CUET 2026 May 14 Shift 2 Physics

Question Paper (Memory-Based) with Solutions

Conducted by National Testing Agency (NTA)

General Instructions

(i) The examination will be conducted in Computer-Based Test (CBT) mode.

(ii) Each question carries +5 marks for correct answer and -1 mark for wrong answer.

(iii) The total number of questions are 50.

(iv) Duration of the exam is 1 hour (60 minutes).

1. What are the respective numbers of α and β particles emitted respectively in the following radioactive decay?

$$^{200}_{90}X \rightarrow ^{168}_{80}Y$$

(A) 8 and 8

(B) 8 and 6

(C) 6 and 8

(D) 6 and 6

Correct Answer: (B) 8 and 6

Solution:

Concept:

In radioactive decay:

$$\alpha\text{-particle} = ^{4}_{2}\text{He}$$

So, emission of one α-particle decreases mass number by 4 and atomic number by 2.

$$\beta^{-}\text{-particle}$$

emission does not change mass number, but increases atomic number by 1.

Step 1: Find the number of α-particles using mass number.

Initial mass number:

$$200$$

Final mass number:

$$168$$

Decrease in mass number:

$$200 - 168 = 32$$

Since one α-particle decreases mass number by 4,

$$\text{Number of } \alpha\text{-particles} = \frac{32}{4} = 8$$

So,

$$\alpha = 8$$

Step 2: Find atomic number after emitting 8α-particles.

Initial atomic number:

$$90$$

One α-particle decreases atomic number by 2.
So, 8α-particles decrease atomic number by:

$$8 \times 2 = 16$$

Therefore, atomic number after α-emission:

$$90 - 16 = 74$$

Step 3: Find the number of β-particles.

Final atomic number is:

$$80$$

After α-emission, atomic number is:

$$74$$

Now it must increase from 74 to 80.

Increase required:

$$80 - 74 = 6$$

Since one β^--particle increases atomic number by 1,

$$\beta = 6$$

Step 4: Final conclusion.

Hence, the respective numbers of α and β particles are:

$$\boxed{8 \text{ and } 6}$$

Quick Tip: For α-decay, mass number decreases by 4 and atomic number decreases by 2. For β^--decay, mass number remains same and atomic number increases by 1.

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2. Consider a parallel plate capacitor of area A of each plate and separation d between the plates. If E is the electric field and ε_0 is the permittivity of free space between the plates, then potential energy stored in the capacitor is:

(A) $\frac{1}{2}\varepsilon_0 E^2 Ad$

(B) $\frac{3}{4}\varepsilon_0 E^2 Ad$

(C) $\frac{1}{4}\varepsilon_0 E^2 Ad$

(D) $\varepsilon_0 E^2 Ad$

Correct Answer: (A) $\frac{1}{2}\varepsilon_0 E^2 Ad$

Solution:

Concept:

The energy density of an electric field is given by:

$$u = \frac{1}{2}\varepsilon_0 E^2$$

where u is energy per unit volume.

Step 1: Find the volume between the capacitor plates.

For a parallel plate capacitor,

$$\text{Volume} = \text{Area} \times \text{separation}$$

$$V_{\text{volume}} = A \times d$$

$$V_{\text{volume}} = Ad$$

Step 2: Use energy density formula.

Energy stored is:

$$U = \text{Energy density} \times \text{Volume}$$

$$U = \left(\frac{1}{2}\varepsilon_0 E^2\right)(Ad)$$

$$U = \frac{1}{2}\varepsilon_0 E^2 Ad$$

Step 3: Final conclusion.

Hence, the potential energy stored in the capacitor is:

$$\boxed{\frac{1}{2}\varepsilon_0 E^2 Ad}$$

Quick Tip: Energy density in an electric field is $\frac{1}{2}\varepsilon_0 E^2$. Multiply it by volume Ad to get total energy stored.

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3. What is the relative decrease in focal length of a lens for an increase in optical power by 0.1 D from 2.5 D?

(A) 0.04

(B) 0.40

(C) 0.1

(D) 0.01

Correct Answer: (A) 0.04

Solution:

Concept:

Power of a lens is reciprocal of focal length in metre.

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

Therefore,

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

If power increases, focal length decreases.

Step 1: Write the initial and final power.

Initial power:

$$P_1 = 2.5 \text{ D}$$

Increase in power:

$$\Delta P = 0.1 \text{ D}$$

Final power:

$$P_2 = 2.5 + 0.1 = 2.6 \text{ D}$$

Step 2: Write initial and final focal lengths.

Initial focal length:

$$f_1 = \frac{1}{P_1}$$

Final focal length:

$$f_2 = \frac{1}{P_2}$$

Step 3: Find relative decrease in focal length.

Relative decrease is:

$$\frac{f_1 - f_2}{f_1}$$

Substitute $f_1 = \frac{1}{P_1}$ and $f_2 = \frac{1}{P_2}$:

$$\frac{\frac{1}{P_1} - \frac{1}{P_2}}{\frac{1}{P_1}}$$

$$= 1 - \frac{P_1}{P_2}$$

$$= 1 - \frac{2.5}{2.6}$$

$$= \frac{2.6 - 2.5}{2.6}$$

$$= \frac{0.1}{2.6}$$

$$= 0.03846$$

Step 4: Choose the nearest option.

$$0.03846 \approx 0.04$$

Hence:

$$\boxed{0.04}$$

Quick Tip: Since $P = \frac{1}{f}$, increase in power causes decrease in focal length. Relative decrease $= \frac{P_2 - P_1}{P_2}$.

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4. The Young's double slit interference experiment is performed using light consisting of 480 nm and 600 nm wavelengths to form interference patterns. The least number of the bright fringes of 480 nm light that are required for the first coincidence with the bright fringes formed by 600 nm light is:

(A) 4

(B) 8

(C) 6

(D) 5

Correct Answer: (D) 5

Solution:

Concept:

In Young's double slit experiment, bright fringes coincide when their path differences are equal. For two wavelengths λ_1 and λ_2, coincidence occurs when:

$$n_1\lambda_1 = n_2\lambda_2$$

where n_1 and n_2 are fringe orders.

Step 1: Write the wavelengths.

$$\lambda_1 = 480 \text{ nm}$$

$$\lambda_2 = 600 \text{ nm}$$

Step 2: Apply condition for coincidence.

Let n_1 be the order for 480 nm light and n_2 be the order for 600 nm light.

$$n_1(480) = n_2(600)$$

$$\frac{n_1}{n_2} = \frac{600}{480}$$

$$\frac{n_1}{n_2} = \frac{5}{4}$$

Step 3: Find least integral values.

The least values satisfying the ratio are:

$$n_1 = 5, \quad n_2 = 4$$

So, the 5^{th} bright fringe of 480 nm coincides with the 4^{th} bright fringe of 600 nm.

Step 4: Final conclusion.

Hence, the least number of bright fringes of 480 nm light is:

$$\boxed{5}$$

Quick Tip: For first coincidence of bright fringes, use $n_1\lambda_1 = n_2\lambda_2$ and take the smallest whole number ratio.

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5. A steady current I flows through a long straight wire of radius a. The current is uniformly distributed across its cross-section. The ratio of the magnetic fields due to the wire at distances $\frac{a}{4}$ and $3a$ respectively from the axis of the wire is:

(A) 3 : 4
(B) 4 : 3
(C) 2 : 3
(D) 1 : 4

Correct Answer: (A) 3 : 4

Solution:

Concept:

For a long straight wire with uniformly distributed current:
Inside the wire ($r < a$):

$$B = \frac{\mu_0 I r}{2\pi a^2}$$

Outside the wire ($r > a$):

$$B = \frac{\mu_0 I}{2\pi r}$$

Step 1: Find magnetic field at $r = \frac{a}{4}$.

Since $\frac{a}{4} < a$, the point is inside the wire.

$$B_1 = \frac{\mu_0 I r}{2\pi a^2}$$

$$B_1 = \frac{\mu_0 I \left(\frac{a}{4}\right)}{2\pi a^2}$$

$$B_1 = \frac{\mu_0 I}{8\pi a}$$

Step 2: Find magnetic field at $r = 3a$.

Since $3a > a$, the point is outside the wire.

$$B_2 = \frac{\mu_0 I}{2\pi(3a)}$$

$$B_2 = \frac{\mu_0 I}{6\pi a}$$

Step 3: Find the ratio.

$$\frac{B_1}{B_2} = \frac{\frac{\mu_0 I}{8\pi a}}{\frac{\mu_0 I}{6\pi a}}$$

$$= \frac{1}{8} \times 6$$

$$= \frac{6}{8}$$

$$= \frac{3}{4}$$

Therefore,

$$B_1 : B_2 = 3 : 4$$

Quick Tip: Inside a uniformly current-carrying wire, $B \propto r$. Outside the wire, $B \propto \frac{1}{r}$.

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6. Two electrons are moving with different kinetic energies. If the first electron is moving with kinetic energy k and the second electron with kinetic energy $4k$, the ratio of their de Broglie wavelengths respectively will be:

(A) 1 : 2

(B) 1 : 4

(C) 2 : 1

(D) 4 : 1

Correct Answer: (C) 2 : 1

Solution:

Concept:

The de Broglie wavelength of a particle is:

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

For a non-relativistic particle,

$$K = \frac{p^2}{2m}$$

So,

$$p = \sqrt{2mK}$$

Therefore,

$$\lambda = \frac{h}{\sqrt{2mK}}$$

Thus,

$$\lambda \propto \frac{1}{\sqrt{K}}$$

Step 1: Write the kinetic energies.

For first electron:

$$K_1 = k$$

For second electron:

$$K_2 = 4k$$

Step 2: Use relation between wavelength and kinetic energy.

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}}$$

Substitute the values:

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{4k}{k}}$$

$$= \sqrt{4}$$

$$= 2$$

Step 3: Write the ratio.

$$\lambda_1 : \lambda_2 = 2 : 1$$

Step 4: Final conclusion.

Hence, the ratio of their de Broglie wavelengths is:

$$\boxed{2 : 1}$$

Quick Tip: For the same particle, de Broglie wavelength varies inversely as the square root of kinetic energy:

$$\lambda \propto \frac{1}{\sqrt{K}}$$

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7. The distance estimation for which ray optics is a good approximation for an aperture of 3 mm and wavelength 300 nm would be:

(A) 40 m

(B) 30 m

(C) 20 m

(D) 10 m

Correct Answer: (B) 30 m

Solution:

Concept:

Ray optics is a good approximation when diffraction effects are negligible.
A commonly used distance estimate is:

$$L \approx \frac{a^2}{\lambda}$$

where,

$$a = \text{aperture size}$$

$$\lambda = \text{wavelength}$$

Step 1: Convert aperture into metre.

$$a = 3 \text{ mm}$$

$$a = 3 \times 10^{-3} \text{ m}$$

Step 2: Convert wavelength into metre.

$$\lambda = 300 \text{ nm}$$

$$\lambda = 300 \times 10^{-9} \text{ m}$$

$$\lambda = 3 \times 10^{-7}\ \text{m}$$

Step 3: Apply the formula.

$$L = \frac{a^2}{\lambda}$$

$$L = \frac{(3 \times 10^{-3})^2}{3 \times 10^{-7}}$$

$$L = \frac{9 \times 10^{-6}}{3 \times 10^{-7}}$$

$$L = 3 \times 10^{1}$$

$$L = 30\ \text{m}$$

Step 4: Final conclusion.

Hence, the distance is:

$$\boxed{30\ \text{m}}$$

Quick Tip: For ray optics approximation, use the distance estimate $L \approx \frac{a^2}{\lambda}$.

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8. Let a rod AB of length l having resistance r is moving perpendicular to a magnetic field B with constant velocity v. If the ends of the rod are connected to a wire $PQRS$ of negligible resistance, then current passing through the wire will be:

(A) $\frac{Blv}{2r}$

(B) $\frac{Blv}{r}$

(C) $\frac{Blv}{4}$

(D) $\dfrac{3Blv}{4r}$

Correct Answer: (B) $\dfrac{Blv}{r}$

Solution:

Concept:

When a conducting rod of length l moves with velocity v perpendicular to a magnetic field B, motional emf is induced across its ends.
The induced emf is:

$$\varepsilon = Blv$$

Step 1: Write the induced emf.

For the moving rod:

$$\varepsilon = Blv$$

Step 2: Find total resistance of the circuit.

The wire $PQRS$ has negligible resistance.
Only the rod has resistance r.
Therefore, total resistance is:

$$R = r$$

Step 3: Apply Ohm's law.

Current is:

$$I = \frac{\varepsilon}{R}$$

$$I = \frac{Blv}{r}$$

Step 4: Final conclusion.

Hence, the current passing through the wire will be:

$$\boxed{\frac{Blv}{r}}$$

Quick Tip: For a rod moving perpendicular to a magnetic field, induced emf is $\varepsilon = Blv$. Then use $I = \frac{\varepsilon}{R}$.

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9. A parallel plate capacitor of capacitance $1\ \mu$F is charged to a potential difference of 20 V. The distance between plates is $1\ \mu$m. The energy density between plates of capacitor is:

(A) 1.8×10^3 J/m^3
(B) 2×10^3 J/m^3
(C) 2×10^2 J/m^3
(D) 1.8×10^5 J/m^3

Correct Answer: (A) 1.8×10^3 J/m^3

Solution:

Concept:

Energy density in an electric field is:

$$u = \frac{1}{2}\varepsilon_0 E^2$$

Also, electric field between plates is:

$$E = \frac{V}{d}$$

Step 1: Write the given values.

Potential difference:

$$V = 20 \text{ V}$$

Distance between plates:

$$d = 1\ \mu\text{m}$$

$$d = 1 \times 10^{-6} \text{ m}$$

Step 2: Find electric field.

$$E = \frac{V}{d}$$

$$E = \frac{20}{1 \times 10^{-6}}$$

$$E = 2 \times 10^{7} \text{ V/m}$$

Step 3: Find energy density.

$$u = \frac{1}{2}\varepsilon_0 E^2$$

Using:

$$\varepsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$$

$$u = \frac{1}{2}(8.85 \times 10^{-12})(2 \times 10^{7})^2$$

$$u = \frac{1}{2}(8.85 \times 10^{-12})(4 \times 10^{14})$$

$$u = \frac{1}{2}(35.4 \times 10^2)$$

$$u = 17.7 \times 10^2$$

$$u = 1.77 \times 10^3 \text{ J/m}^3$$

$$u \approx 1.8 \times 10^3 \text{ J/m}^3$$

Step 4: Final conclusion.

Hence, the energy density is:

$$\boxed{1.8 \times 10^3 \text{ J/m}^3}$$

Quick Tip: For capacitor energy density, first calculate $E = \frac{V}{d}$, then use $u = \frac{1}{2}\varepsilon_0 E^2$.

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10. Match List-I with List-II.

List-I	List-II
A. The current lags behind the emf by $\frac{\pi}{4}$ in phase	I. A.C. circuit containing only an inductor
B. The e.m.f. lags behind the current by $\frac{\pi}{4}$ in phase	II. A.C. circuit with resistance and inductance in series
C. The current lags behind the e.m.f. in phase by $\frac{\pi}{2}$	III. A.C. circuit containing only a capacitor
D. The e.m.f. lags behind the current in phase by $\frac{\pi}{2}$	IV. A.C. circuit with resistance and capacitor in series

(A) A-I, B-III, C-IV, D-II
(B) A-II, B-IV, C-I, D-III
(C) A-II, B-III, C-IV, D-I
(D) A-IV, B-II, C-I, D-III

Correct Answer: (B) A-II, B-IV, C-I, D-III

Solution:

Concept:

In A.C. circuits, the phase relation between current and voltage depends on the circuit element.
For inductor:

$$\text{Current lags voltage}$$

For capacitor:

$$\text{Current leads voltage}$$

Step 1: Match pure inductor.

In a pure inductive circuit, current lags behind e.m.f. by:

$$\frac{\pi}{2}$$

So:

$$C \rightarrow I$$

Step 2: Match pure capacitor.

In a pure capacitive circuit, current leads e.m.f. by:

$$\frac{\pi}{2}$$

This means e.m.f. lags behind current by:

$$\frac{\pi}{2}$$

So:

$$D \rightarrow III$$

Step 3: Match $R - L$ series circuit.

In an $R-L$ series circuit, current lags behind e.m.f. by an angle between 0 and $\frac{\pi}{2}$.
Here, the given angle is:

$$\frac{\pi}{4}$$

So:

$$A \to II$$

Step 4: Match $R-C$ series circuit.

In an $R-C$ series circuit, current leads e.m.f. by an angle between 0 and $\frac{\pi}{2}$.
This means e.m.f. lags behind current by an angle such as:

$$\frac{\pi}{4}$$

So:

$$B \to IV$$

Step 5: Final matching.

The correct matching is:

$$A-II, \quad B-IV, \quad C-I, \quad D-III$$

Hence:

$$\boxed{\text{(B)}}$$

Quick Tip: In pure inductor, current lags voltage by $\frac{\pi}{2}$. In pure capacitor, current leads voltage by $\frac{\pi}{2}$.