-II

List-I	List-II
Electromagnetic waves	**Wavelength range**
(A) X-rays	(I) 1 mm to 700 nm
(B) Radio waves	(II) 0.1 m to 1 mm
(C) Infrared waves	(III) 1 nm to 10^{-3} nm
(D) Microwaves	(IV) $>$ 0.1 m

Choose the correct answer from the options given below:

1. (A) – (IV), (B) – (II), (C) – (III), (D) – (I)

2. (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

3. (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

4. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Q32. The electric field E associated with a progressive electromagnetic wave is given by $E = E_0 sin(kx - \omega t)$. If B_0 is the amplitude of the magnetic field associated with the wave, then

1. $\frac{E_0}{B_0} = \frac{\omega}{k}$

2. $\frac{E_0}{B_0} = \frac{\omega^2}{k^2}$

3. $\frac{E_0}{B_0} = \frac{k}{\omega}$

4. $\frac{E_0}{B_0} = \frac{k^2}{\omega^2}$

Q33. Which of the following statements are correct?

(A) All mirrors follow the laws of reflection.

(B) The angle between the ray of incidence and the plane surface of the mirror is equal to the angle between the plane surface of mirror and the ray of reflection for plane mirror

(C) the rays coming parallel to the principal axis will go after reflection through the focus of the curved mirror

(D) the rays coming to the pole of a curved mirror making an angle with axis will be reflected making the equal angle with the axis on the other side of the axis.

Choose the correct answer from the options given below:

1. (A), (B), (C) and (D)

2. (A), (C) and (D) only

3. (A), (B) and (C) only

4. (B), (C) and (D) only

Q34. Which of the following statement(s) is/are correct?

(A) The power of a lens is the ability of the lens to converge or diverge the incident rays.

(B) S.I unit of the power of a lens is dioptre while focal length is in centimetres

(C) For a lens of larger focal length, power is smaller

(D) In any combination of lenses, the power of combination is not algebraic addition of power of combined lenses

Choose the correct answer from the options given below:

1. (A) and (C) only

2. (B), (C) and (D) only

3. (A) and (B) only

4. (A) only

Q35. In an experiment with a convex lens, the length of an image is 1 cm, and the object length is 5 cm. If the object is placed at a distance of 40 cm from the lens, then the focal length of the lens is

1. 6.67 cm

2. 13.5 cm

3. 5.6 cm

4. 3.6 cm

Q36. In a Young's double-slit experiment, two slits are 1.5 mm apart while the screen is 1.2 m away. When a light of wavelength 600 nm is incident on slits, the fringe width will be

1. 0.48 mm

2. 4.5 mm

3. 4.8 mm

4. 4.2 mm

Q37. The critical angle of incidence i_c for a ray incident from a denser to rarer medium, is that angle for which

1. the angle of reflection is 90°

2. the angle of refraction is 90°

3. the angle of refraction is 0°

4. the angle of reflection is 0°

Q38. A polaroid sheet is rotated between two crossed polarizers. The intensity of transmitted light would be maximum, when the angle between the axes of the first polarizer and the polaroid sheet is

1. π/2

2. π /4

3. π

4. π /3

Q39. Which of the following statements are correct?

(A) Total internal reflection occurs when a ray of light travels from a rarer transparent medium to a denser medium.

(B) In total internal reflection, the incident ray of light remains in the same medium after reflection.

(C) In total internal reflection, the angle of incidence inside the denser transparent medium is equal to the angle of reflection in the same medium.

(D) In total internal reflection inside a denser medium there is no angle of refraction

Choose the correct answer from the options given below:

1. (B) and (C) only

2. (A) and (B) only

3. (B), (C) and (D) only

4. (C) and (D) only

Q40. If focal length of a concave lens is 50 cm, then the power of the lens would be

1. +5 D

2. -5 D

3. +2 D

4. -2 D

Q41. The photoelectric current is directly proportional to the number of photo electrons emitted per second. This implies that

1. the number of photoelectrons emitted per second is equal to the frequency of incident radiation.

2. the number of photoelectrons emitted per second is inversely proportional to the intensity of incident radiation.

3. the number of photoelectrons emitted per second is directly proportional to the intensity of incident radiation.

4. the number of photoelectrons emitted per second is not related to the intensity of incident radiation.

Q42. The de-Broglie wavelength associated with a ball of mass 150 g traveling at 30.0 m/s would be

1. $1.47 \times 10^{-34}\, m$

2. $14.7 \times 10^{-34}\, m$

3. $0.147 \times 10^{-34}\, m$

4. $7.14 \times 10^{-34}\, m$

Q43. Which of the following statements are correct?

(A) A nucleus of mass number A has a radius R given by the expression $R = R_0A^{1/3}$

(B) Volume of nucleus is proportional to mass number A

(C) The density of nucleus increases with the radius of nucleus.

(D) Density of nuclear matter does not depend on its mass number A

Choose the correct answer from the options given below:

1. (A), (B) and (C) only

2. (A), (B), (C) and (D)

3. (A) (B) and (D) only

4. (B) and (C) only

Q44. An electron in the ground state of a hydrogen atom absorbs 12.09 eV energy. The angular momentum of the electron increases by

1. $(h/2\pi)$

2. $2(h/2\pi)$

3. $3(h/2\pi)$

4. $4(h/2\pi)$

Q45. Which of the following statements are correct?

(A) The electrostatic repulsive force between the protons can be greater than the nuclear force to bind the nucleons together inside a nucleus.

(B)The repulsive electrostatic force between protons in smaller nuclei is much smaller than the nuclear force between nucleons inside a nucleus.

(C) The gravitational force between nucleons is much smaller than the nuclear force between the nucleons inside a nucleus.

(D) The binding energy per nucleon between nucleons is almost constant because the nuclear force is a long range force.

Choose the correct answer from the options given below:

1. (A) and (D) only

2. (B) and (C) only

3. (C) and (D) only

4. (A) only

Q46. Below given are some statements about electronic devices:

(A) Diodes can be used for rectifying an ac voltage.

(B) For semiconductors, band gap energy $E_g > 3$ eV.

(C) By changing the external applied voltage, junction barriers can be changed.

(D) p-n junction is the 'key' to all semiconductor devices.

Choose the correct answer from the options given below:

1. (A), (B) and (D) only

2. (A), (B) and (C) only

3. (B), (C) and (D) only

4. (A), (C) and (D) only

Q47. On connecting a device X in a series circuit with a battery and a resistor, a current passes through the circuit. On reversing the polarity of the battery, the current in the circuit drops to almost zero. The device X may be a

1. *p* - type semiconductor

2. *n* - type semiconductor

3. *p-n* junction diode

4. capacitor

Q48. Which of the following statement(s) is/are true for p-type semiconductors?

(A) Holes are minority carriers and pentavalent atoms are the dopants.

(B) Electrons are majority carriers and trivalent atoms are the dopants.

(C) Holes are majority carriers and trivalent atoms are the dopants.

(D) Electrons are minority carriers and pentavalent atoms are the dopants.

Choose the correct answer from the options given below:

1. (B) only

2. (C) only

3. (C) and (D) only

4. (A) and (C) only

Q49. In the following nuclear reaction,

$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{140}_{54}Xe + ^{a}_{b}Sr + 2^{1}_{0}n$ we have

1. $a = 38$, $b = 94$

2. $a = 94$, $b = 38$

3. $a = 94$, $b = 40$

4. $a = 96$, $b = 38$

Q50. A proton accelerated through a potential difference of V volts has a de-Broglie wavelength λ associated with it. In order to get the same wavelength associated with an α-particle, the required accelerating potential is

1. $\mathrm{V}/16$

2. $\mathrm{V}/8$

3. $4\mathrm{V}$

4. $8\mathrm{V}$

Solution

Q1.

Ans.

Step 1. Recall the basic charges

- Charge of **1 proton** = **+e**
- Charge of **1 electron** = **–e**

Step 2. Calculate total charge

If the object has:

- **x electrons** → total charge = **–x·e**
- **y protons** → total charge = **+y·e**

Step 3. Find the net charge

Net charge = (Charge due to protons) + (Charge due to electrons)

= (+y·e) + (–x·e)

= (y – x)·e

☑ **Final Answer: (y – x)e**

Correct Option: 4)

Q2.

Ans.

Step 1. Given data

Charge $q_1 = 3 \times 10^{-7}\,C$
Charge $q_2 = 2 \times 10^{-9}\,C$
Distance $r = 0.09\,m$
Coulomb's constant $k = 9 \times 10^9\,N \cdot m^2/C^2$

Step 2. Formula for work done

Work done (W) = Potential energy =

$$W = \frac{kq_1q_2}{r}$$

Step 3. Substitute the values

$$W = \frac{9 \times 10^9 \times (3 \times 10^{-7}) \times (2 \times 10^{-9})}{0.09}$$

Step 4. Simplify step by step

Numerator = $9 \times 3 \times 2 \times 10^{9-7-9} = 54 \times 10^{-7} = 5.4 \times 10^{-6}$

Divide by 0.09:

$$W = \frac{5.4 \times 10^{-6}}{0.09} = 6 \times 10^{-5}\, J$$

✅ **Final Answer: 6×10^{-5} J**

Correct Option: 3)

Q3.

Ans.

Step 1. Recall the rule for capacitors in series

When capacitors are connected **in series**, the **same charge (Q)** flows through each capacitor because the charge has only **one path** to move through.

This is similar to how in a series circuit of resistors, the same current flows through all components.

Step 2. Relation between charge, voltage, and capacitance

For a capacitor,

$$Q = C \times V$$

In series combination:

- The **total voltage (V)** is divided among capacitors.
- But the **charge (Q)** on each capacitor remains **the same**, regardless of their capacitance.

Step 3. Conclusion

Therefore, in a **series combination**, each capacitor carries an **equal charge** for **any value of its capacitance**.

✅ **Final Answer: each capacitor has equal charge for any value of its capacitance**

Correct Option: 3)

Q4.

Ans.

Step 1. Use potential energy of two point charges:

$$U = \frac{kq_1q_2}{r}, \quad k = 9 \times 10^9 \text{ N m}^2/\text{C}^2$$

Here $q_1 = 4\,\mu\text{C} = 4 \times 10^{-6}$ C,

$q_2 = -3\,\mu\text{C} = -3 \times 10^{-6}$ C, and the separation is

$r = |6 - (-6)|\text{ cm} = 12\text{ cm} = 0.12\text{ m.}$

Step 2. Compute initial potential energy:

$$U_i = \frac{(9 \times 10^9)(4 \times 10^{-6})(-3 \times 10^{-6})}{0.12} = -0.9\text{ J.}$$

Step 3. At infinite separation, potential energy, $Uf = 0$.

Step 4. Work required by an external agent to separate them:

$$W = U_f - U_i = 0 - (-0.9) = +0.9\text{ J.}$$

✅ **Final Answer:** 0.9 J

Correct Option: 1)

Q5.

Ans.

Step 1. Recall the basic formula from Gauss's Law.

Gauss's Law in electrostatics provides the relationship between the net electric flux (Φ) through a closed surface and the net charge enclosed (q_{inside}) by it.

- **Formula:** $\Phi = \frac{q_{inside}}{\epsilon_0}$

(Where ϵ0 is the permittivity of free space.)

Step 2. Identify the given values from the question.

- Net flux (Φ) = $1.05\text{ N m}^2\text{ C}^{-1}$
- Permittivity of free space (ϵ_0) = $8.85 \times 10^{-12}\text{ C}^2\text{ N}^{-1}\text{ m}^{-2}$

Step 3. Rearrange the formula to find the net charge (q_{inside}).

To solve for the charge, we multiply both sides of the formula by ϵ_0.

- **Rearranged Formula:** $q_{inside} = \Phi \times \epsilon_0$

Step 4. Substitute the given values and calculate.

Now, we plug the values from Step 2 into the rearranged formula from Step 3.

- **Calculation:**

$$q_{inside} = (1.05) \times (8.85 \times 10^{-12})$$

$$q_{inside} = 9.2925 \times 10^{-12}\ \text{C}$$

✅ **Final Answer: 9.29 × 10^{-12} C**

Correct Option: 4)

Q6.

Ans.

Step 1. List the given data and convert to SI units.

First, we write down all the values from the problem and convert them into standard SI units for calculation.

- **Area (A):** $200\ \text{cm}^2 = 200 \times 10^{-4}\ \text{m}^2 = 2 \times 10^{-2}\ \text{m}^2$
- **Separation (d):** $2.0\ \text{mm} = 2.0 \times 10^{-3}\ \text{m}$
- **Charge (Q):** $0.06\ \mu\text{C} = 0.06 \times 10^{-6}\ \text{C} = 6 \times 10^{-8}\ \text{C}$
- **Voltage (V):** $60\ \text{V}$
- **Permittivity of free space (ϵ_0):** $8.85 \times 10^{-12}\ \text{F/m}$

Step 2. Calculate the capacitance (C) of the capacitor.

The basic definition of capacitance is the ratio of the charge stored to the potential difference across it.

- **Formula:** $C = \frac{Q}{V}$
- **Calculation:** $C = \frac{6 \times 10^{-8}\ \mathrm{C}}{60\ \mathrm{V}} = 1 \times 10^{-9}\ \mathrm{F}$

Step 3. Recall the formula for a parallel plate capacitor with a dielectric.

The capacitance of a parallel plate capacitor also depends on its physical dimensions and the dielectric material between its plates.

- **Formula:** $C = \frac{K\epsilon_0 A}{d}$

(Here, **K** is the dielectric constant we need to find.)

Step 4. Rearrange the formula and solve for K.

Now we rearrange the formula from Step 3 to solve for K and substitute all the known values.

- **Rearranged Formula:** $K = \frac{C \cdot d}{\epsilon_0 A}$
- **Substitution:**

$$K = \frac{(1 \times 10^{-9}\ \mathrm{F}) \times (2 \times 10^{-3}\ \mathrm{m})}{(8.85 \times 10^{-12}\ \mathrm{F/m}) \times (2 \times 10^{-2}\ \mathrm{m}^2)}$$

- **Calculation:**

$$K = \frac{2 \times 10^{-12}}{17.7 \times 10^{-14}}$$

$$K = \frac{2}{17.7} \times 10^2 = \frac{200}{17.7} \approx 11.299$$

Rounding off, we get $K = 11.3$.

✅ **Final Answer: 11.3**

Correct Option: 3)

Q7.

Ans.

Step 1. Recall the formula for potential due to an electric dipole

The electric potential at a point due to a dipole is given by:

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p\cos\theta}{r^2}$$

Where:

- p = dipole moment
- r = distance from dipole center
- θ = angle between dipole axis and position vector

Step 2. Analyze each statement

(A) Depends on r: ✅

Since $V \propto \frac{1}{r^2}$, it clearly depends on distance r.

(B) Depends on the angle between the position vector and dipole moment vector: ☑

The formula includes $\cos\theta$, so V depends on angle θ.

(C) Falls off at long distances as $1/r^2$: ✅

(D) Does not depend on the distance separating the charges: ✕

The dipole moment $p = q \times 2a$, so potential **does depend** indirectly on the separation (through p).

Step 3. Correct statements

(A), (B), and (C) are **correct.**

☑ **Final Answer: (A), (B), and (C) only**

Correct Option: 2)

Q8.

Ans.

Step 1. Write the original force using Coulomb's law

$$F = \frac{kq_1q_2}{d^2}$$

where

F = electrostatic force,

q_1 and q_2 = magnitudes of charges,

d = distance between them,

k = Coulomb's constant.

Step 2. One of the charges is doubled

Let the new charge be $2q_1$, and new distance = d'.

The new force F' becomes:

$$F' = \frac{k(2q_1)q_2}{d'^2} = \frac{2kq_1q_2}{d'^2}$$

Step 3. Force remains the same

Given $F' = F$,

$$\frac{2kq_1q_2}{d'^2} = \frac{kq_1q_2}{d^2}$$

Step 4. Simplify the equation

$$\frac{2}{d'^2} = \frac{1}{d^2}$$

$$d'^2 = 2d^2$$

$$d' = \sqrt{2}d$$

☑ **Final Answer: √2 d**

Correct Option: 3)

Q9.

Ans.

Step 1. Recall the concept of current in conductors

Electric current is the **flow of free electrons** through a conductor.
For electrons to move, there must be a **force** acting on them - this force is provided by an **electric field**.

Step 2. When does a conductor develop current?

- When an **electric field** is applied, electrons experience a force and start moving in the opposite direction of the field.
- This movement of electrons constitutes **electric current**.

Step 3. Analyze other options

- Magnetic field alone → does **not** produce current in a stationary conductor.
- Gravitational field → effect is **negligible** on electrons due to their very small mass.
- Both magnetic and gravitational fields together → still do not produce current without an electric field.

✅ **Final Answer: On applying electric field**

Correct Option: 1)

Q10.

Ans.

Step 1. Recall the concept of resistivity

Resistivity (ρ) is an intrinsic property of a material that determines how strongly it resists the flow of electric current.

It is **independent of the conductor's shape or size** — it depends only on the **nature of the material** and **temperature**.

Step 2. Key relation

The resistance R of a conductor is given by:

$$R = \rho \frac{L}{A}$$

where:

- $R =$ resistance
- $\rho =$ resistivity

- L = length
- A = cross-sectional area

Here, R depends on L and A, but **resistivity (ρ)** does **not** — it depends on:

1. **Material of the conductor** (different materials have different ρ)
2. **Temperature** (resistivity increases with temperature for metals)

✅ **Final Answer: Its material and temperature of the conductor**

Correct Option: 2)

Q11.

Ans.

Step 1. Recall the behavior of electrons in a conductor

Electrons in a metal move freely but continuously collide with positive ions (the metal lattice).

Their motion between collisions depends on whether an **electric field** is applied or not.

Step 2. Case (i): Absence of electric field

- Without an electric field, electrons move **randomly** due to thermal energy.
- Between collisions, no external force acts on them.
- So, each electron moves in a **straight line** between collisions.

Step 3. Case (ii): Presence of electric field

- When an electric field is applied, electrons experience a **force opposite to the field direction**.
- Due to this force, their paths are **slightly curved** between collisions (not straight), as they accelerate under the field.

Step 4. Conclusion

(i) In the absence of electric field → Straight line

(ii) In the presence of electric field → Curved in general

✅ **Final Answer: (i) Straight line, (ii) Curved in general**

Correct Option: 4)

Q12.

Ans.

Step 1. Given data

$$V = 20 \text{ V}, \quad t = 20 \text{ s}, \quad H = 800 \text{ J}$$

We need to find **R** (resistance).

Step 2. Use Joule's law of heating

The heat (energy) developed in a resistor is given by:

$$H = \frac{V^2}{R} \times t$$

Step 3. Rearrange to find R

$$R = \frac{V^2 \times t}{H}$$

Substitute values:

$$R = \frac{20^2 \times 20}{800}$$

$$R = \frac{400 \times 20}{800} = \frac{8000}{800} = 10\,\Omega$$

✅ **Final Answer: 10 Ω**

Correct Option: 2)

Q13.

Ans.

Step 1. Given data

$R = 4\Omega, \quad r = 7\text{cm} = 0.07 \text{ m}, \quad \rho = 2 \times 10^{-7}\ \Omega m, \quad d = 1.4 \text{ mm} = 1.4 \times 10^{-3} \text{ m}$

We have to find the **number of turns (n)**.

Step 2. Formula for resistance

$$R = \rho \frac{L}{A}$$

Where

- $L =$ total length of the wire
- $A =$ cross-sectional area of the wire

Step 3. Find the cross-sectional area

$$A = \pi \left(\frac{d}{2}\right)^2 = \pi \left(\frac{1.4 \times 10^{-3}}{2}\right)^2$$

$$A = \pi(0.7 \times 10^{-3})^2 = \pi \times 0.49 \times 10^{-6}$$

$$A = 1.54 \times 10^{-6}\,\mathrm{m}^2$$

Step 4. Find the total length of the wire

$$L = \frac{RA}{\rho}$$

$$L = \frac{4 \times 1.54 \times 10^{-6}}{2 \times 10^{-7}} = \frac{6.16 \times 10^{-6}}{2 \times 10^{-7}} = 30.8\,\mathrm{m}$$

Step 5. Find length of one turn

Each turn forms a circle of radius $r = 0.07$ m

$$\text{Length of one turn} = 2\pi r = 2\pi \times 0.07 = 0.44 \text{ m}$$

Step 6. Find the number of turns

$$n = \frac{L}{2\pi r} = \frac{30.8}{0.44} = 70$$

☑ **Final Answer: 70**

Correct Option: 1)

Q14.

Ans.

Step 1. Given data

$$E = 12\,\text{V}, \quad r = 3\,\Omega, \quad I = 0.6\,\text{A}$$

We need to find **the voltage across the external resistor (V).**

Step 2. Concept used

When a battery of emf E and internal resistance r is connected in a circuit where

- V = potential difference across the external resistor
- Ir = voltage drop across internal resistance

Step 3. Substitute values

$$V = E - Ir$$

$$V = 12 - (0.6 \times 3)$$

$$V = 12 - 1.8 = 10.2\,\text{V}$$

✅ **Final Answer: 10.2 V**

Correct Option: 1)

Q15.

Ans.

Step 1. Given data

- Total resistance of the wire $R = 12\ \Omega$
- It is cut into **three parts in the ratio 1 : 2 : 3**
- Hence, total length ratio sum = 1 + 2 + 3 = 6

Step 2. Calculate individual resistances

Resistance is proportional to length.

$$R_1 = \frac{1}{6} \times 12 = 2\,\Omega$$

$$R_2 = \frac{2}{6} \times 12 = 4\,\Omega$$

$$R_3 = \frac{3}{6} \times 12 = 6\,\Omega$$

Step 3. Forming a triangle

When the three resistors are connected to form a triangle (Δ), and the cell is connected across the **highest resistor (6 Ω)**, the other two resistors (2 Ω and 4 Ω) are connected **in series**, and this combination is **in parallel** with the 6 Ω resistor.

Step 4. Equivalent resistance of (2 Ω + 4 Ω)

$$R_{\text{series}} = 2 + 4 = 6\Omega$$

Now, this 6 Ω is in **parallel** with the 6 Ω resistor:

$$R_{\text{eq}} = \frac{6 \times 6}{6 + 6} = \frac{36}{12} = 3\,\Omega$$

Step 5. Total resistance in circuit

The total resistance includes the internal resistance $r = 5\Omega$:

$$R_{\text{total}} = R_{\text{eq}} + r = 3 + 5 = 8\Omega$$

Step 6. Calculate current

Using Ohm's law:

$$I = \frac{E}{R_{\text{total}}} = \frac{8}{8} = 1\text{ A}$$

✅ **Final Answer: 1 A**

Correct Option: 4)

Q16.

Ans.

Step 1. Use the relation

- Magnetic moment $\mathrm{M} = \mathrm{p} \times \mathrm{d}$

(where p = pole strength, d = distance between poles)

Step 2. Convert distance

• 20 cm = 0.20 m

Step 3. Calculate pole strength

$$p = \frac{M}{d} = \frac{5.0\ A.m^2}{0.20\ m} = 25\ A.m$$

✅ **Final Answer: 25 A·m**

Correct Option: 4)

Q17.

Ans.

Step 1. Recall the physical meaning and units of each quantity

Let's understand each term one by one:

(A) Magnetic Field (B)

- The **magnetic field** is defined as the magnetic flux per unit area.
- Its SI unit is **Weber per square meter ($Wb.m^{-2}$)**, which is also equivalent to **Tesla (T)**.

  1 Tesla = 1 Weber per square meter

- Hence, the correct unit for magnetic field is **$Wb.m^{-2}$**.

  → Matches with **(IV)**.

(B) Magnetic Moment (M)

- The **magnetic moment** of a magnet or a current-carrying coil is a measure of its strength and direction.
- For a bar magnet, magnetic moment $M =$ pole strength × distance between poles.
- Its SI unit is **Ampere.meter² ($A.m^2$)**.
- However, it can also be expressed as **Joule per Tesla ($J.T^{-1}$)** because torque $\tau = MB \sin\theta$, and torque has the unit of **Joule (N.m)**.

  Thus,

$$[M] = \frac{[\tau]}{[B]} = \frac{\text{Joule}}{\text{Tesla}} = \text{J.T}^{-1}.$$

- Hence, the correct unit for magnetic moment is **$J.T^{-1}$.**

  → Matches with (I).

(C) Pole Strength (m)

- The **pole strength** is the magnetic strength of one pole of a magnet.
- Magnetic moment is given by:

$$M = m \times 2l$$

where $2l$ is the distance between the two poles.

Therefore,

$$[m] = \frac{[M]}{[l]} = \frac{\text{J.T}^{-1}}{\text{m}} = \text{J.T}^{-1}.\text{m}^{-1}.$$

- Hence, the correct unit for pole strength is **$J.T^{-1}.m^{-1}$**.

  → Matches with **(III)**.

(D) Permeability of Free Space (μ_0)

- The **permeability of free space** represents how well a magnetic field can be established in vacuum.
- It relates the magnetic field B and the magnetic field intensity H:

$B = \mu_0 H$

- Thus,

$$[\mu_0] = \frac{[B]}{[H]} = \frac{\text{Tesla}}{\text{Ampere per meter}} = \text{T.m.A}^{-1}.$$

- Hence, the correct unit for permeability of free space is **$T.m.A^{-1}$**.

  → Matches with **(II)**.

Step 2. Match List-I with List-II

List-I	**List-II**
Physical Quantity	**Units**
(A) Magnetic field	(IV) $Wb.m^{-2}$
(B) Magnetic moment	(I) $J.T^{-1}$

(C) Pole strength	(III) $J.T^{-1}.m^{-1}$
(D) Permeability of free space	(II) $T.m.A^{-1}$

✅ **Final Answer: (A) – (IV), (B) – (I), (C) – (III), (D) – (II)**

Correct Option: 2)

Q18.

Ans.

Step 1. Concept Used – Biot–Savart Law

The magnetic field dB due to a small current element is given by:

$$dB = \frac{\mu_0}{4\pi} \frac{I\, dl\, \sin\theta}{r^2}$$

where:

- I = current in the wire
- dl = length of current element
- r = distance from the element to the point
- θ = angle between dl and r
- $\mu_0 = 4\pi \times 10^{-7}\, T \cdot m/A$

Step 2. Given Data

$$I = 10\,A, \quad dl = 1\,cm = 1 \times 10^{-2}\,m, \quad r = 0.5\,m$$

Since the wire is along the x-axis and the field point is on the y-axis,

$\theta = 90^\circ \Rightarrow \sin\theta = 1.$

Step 3. Substitute Values

$$dB = \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{10 \times 1 \times 10^{-2}}{(0.5)^2}$$

Simplify:

$$dB = 10^{-7} \times \frac{0.1}{0.25}$$

$$dB = 10^{-7} \times 0.4$$

Step 4. Calculate the Result

$$dB = 4 \times 10^{-8}\,T$$

✅ **Final Answer: 4 × 10^{-8} T**

Correct Option: 1)

Q19.

Ans.

Step 1. Formula and Concept Used

The **magnetic force on a current-carrying conductor** placed in a magnetic field is given by:

$$\vec{F} = I(\vec{L} \times \vec{B})$$

where

- I = current in the conductor,
- $\vec{L}$ = length vector of the conductor (direction of current),
- $\vec{B}$ = magnetic field vector,
- The direction of $\vec{F}$ is given by the **right-hand rule** for cross product.

Step 2. Given Data

- The conductor is along the **z-axis** → current ($\vec{L}$) is along **+z direction**.

$$\vec{L} = L\,\hat{k}$$

- The magnetic field is along the **y-axis** →

$$\vec{B} = B\,\hat{j}$$

Step 3. Apply the Cross Product

$$\vec{F} = I(\vec{L} \times \vec{B}) = I(L\,\hat{k} \times B\,\hat{j})$$

$$\hat{k} \times \hat{j} = -\hat{i}$$

Therefore,

$$\vec{F} = -I\,L\,B\,\hat{i}$$

Step 4. Interpret the Direction

The force is in the **negative x-direction** (−x-axis).

✅ **Final Answer: The magnetic force acts along the negative x-axis.**

Correct Option: 4)

Q20.

Ans.

Step 1. Concept – Converting a Galvanometer into an Ammeter

A **galvanometer** detects small currents.

To measure large currents, we connect a **low resistance (called a shunt)** in **parallel** with it.

This allows most of the current to pass through the shunt and only a small part through the galvanometer, protecting it from damage.

The total (effective) resistance of the ammeter is the **parallel combination** of the galvanometer resistance R_g and the shunt resistance R_s.

Step 2. Formula

The effective resistance R_A of the ammeter is given by:

$$R_A = \frac{R_g R_s}{R_g + R_s}$$

Step 3. Substitution of Given Values

$$R_g = 520\,\Omega, \quad R_s = 20\,\Omega$$

$$R_A = \frac{520 \times 20}{520 + 20}$$

$$R_A = \frac{10400}{540}$$

Step 4. Simplify

$$R_A = 19.26\,\Omega \approx 19.3\,\Omega$$

Step 5. Interpretation

The ammeter has **low resistance** so that it doesn't affect the current in the circuit.

✅ **Final Answer: 19.3 Ω**

Correct Option: 3)

Q21.

Ans.

Step 1. Concept – Magnetic Field Inside a Solenoid

The magnetic field inside a long solenoid is **uniform** and given by the formula:

$$B = \mu_0 n I$$

where

- B = magnetic field inside the solenoid
- $\mu_0 = 4\pi \times 10^{-7}\, T \cdot m/A$ (permeability of free space)
- $n = \frac{N}{L}$ = number of turns per meter
- I = current through the solenoid

Step 2. Given Data

$$N = 800, \quad L = 0.3\, m, \quad I = 6\, A$$

Step 3. Calculate Number of Turns per Unit Length

$$n = \frac{N}{L} = \frac{800}{0.3} = 2666.67\, \text{turns/m}$$

Step 4. Substitute Values into Formula

$$B = (4\pi \times 10^{-7}) \times 2666.67 \times 6$$

$$B = 4\pi \times 10^{-7} \times 16000$$

Step 5. Simplify

$$B = (4 \times 3.1416 \times 1.6 \times 10^{-3})\, T$$

$$B = 20.1 \times 10^{-3}\, T = 20.1\, mT$$

✅ **Final Answer:** $B = 20\ mT$

Correct Option: 3)

Q22.

Ans.

Step 1: Relate potential difference and velocity

When a charged particle (charge q, mass m) is accelerated through a potential difference V:

$$qV = \frac{1}{2}mu^2$$

$$\Rightarrow u = \sqrt{\frac{2qV}{m}}$$

This shows that **speed u** depends on the **square root of the potential V**.

Step 2: Radius in a magnetic field

When the charged particle enters a magnetic field B perpendicularly, it moves in a circular path because the magnetic force provides the necessary centripetal force:

$$quB = \frac{mu^2}{r}$$

$$\Rightarrow r = \frac{mu}{qB}$$

So, **radius r** is **directly proportional to the speed u**.

Step 3: Substitute the value of u

Substitute $u = \sqrt{\frac{2qV}{m}}$ in $r = \frac{mu}{qB}$:

$$r = \frac{m}{qB}\sqrt{\frac{2qV}{m}}$$

$$\Rightarrow r \propto \sqrt{V}$$

This means the radius increases with the square root of the potential difference V.

Step 4: Compare with given options

We know $u \propto \sqrt{V}$.

Now, check the given expressions:

$$\frac{V}{u} \propto \frac{V}{\sqrt{V}} = \sqrt{V}$$

Hence,

$$r \propto \sqrt{V} \propto \frac{V}{u}$$

✅ **Final Answer: V/u**

Correct Option: 1)

Q23.

Ans.

Step 1. Understand the concept

This question is based on **Faraday's law of electromagnetic induction** and **Lenz's law**.

- When a magnet moves relative to a coil, the **magnetic flux** through the coil changes.
- A **changing magnetic flux** induces an **emf** in the coil, producing an **induced current**.
- The **direction** of the induced current is such that it **opposes the change** (Lenz's law).

Step 2. Analyze each statement

(A) "It indicates the presence of electric current in the coil." ✅ **True.**

Deflection of the galvanometer pointer shows that **current is induced** in the coil - hence an electric current flows momentarily.

(B) "The deflection is found to be smaller when the magnet is pushed towards the coil faster." ❌ **False.**

According to Faraday's law,

$$\text{Induced emf} \propto \frac{d\phi}{dt}$$

The faster the magnet moves, the **greater the rate of change of magnetic flux**, so **deflection increases**, not decreases.

(C) "There is repulsion between the moving magnet and the magnetic pole induced in the coil facing towards the N pole of the magnet." ✅ **True.**

By **Lenz's law**, the induced current sets up a magnetic pole that **opposes** the approaching magnet - so the coil's near face becomes a **north pole**, causing **repulsion**.

(D) "If the bar magnet does not move, there is no induced current in the coil." ✅ **True.**

When the magnet is stationary, the **magnetic flux through the coil remains constant**, so **no emf or current** is induced.

Step 3. Identify the correct combination

Correct Statements: (A), (C), and (D)

✅ **Final Answer: (A), (C), and (D) only**

Correct Option: 1)

Q24.

Ans.

Step 1. Understanding the situation

We are given a **rectangular conductor PQRS** placed in a uniform magnetic field.

- The magnetic field (**B**) is directed **into the page** (represented by crosses "×").
- The side PQ (of length l) is **free to move**.
- The distance between PQ and the opposite side SR is x.
- The conductor PQ moves **left** with constant velocity V.

As PQ moves, the **area** of the loop PQRS changes with time, leading to a change in **magnetic flux**, which produces an **induced emf** according to **Faraday's Law**.

Step 2. Expression for magnetic flux

Magnetic flux (Φ) through the loop is given by:

$$\Phi = B \times \text{Area}$$

Since the area of the rectangle is $A = l \times x$,

$$\Phi = Blx$$

So, the magnetic flux linked with the loop at any instant is:

$$\boxed{\Phi = Blx}$$

Step 3. Finding motional emf

According to **Faraday's Law**, the induced emf (ε) is the rate of change of magnetic flux:

$$\varepsilon = \left| \frac{d\Phi}{dt} \right|$$

Substituting $\Phi = Blx$:

$$\varepsilon = \left| Bl\frac{dx}{dt} \right|$$

Since the rod moves left with constant speed V,

$$\frac{dx}{dt} = -V$$

Taking the magnitude (emf is always positive in magnitude),

$$\varepsilon = BlV$$

Step 4. Physical explanation

- As PQ moves left, the loop area decreases.
- This decreases the magnetic flux (since $\Phi = Blx$).
- To **oppose** this decrease, an induced current is produced in a **clockwise direction** (by Lenz's Law).
- The magnitude of the induced emf depends on B, l, and V.

Step 5. Final results

$$\boxed{\text{Magnetic flux} = Blx}$$

$$\boxed{\text{Motional emf} = BlV}$$

✅ **Final Answer: Magnetic flux = Blx; Motional emf = BlV.**

Correct Option: 3)

Q25.

Ans.

Step 1. Formula for induced emf in an inductor

The average emf induced in a coil is given by Faraday's law of electromagnetic induction:

$$E = L\frac{\Delta I}{\Delta t}$$

where

E = induced emf,

L = self-inductance of the coil,

ΔI = change in current,

Δt = time taken for the change.

Step 2. For case (A)

Given:

$$E = 2\,V, \quad \Delta I = 5 - 2 = 3\,A, \quad \Delta t = 0.4\,s$$

Substitute in formula:

$$L = \frac{E\Delta t}{\Delta I} = \frac{2 \times 0.4}{3} = \frac{0.8}{3} = 0.266\,H = 266\,mH$$

But in the question, it says **L = 0.266 mH**, which is **1000 times smaller**. Hence, the given value is **incorrect**.

Step 3. For case (B)

Here, current changes **from +4 A to -4 A**, so

$$\Delta I = 4 - (-4) = 8\,A$$

Given:

$$E = 2\,V, \quad \Delta t = 0.4\,s$$

Substitute:

$$L = \frac{E\Delta t}{\Delta I} = \frac{2 \times 0.4}{8} = \frac{0.8}{8} = 0.1\,H = 100\,mH$$

This matches the given **0.10 mH**?

No — that's **0.10 H = 100 mH**, not **0.10 mH = 0.0001 H**.

So, the given value (0.10 mH) is **also incorrect**.

✅ **Final Answer: Both (A) and (B) are incorrect.**

Correct Option: 4)

Q26.

Ans.

Step 1. Concept — Condition for maximum current

In an **LCR series circuit**, the current is maximum at **resonance**, when the inductive reactance equals the capacitive reactance:

$$X_L = X_C$$

$$2\pi f L = \frac{1}{2\pi f C}$$

From this, the capacitance at resonance is:

$$C = \frac{1}{(2\pi f)^2 L}$$

Step 2. Substitute given values

Given:

$$L = 500\,mH = 500 \times 10^{-3} H = 0.5\,H$$

$$f = 0.4\,kHz = 0.4 \times 10^3 = 400\,Hz$$

Substitute in the formula:

$$C = \frac{1}{(2\pi \times 400)^2 \times 0.5}$$

Step 3. Simplify

$$2\pi \times 400 = 2513.27$$

$$(2513.27)^2 = 6.32 \times 10^6$$

$$C = \frac{1}{6.32 \times 10^6 \times 0.5} = \frac{1}{3.16 \times 10^6} = 3.16 \times 10^{-7} F$$

Convert to microfarads:

$$C = 0.316\,\mu F \approx 0.32\,\mu F$$

✅ **Final Answer:** The capacitance required for maximum current is **0.32 μF**

Correct Option: 2)

Q27.

Ans.

Step 1. Given data

$V = 12\,V$, R = 6Ω, $L = 10mH = 10 \times 10^{-3}$ H, $\Delta t = 1\,ms = 1 \times 10^{-3}$ s

Step 2. Find initial current

When the circuit is closed for a long time, current reaches a steady value given by Ohm's law:

$$I = \frac{V}{R} = \frac{12}{6} = 2\,A$$

Step 3. When the switch is opened

The current in the inductor falls from $I = 2\,A$ to $0\,A$ in time $\Delta t = 1 \times 10^{-3}$ s

An emf is induced in the coil given by:

$$E = L\frac{\Delta I}{\Delta t}$$

Substitute the values:

$$E = 10 \times 10^{-3} \times \frac{2-0}{1 \times 10^{-3}}$$

$$E = 10 \times 10^{-3} \times 2000 = 20\,V$$

✅ **Final Answer:** The average emf induced across the coil is **20 V**

Correct Option: 2)

Q28.

Ans.

Step 1. Given information

AC source rating:

$$V_{\text{rms}} = 220\,V, \quad f = 50\,Hz$$

Hence, the **time period** of the AC signal is:

$$T = \frac{1}{f} = \frac{1}{50} = 0.02\,s$$

Step 2. Understanding what each value means

- **RMS value (220 V)** → Effective voltage that produces the same heating effect as DC.
- **Peak value** → Maximum voltage of the waveform:

$$V_{\text{max}} = \sqrt{2} \times V_{\text{rms}} = 1.414 \times 220 = 311\,V$$

- **Average value over a complete cycle (T = 1/50 s) → For** a sinusoidal AC:

$$V_{\text{avg (over one full cycle)}} = 0$$

Because the positive and negative halves cancel each other.

Step 3. Evaluate each statement

1. ❌ "The peak value over a period of (1/50) s is 220 V"

   → Incorrect, peak value = **311 V** not 220 V.

2. ❌ "The average value over a period of (1/50) s is 220 V"

   → Incorrect, average over a complete cycle is **0 V**.

3. ✅ "The average value over a period of (1/50) s is 0 V"

   → Correct, because for one full AC cycle, the net area under the curve is zero.

4. ✕ "The average value over a period of (1/50) s is $220\sqrt{2}$ V"

→ Incorrect, this is the **peak** value, not the average.

☑ **Final Answer:** The average value over a period of (1/50) s is **0 V**.

Correct Option: 3)

Q29.

Ans.

Step 1. Recall Faraday's laws of electromagnetic induction

According to **Faraday's first and second laws**:

1. **First law:** Whenever the magnetic flux linked with a circuit changes, an emf is induced in the circuit.
2. **Second law:** The **magnitude** of the induced emf is **equal to the rate of change of magnetic flux** through the circuit.

$$E = -\frac{d\Phi}{dt}$$

Step 2. Check each statement

(1) ☑ Correct - This directly matches Faraday's law:

$$E = \frac{d\Phi}{dt}$$

(2) ✕ Incorrect - The emf is **not** equal to the *total* change of magnetic flux; it depends on the **rate** of change (how fast the flux changes), not just the total amount.

(3) ☑ Correct - Increasing the number of turns N increases the induced emf because

$$E = -N\frac{d\Phi}{dt}$$

(4) ☑ Correct - This follows from **Lenz's Law**, which states that the polarity of the induced emf always opposes the change in flux that causes it.

✅ **Final Answer:** "The magnitude of induced emf in a circuit is equal to the total change of magnetic flux through the circuit" is **not correct**.

Correct Option: 2)

Q30.

Ans.

Step 1. Concept of displacement current

According to **Maxwell**, even when no actual charge flows (as in the gap of a capacitor), a changing **electric field** produces a magnetic field just like a current does.

This effect is called **displacement current**.

Step 2. Formula

The displacement current is given by:

$$I_d = \varepsilon_0 \frac{d\Phi_E}{dt}$$

where

ε_0 = permittivity of free space,

Φ_E = electric flux.

Hence, it is **proportional to the rate of change of the electric field**.

Step 3. Correct interpretation

- It is **not** due to the flow of charges (that's conduction current).
- It is **not** related to gravitational or magnetic fields.
- It is **caused by a changing electric field** between capacitor plates or in free space.

✅ **Final Answer: Due to changing electric field.**

Correct Option: 3)

Q31.

Ans.

Step 1. Understanding the Question

We need to match different types of electromagnetic (EM) waves from **List-I** with their **wavelength ranges** from **List-II**.

Each type of EM wave has its own unique wavelength and frequency range.

Step 2. Analyze Each Wave and Its Range

(A) X-rays → X-rays have **very short wavelengths**, typically between **1 nm to 10^{-3} nm**.

They are used in **medical imaging** and **material analysis**.

→ Matches with **(III)**.

(B) Radio waves → Radio waves have the **longest wavelengths**, usually **greater than 0.1 m**.

They are used for **communication systems** such as radio and television.

→ Matches with **(IV)**.

(C) Infrared waves → Infrared waves lie between **visible light and microwaves**, having wavelengths from **1 mm to 700 nm**.

They are responsible for **heat radiation.**

→ Matches with **(I)**.

(D) Microwaves → Microwaves have wavelengths between **0.1 m to 1 mm**.

They are used in **microwave ovens**, **radar systems**, and **satellite communication**.

→ Matches with **(II)**.

✅ **Final Answer: (A) – (III), (B) – (IV), (C) – (I), (D) – (II)**

Correct Option: 4)

Q32.

Ans.

Step 1. Understanding the Question

We are given the equation of an electromagnetic wave:

$$E = E_0 \sin(kx - \omega t)$$

where:

- E_0 = amplitude of the electric field
- B_0 = amplitude of the magnetic field
- k = wave number
- ω = angular frequency

We are asked to find the relation between E_0 and B_0.

Step 2. Relation Between Electric and Magnetic Fields in an EM Wave

In an electromagnetic wave traveling in free space, the magnitudes of the electric and magnetic fields are related by the **speed of light (c)**:

$$\frac{E_0}{B_0} = c$$

Step 3. Express ccc in Terms of ω and k

We know that the **speed of the wave** is given by:

$$c = \frac{\omega}{k}$$

Substitute this into the relation:

$$\frac{E_0}{B_0} = \frac{\omega}{k}$$

✅ **Final Answer:**

$$\frac{E_0}{B_0} = \frac{\omega}{k}$$

Correct Option: 1)

Q33.

Ans.

Step 1. Understanding the Question

The question asks which of the given statements about mirrors and reflection are **correct**.

We must analyze each statement based on the **laws of reflection** and the **properties of plane and curved mirrors**.

Step 2. Analyze Each Statement

(A) All mirrors follow the laws of reflection.

✅ **True.**

Both **plane** and **curved** mirrors obey the **laws of reflection**:

1. The angle of incidence equals the angle of reflection.
2. The incident ray, reflected ray, and the normal lie in the same plane.

(B) The angle between the ray of incidence and the plane surface of the mirror is equal to the angle between the plane surface of mirror and the ray of reflection for plane mirror.

✅ **True.**

In a **plane mirror**, the **angle between the incident ray and the mirror surface** equals the **angle between the mirror surface and the reflected ray**, because the mirror surface acts as the reference plane.

(This follows directly from the geometry of reflection.)

(C) The rays coming parallel to the principal axis will go after reflection through the focus of the curved mirror.

✅ **True.**

For a **concave mirror**, any light ray parallel to the **principal axis** reflects and passes through the **focus (F)**.

For a **convex mirror**, the rays appear to diverge from the focus.

Thus, this statement is **correct** for both cases conceptually.

(D) The rays coming to the pole of a curved mirror making an angle with axis will be reflected making the equal angle with the axis on the other side of the axis.

✅ **True.**

The **pole (P)** of the mirror is the center point on its surface.
At the pole, the **normal to the mirror** coincides with the **principal axis**, so the **angle of incidence equals the angle of reflection**, satisfying this condition.

✅ **Final Answer: All four statements are correct. (A), (B), (C) and (D)**

Correct Option: 1)

Q34.

Ans.

Step 1. Understanding the Question

We are given four statements related to the **power of a lens** and must determine which are correct.

Power (P) of a lens is defined as the ability of the lens to **converge or diverge light rays**, mathematically given by:

$$P = \frac{1}{f}$$

where f is the focal length in **metres** and the unit of power is **dioptre (D)**.

Step 2. Check each statement

(A) The power of a lens is the ability of the lens to converge or diverge the incident rays.

☑ **True.** This is the definition of power of a lens.

(B) S.I. unit of the power of a lens is dioptre while focal length is in centimetres.

✕ **Incorrect.**

For power in dioptres, focal length must be in **metres**, not centimetres.

(If $f = 1$ m, then $P = 1$D).

(C) For a lens of larger focal length, power is smaller.

☑ **True.**

Since $P = 1/f$, as focal length increases, power decreases.

(D) In any combination of lenses, the power of combination is not algebraic addition of power of combined lenses.

✕ **Incorrect.**

For thin lenses in contact:

$$P_{\text{total}} = P_1 + P_2$$

So, this statement is false.

☑ **Final Answer: (A) and (C) only**

Correct Option: 1)

Q35.

Ans.

Step 1: Find the image distance (v) using the magnification formula

The magnification (m) of a lens is given by the ratio of the image length (h_i) to the object length (h_o), and also by the ratio of the image distance (v) to the object distance (u).

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

Given:

- Image length (h_i) = 1 cm
- Object length (h_o) = 5 cm
- Object distance (u) = -40 cm (negative because the object is on the same side as the incoming light)

$$\frac{1}{5} = \frac{v}{-40}$$

$$v = \frac{-40}{5} = -8 \text{ cm}$$

Step 2: Use the lens formula to find the focal length (f)

The lens formula is given by:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substitute the values for v and u:

$$\frac{1}{f} = \frac{1}{-8} - \frac{1}{-40}$$

$$\frac{1}{f} = \frac{-1}{8} + \frac{1}{40}$$

To add the fractions, find a common denominator, which is 40:

$$\frac{1}{f} = \frac{-5}{40} + \frac{1}{40}$$

$$\frac{1}{f} = \frac{-4}{40} = \frac{-1}{10}$$

$$f = -10 \text{ cm}$$

The focal length of a convex lens is positive. Let's re-evaluate the problem. Since a convex lens forms a real image when the object is outside the focal length, the image is inverted. Therefore, the image length should be negative.

$$m = \frac{h_i}{h_o} = \frac{-1}{5}$$

$$\frac{-1}{5} = \frac{v}{-40}$$

$$v = \frac{-40 \times (-1)}{5} = 8 \text{ cm}$$

Now, use the lens formula with the corrected image distance:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f} = \frac{1}{8} - \frac{1}{-40}$$

$$\frac{1}{f} = \frac{1}{8} + \frac{1}{40}$$

$$\frac{1}{f} = \frac{5}{40} + \frac{1}{40}$$

$$\frac{1}{f} = \frac{6}{40} = \frac{3}{20}$$

$$f = \frac{20}{3} \approx 6.67 \text{ cm}$$

✅ **Final Answer: The focal length of the lens is approximately 6.67 cm.**

Correct Option: 1)

Q36.

Ans.

Step 1. Given data

We are given:

- Distance between slits, $d = 1.5$ mm $= 1.5 \times 10^{-3}$ m
- Distance between slits and screen, $D = 1.2$ m
- Wavelength of light, $\lambda = 600 \times 10^{-9}$ m

We need to find the **fringe width (β)**.

Step 2. Formula used

Fringe width in Young's double-slit experiment is given by:

$$\beta = \frac{\lambda D}{d}$$

Step 3. Substituting values

$$\beta = \frac{600 \times 10^{-9} \times 1.2}{1.5 \times 10^{-3}}$$

$$\beta = \frac{720 \times 10^{-9}}{1.5 \times 10^{-3}} = 480 \times 10^{-6} \text{ m}$$

$$\beta = 0.48 \times 10^{-3} \text{ m} = 0.48 \text{ mm}$$

✅ **Final Answer: β = 0.48 mm**

Correct Option: 1)

Q37.

Ans.

Step 1. Understanding the question

When light travels from a **denser medium (like glass)** to a **rarer medium (like air)**, it bends **away from the normal**.

As the angle of incidence increases, the angle of refraction also increases.

At a particular angle of incidence, the refracted ray just grazes the surface - i.e., it makes **an angle of 90°** with the normal.

This particular angle of incidence is called the **critical angle (i_n)**.

Step 2. Definition

At the **critical angle**,

Angle of refraction = 90°

Beyond this angle, light is **totally internally reflected** instead of refracted.

✅ **Final Answer: The angle of refraction is 90°**

Correct Option: 2)

Q38.

Ans.

Step 1. Understanding the question

There are two **crossed polarizers**, meaning their transmission axes are at 90° (or π/2 radians) to each other. Normally, no light passes through both polarizers since the second one blocks all light coming from the first.

However, when a **Polaroid sheet** is placed between them and rotated, some light passes through, and the intensity changes depending on the angle between the first polarizer and the Polaroid sheet.

We need to find the angle at which the transmitted light intensity becomes **maximum**.

Step 2. Using Malus's Law

According to **Malus's law**, the intensity of transmitted light through a polarizer is given by:

$$I = I_0 \cos^2 \theta$$

where θ is the angle between the light's polarization direction and the axis of the polarizer.

If the light then passes through a second polarizer that makes an angle (π/2 - θ) with the first, the final intensity becomes:

$$I = I_0 \cos^2 \theta \sin^2 \theta$$

Step 3. Simplify the expression

We can rewrite this as:

$$I = \frac{I_0}{4} \sin^2(2\theta)$$

For **maximum intensity**,

$$\sin^2(2\theta) = 1$$

This happens when:

$$2\theta = \frac{\pi}{2} \Rightarrow \theta = \frac{\pi}{4}$$

✅ **Final Answer:**

$$\theta = \frac{\pi}{4}$$

Correct Option: 2)

Q39.

Ans.

Step 1. Understanding the Concept

Total Internal Reflection (TIR) happens when light travels **from a denser medium to a rarer medium** and the **angle of incidence** is greater than the **critical angle**.

In this case, light is **completely reflected back** into the denser medium, and no refracted ray exists.

Step 2. Checking Each Statement

(A) Total internal reflection occurs when a ray of light travels from a rarer transparent medium to a denser medium.

→ Incorrect. ❌

TIR occurs when light travels **from denser to rarer**, not the other way.

(B) In total internal reflection, the incident ray of light remains in the same medium after reflection.

→ Correct. ✅

In TIR, light does not pass into the second medium - it **remains in the denser medium** after reflection.

(C) In total internal reflection, the angle of incidence inside the denser transparent medium is equal to the angle of reflection in the same medium.

→ Correct. ✅

This follows the **law of reflection** - angle of incidence = angle of reflection.

(D) In total internal reflection inside a denser medium there is no angle of refraction.

→ Correct. ✅

There is **no refracted ray**, hence **no refraction angle** during TIR.

✅ **Final Answer: (B), (C) and (D) only**

Correct Option: 3)

Q40.

Ans.

Step 1: Identify the given values and formula

The focal length (f) of the concave lens is given as 50 cm.

The power of a lens (P) is related to its focal length by the formula:

$$P = \frac{1}{f}$$

where f is in meters.

Step 2: Convert the focal length to meters

The given focal length is f = 50 cm. To convert it to meters, divide by 100:

$$f = \frac{50}{100} \text{ m} = 0.5 \text{ m}$$

Step 3: Determine the sign of the focal length

A concave lens is a diverging lens, and its focal length is conventionally considered negative.

Therefore, f = -0.5 m.

Step 4: Calculate the power of the lens

Using the formula from Step 1 and the focal length from Step 3:

$$P = \frac{1}{f} = \frac{1}{-0.5} \text{ D} = -2 \text{ D}$$

The power of the lens is -2 D.

✅ **Final Answer: -2 D**

Correct Option: 4)

Q41.

Ans.

Step 1. Concept Understanding

When light falls on a metal surface, it emits electrons - this is called the **photoelectric effect.**

The emitted electrons are called **photoelectrons**, and the current due to their flow is known as **photoelectric current (I)**.

The current depends on **how many electrons are emitted per second**, i.e.

$$I \propto n$$

where n = number of photoelectrons emitted per second.

Step 2. Relation between Intensity and Number of Photoelectrons

- The **intensity** of light means the **energy incident per unit area per second**.
- If the **frequency** of the light is above the threshold frequency, then:
    - Increasing the **intensity** increases the number of photons striking the surface per second.
    - Each photon can eject one electron.
    - Hence, more photons → more electrons emitted → greater photoelectric current.

So,

$$n \propto \text{Intensity of light}$$

Step 3. What does not affect the number of photoelectrons

- The **frequency** of the radiation affects only the **energy** of emitted electrons, not their number.
- The **number** of emitted electrons depends only on **intensity** (for a fixed frequency above the threshold).

✅ **Final Answer: the number of photoelectrons emitted per second is directly proportional to the intensity of incident radiation.**

Correct Option: 3)

Q42.

Ans.

Step 1. Given data:

Mass of the ball,

$$m = 150\,g = 0.150\,kg$$

Velocity,

$$v = 30.0\,m/s$$

Planck's constant,

$$h = 6.63 \times 10^{-34}\,J \cdot s$$

Step 2. Formula used:

The de-Broglie wavelength is given by:

$$\lambda = \frac{h}{mv}$$

Step 3. Substitute the values:

$$\lambda = \frac{6.63 \times 10^{-34}}{0.150 \times 30.0}$$

$$\lambda = \frac{6.63 \times 10^{-34}}{4.5}$$

$$\lambda = 1.47 \times 10^{-34}\,m$$

Step 4. Interpretation

The wavelength associated with a macroscopic object (like a ball) is **extremely small**, which is why wave nature is **negligible** for large objects.

✅ **Final Answer: 1.47 × 10^{-34} m**

Correct Option: 1)

Q43.

Ans.

Step 1. Understanding the question

We are given four statements related to the radius, volume, and density of an atomic nucleus and must find which are correct.

Step 2. Recall important nuclear relations

1. The radius of a nucleus is given by:

$$R = R_0 A^{1/3}$$

   where $R_0 \approx 1.2 \times 10^{-15}$ m, and A is the mass number.

2. The volume of a sphere (nucleus) is proportional to R^3, so:

$$V \propto R^3 \propto (A^{1/3})^3 = A$$

3. Density of nucleus:

$$\rho = \frac{\text{Mass}}{\text{Volume}} \propto \frac{A}{A} = \text{constant}$$

Hence, **nuclear density is constant** and does **not depend on A**.

Step 3. Evaluate each statement

(A) ✅ A nucleus of mass number A has a radius $R = R_0 A^{1/3}$

→ **Correct**, this is the standard nuclear radius formula.

(B) ✅ Volume of nucleus is proportional to mass number A

→ **Correct**, since $V \propto A$.

(C) ❌ The density of nucleus increases with the radius of nucleus

→ **Incorrect**, density is constant, independent of radius.

(D) ✅ Density of nuclear matter does not depend on its mass number A

→ **Correct**, because p is constant for all nuclei.

☑ **Final Answer: (A), (B), and (D) only**

Correct Option: 3)

Q44.

Ans.

Step 1. Given data:

- Energy absorbed by the electron = **12.09 eV**
- The electron is initially in the **ground state (n = 1)**.

  We need to find the increase in angular momentum after absorption.

Step 2. Formula for energy levels of hydrogen atom:

$$E_n = -\frac{13.6}{n^2}\ \text{eV}$$

When the electron absorbs energy, the energy difference between levels is:

$$E_2 - E_1 = 12.09\ \text{eV}$$

Step 3. Substitute the values:

$$\left(-\frac{13.6}{n_2^2}\right) - (-13.6) = 12.09$$

$$13.6\left(1 - \frac{1}{n_2^2}\right) = 12.09$$

Step 4. Solve for n_2:

$$1 - \frac{1}{n_2^2} = \frac{12.09}{13.6} = 0.89$$

$$\frac{1}{n_2^2} = 0.11$$

$$n_2^2 = \frac{1}{0.11} \approx 9$$

$$n_2 = 3$$

Step 5. Angular momentum formula:

Angular momentum of an electron in orbit n is given by:

$$L_n = n\frac{h}{2\pi}$$

Change in angular momentum:

$$\Delta L = L_2 - L_1 = (3-1)\frac{h}{2\pi} = 2\frac{h}{2\pi}$$

☑ **Final Answer: Increase in angular momentum = 2(h/2π)**

Correct Option: 2)

Q45.

Ans.

Step 1. Understanding the question

We are given four statements about forces inside an atomic nucleus and need to identify which are correct.

Step 2. Analyze each statement

(A) The electrostatic repulsive force between the protons can be greater than the nuclear force to bind the nucleons together inside a nucleus.

✕ **Incorrect.**

Inside a nucleus, the **nuclear (strong) force** is much stronger than the electrostatic repulsion between protons - otherwise, the nucleus would not remain stable.

(B) The repulsive electrostatic force between protons in smaller nuclei is much smaller than the nuclear force between nucleons inside a nucleus.

☑ **Correct.**

For small nuclei, protons are close together, but the **strong nuclear force** dominates over electrostatic repulsion, keeping the nucleus stable.

(C) The gravitational force between nucleons is much smaller than the nuclear force between the nucleons inside a nucleus.

☑ **Correct.**

The **gravitational force** between nucleons is negligible compared to the **strong nuclear force**, which is responsible for holding the nucleus together.

(D) The binding energy per nucleon between nucleons is almost constant because the nuclear force is a long-range force.

❌ **Incorrect.**

The **nuclear force** is a **short-range force**, effective only up to about 2–3 femtometers (fm). The binding energy per nucleon is nearly constant due to **saturation of nuclear force**, not because it is long-range.

✅ **Final Answer: (B) and (C) only**

Correct Option: 2)

Q46.

Ans.

Step 1. Understanding the question

We are given statements related to **electronic devices**, and we must identify which ones are **true**.

Step 2. Analyze each statement

(A) Diodes can be used for rectifying an AC voltage.

✅ **True.** A **diode** allows current to flow only in one direction, converting **AC into DC**. Hence, it is used in **rectifiers**.

(B) For semiconductors, band gap energy **(E_g) > 3 eV.**

❌ **False.** For semiconductors, the **band gap is less than 3 eV**.
Examples:

- Silicon (Si): 1.1 eV
- Germanium (Ge): 0.7 eV

  If **E_g > 3 eV,** the material is an **insulator**.

(C) By changing the external applied voltage, junction barriers can be changed.

✅ **True.**

In a **p–n junction**, applying **forward or reverse bias** changes the **barrier potential** and **width of the depletion region**.

(D) p–n junction is the 'key' to all semiconductor devices.

✅ **True.**

Most semiconductor devices such as **diodes, transistors, LEDs, and solar cells** are based on **p–n junctions**.

✅ **Final Answer: (A), (C), and (D) only**

Correct Option: 4)

Q47.

Ans.

Step 1. Understanding the question

A device **X** is connected in a series circuit with a **battery and a resistor**.

- When the battery is connected in one direction, **current flows normally**.
- When the polarity of the battery is reversed, the **current drops to almost zero**.

We need to identify which type of device shows this behavior.

Step 2. Analyze the options

(1) p-type semiconductor

❌ A p-type semiconductor alone allows current conduction in both directions (it's not a rectifying device). So, this is **not correct**.

(2) n-type semiconductor

❌ Similarly, an n-type semiconductor conducts in both directions when connected to a battery, so this is also **not correct**.

(3) p–n junction diode

✅ This behavior matches perfectly.

- When the diode is **forward-biased** (p connected to +, n to –), current flows.

- When it is **reverse-biased** (p connected to –, n to +), current becomes **almost zero** (only a very small leakage current flows).

Hence, the current direction sensitivity is a **property of a diode**.

(4) Capacitor

❌ A capacitor charges and discharges but does not behave like this for steady current — it does not stop current completely on polarity reversal in a DC circuit after charging.

✅ **Final Answer: p–n junction diode**

Correct Option: 3)

Q48.

Ans.

Step 1. Recall what a p-type semiconductor is

A **p-type semiconductor** is made when a **trivalent impurity** (like boron, gallium, or indium) is added to a **pure semiconductor** (like silicon or germanium).

- The trivalent atom has **3 valence electrons**, while silicon has **4 valence electrons.**
- This leaves **one missing electron (a hole)** in the crystal structure.

So:

- **Holes** act as the **majority charge carriers.**
- **Electrons** act as the **minority charge carriers.**
- **Trivalent atoms** are the **dopants.**

Step 2. Analyze each statement

(A) “Holes are minority carriers and pentavalent atoms are the dopants.”

❌ Incorrect — Holes are **majority** carriers, and **trivalent**, not pentavalent, atoms are used.

(B) “Electrons are majority carriers and trivalent atoms are the dopants.”

❌ Incorrect — Electrons are **minority** carriers in p-type semiconductors.

(C) “Holes are majority carriers and trivalent atoms are the dopants.”

✅ Correct — This is the true statement for a p-type semiconductor.

(D) "Electrons are minority carriers and pentavalent atoms are the dopants."

❌ Partially correct — Electrons are **minority carriers**, but **pentavalent atoms** are not the dopants here (they are for n-type semiconductors).

✅ **Final Answer: (C) only**

Correct Option: 2)

Q49.

Ans.

Step 1: Balance the atomic numbers

The sum of the atomic numbers (subscripts) on the reactant side must equal the sum of the atomic numbers on the product side.

$$0 + 92 = 54 + a + 2(0)$$

$$92 = 54 + a$$

$$a = 92 - 54$$

$$a = 38$$

Step 2: Balance the mass numbers

The sum of the mass numbers (superscripts) on the reactant side must equal the sum of the mass numbers on the product side.

$$1 + 235 = 140 + b + 2(1)$$

$$236 = 140 + b + 2$$

$$236 = 142 + b$$

$$b = 236 - 142$$

$$b = 94$$

✅ **Final Answer: $a = 38$, $b = 94$**

Correct Option: 1)

Q50.

Ans.

Step 1. de Broglie wavelength for an accelerated particle

For a particle accelerated through potential V:

$$\lambda = \frac{h}{p}, \quad p = \sqrt{2mqV} \ \Rightarrow \ \lambda \propto \frac{1}{\sqrt{m\,q\,V}}$$

Step 2. Set wavelengths equal (proton vs α-particle)

For the **proton** (mass m_p, charge e, potential V):

$$\lambda_p \propto \frac{1}{\sqrt{m_p e V}}$$

For the **α-particle** (mass $m_\alpha = 4m_p$, charge $q_\alpha = 2e$, potential V_α):

$$\lambda_\alpha \propto \frac{1}{\sqrt{m_\alpha q_\alpha V_\alpha}}$$

Equal wavelengths ⇒ denominators equal:

$$m_\alpha q_\alpha V_\alpha = m_p e V$$

Step 3. Solve for V_α using $m_\alpha = 4m_p$, $q_\alpha = 2e$

$$(4m_p)(2e)V_\alpha = m_p e V \Rightarrow V_\alpha = \frac{V}{8}$$

✅ **Final Answer: $V/8$**

Correct Option: 2)