# JEE Main Physics Sample Paper-1

**Duration: 1 Hour** **Maximum Marks: 100**

## Instructions

- This paper contains TWO sections: **Section A** (MCQs) and **Section B** (Numerical).
- Section A contains 20 Multiple Choice Questions.
- Section B contains 5 Numerical Value Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

## Section A — Multiple Choice Questions

**Q1.** A light of frequency 1.5 times the threshold frequency is incident on a photosensitive material. If the frequency is halved and the intensity is doubled, the photoelectric current becomes: [JEE Main 2024]

(A) Doubled

(B) Quadrupled

(C) Halved

(D) Zero

**Q2.** Ratio of wavelengths of last line of Balmer and Lyman series: [JEE Main 2023]

(A) 1

(B) 4

(C) 0.5

(D) 2

**Q3.** Nucleus of mass 218 splits into 214 and 4. Potential energy of daughter nuclei is $V$. $Q$-value: [JEE Main 2022]

(A) $V$

(B) $1.02V$

(C) $0.98V$

(D) More data needed

**Q4.** Energy of electron in $n$th orbit $E_n = -13.6/n^2$ eV. Energy to excite from 1st excited to 3rd excited: [JEE Main 2025]

(A) 10.2 eV

(B) 2.55 eV

(C) 0.66 eV

(D) 1.89 eV

**Q5.** Hollow conducting sphere radius $R$ has charge $+Q$. Electric field at $r < R$: [JEE Main 2024]

(A) $kQ/r^2$

(B) $kQ/R^2$

(C) Zero

(D) $kQ/Rr$

**Q6.** Capacitor 4 $\mu$F charged to 400 V, plates connected through 1 k$\Omega$ resistor. Heat produced: [JEE Main 2021]

(A) 0.16 J

(B) 0.32 J

(C) 0.64 J

(D) 1.28 J

**Q7.** Six charges at vertices of regular hexagon in alternating order. Electric potential at center: [JEE Main 2023]

(A) $3kq/a$

(B) $6kq/a$

(C) Zero

(D) $\sqrt{3}kq/a$

**Q8.** Carbon resistor marked Brown, Black, Green. Resistance: [JEE Main 2022]

(A) 1 k$\Omega$

(B) 1 MΩ

(C) 10 kΩ

(D) 100 kΩ

**Q9.** Meter bridge null point at 20 cm from one end, $X < Y$. Ratio $X : Y$: [JEE Main 2025]

(A) 1:4

(B) 1:5

(C) 4:1

(D) 2:3

**Q10.** Current 2 A, area 2 $mm^2$, electron density $8 \times 10^{28}/m^3$. Drift velocity: [JEE Main 2024]

(A) 0.078 mm/s

(B) 0.156 mm/s

(C) 1.25 mm/s

(D) 0.5 mm/s

**Q11.** Long solenoid 1000 turns/m, current 1 A. Magnetic field at center: [JEE Main 2021]

(A) $4\pi \times 10^{-4}$ T

(B) $2\pi \times 10^{-4}$ T

(C) $4\pi \times 10^{-7}$ T

(D) $10^{-3}$ T

**Q12.** Circular loop radius $r$, angular velocity $\omega$ in uniform B. Maximum induced emf: [JEE Main 2023]

(A) $B\pi r^2\omega$

(B) $2B\pi r^2\omega$

(C) $B\pi r^2\omega/2$

(D) Zero

**Q13.** LCR series, phase difference $\pi/4$, R=100 Ω. Reactance: [JEE Main 2022]

(A) 100 Ω

(B) 200 Ω

(C) 50 Ω

(D) $100\sqrt{2}$ Ω

**Q14.** Convex mirror, object 30 cm, focal length 30 cm. Image distance: [JEE Main 2024]

(A) 15 cm behind mirror

(B) 30 cm in front of mirror

(C) 60 cm behind mirror

(D) Infinity

**Q15.** Young's double slit, fringe width 0.4 mm, immersed in water $n = 4/3$. New fringe width: [JEE Main 2025]

(A) 0.3 mm

(B) 0.4 mm

(C) 0.53 mm

(D) 0.2 mm

**Q16.** Unpolarized light, angle between polaroids 60°, transmitted intensity: [JEE Main 2021]

(A) $I_0/2$

(B) $I_0/4$

(C) $I_0/8$

(D) $3I_0/8$

**Q17.** Average translational kinetic energy of gas molecule at temperature T: [JEE Main 2023]

(A) $kT$

(B) $3/2\,kT$

(C) $1/2\,kT$

(D) $3kT$

**Q18.** Carnot engine between 27°C and 127°C, efficiency: [JEE Main 2022]

(A) 25%

(B) 33%

(C) 50%

(D) 75%

**Q19.** Particle in circle $r = 5$ cm, time period $0.2\pi$ s. Acceleration: [JEE Main 2024]

(A) 5 m/s$^2$

(B) 25 m/s$^2$

(C) 36 m/s$^2$

(D) 50 m/s$^2$

**Q20.** Two bodies 1 kg, 4 kg dropped from same height. Ratio of momenta before impact: [JEE Main 2025]

(A) 1:2

(B) 1:4

(C) 1:16

(D) 4:1

## Section B — Numerical Questions

**Q21.** Series LCR, $R = 10\ \Omega$, $L = 2$ H, $C = 32\ \mu$F. Resonant frequency $X$ Hz. Take $\pi = 3.14$. [JEE Main 2024]

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**Q22.** SHM, $y = 5\sin(20t + 0.5)$ cm. Maximum velocity $X$ m/s. [JEE Main 2023]

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**Q23.** Ball dropped from height $h$, rebounds to $0.64h$. Coefficient of restitution is $0.x$. Find $x$. [JEE Main 2025]

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**Q24.** Two satellites $S_1$, $S_2$ are in the same orbit. Mass of $S_1 = 4\times$ mass of $S_2$. Ratio $T_1/T_2$. [JEE Main 2022]

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**Q25.** A wire of length $L$ and resistance $R$ is bent into a circle. Resistance between two points at the ends of a diameter is $R/x$. Find $x$. [JEE Main 2024]

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## Detailed Solutions

**Q1.**

### Solution

**Concept:** Photoelectric emission occurs only when the incident frequency is at least the threshold frequency.

**Formula:**

$$hf_0 = \phi$$

**Solution:** Initially,

$$f = 1.5f_0$$

If the frequency is halved, the new frequency becomes

$$f' = \frac{1.5f_0}{2} = 0.75f_0$$

Since

$$f' < f_0$$

the new light frequency is below threshold frequency. Therefore no photoelectrons are emitted, no matter how much the intensity is increased.

Hence the photoelectric current becomes zero.

Final Answer: (D)

**Answer: (D)**

## Q2.

### Solution

**Concept:** The last line of a spectral series corresponds to the series limit, where the upper level is at infinity.

**Formula:**

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

**Solution:** For the last line of the Balmer series,

$$n_1 = 2, \quad n_2 \to \infty$$

So,

$$\frac{1}{\lambda_B} = R\left(\frac{1}{2^2}\right) = \frac{R}{4} \Rightarrow \lambda_B = \frac{4}{R}$$

For the last line of the Lyman series,

$$n_1 = 1, \quad n_2 \to \infty$$

So,

$$\frac{1}{\lambda_L} = R \Rightarrow \lambda_L = \frac{1}{R}$$

Therefore,

$$\frac{\lambda_B}{\lambda_L} = \frac{4/R}{1/R} = 4$$

Final Answer: (B)

**Answer: (B)**

## Q3.

### Solution

**Concept:** In nuclear decay, the released $Q$-value appears as the total kinetic energy of the daughter particles. This kinetic energy comes from the mutual electrostatic potential energy of separation.

**Solution:** If the daughter nuclei have mutual potential energy $V$, then this stored potential energy gets converted into their kinetic energy as they move apart. Hence the total energy released in the decay is equal to this potential energy.

Therefore,

$$Q = V$$

Final Answer: (A)

**Answer: (A)**

## Q4.

### Solution

**Concept:** Energy of hydrogen atom in the $n$th orbit is

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

**Solution:** First excited state means

$$n = 2$$

Third excited state means

$$n = 4$$

So,

$$E_2 = -\frac{13.6}{4} = -3.4 \text{ eV}$$

$$E_4 = -\frac{13.6}{16} = -0.85 \text{ eV}$$

Energy required for excitation:

$$\Delta E = E_4 - E_2 = (-0.85) - (-3.4) = 2.55 \text{ eV}$$

Final Answer: (B)

**Answer: (B)**

## Q5.

### Solution

**Concept:** The electric field inside a conductor in electrostatic equilibrium is zero.

**Solution:** A hollow conducting sphere carries all excess charge on its outer surface. Therefore for any interior point with

$$r < R$$

the electric field is

$$E = 0$$

Final Answer: (C)

**Answer: (C)**

## Q6.

### Solution

**Concept:** When a charged capacitor is completely discharged through a resistor, all its stored electrostatic energy is converted into heat.

**Formula:**

$$U = \frac{1}{2}CV^2$$

**Solution:** Given,

$$C = 4 \times 10^{-6} \text{ F}, \qquad V = 400 \text{ V}$$

So heat produced is

$$H = \frac{1}{2} \times 4 \times 10^{-6} \times (400)^2$$

$$H = 2 \times 10^{-6} \times 160000$$

$$H = 0.32 \text{ J}$$

Final Answer: (B)

**Answer: (B)**

## Q7.

### Solution

**Concept:** Electric potential is a scalar quantity. Potentials due to charges at equal distance add algebraically.

**Solution:** All six charges are at the same distance from the center of the regular hexagon. Since the charges are arranged in alternating order, equal positive and negative contributions cancel each other.

Thus net potential at the center is

$$V = 0$$

Final Answer: (C)

**Answer: (C)**

## Q8.

### Solution

**Concept:** Carbon resistor color code: first band = first digit, second band = second digit, third band = multiplier.

**Solution:** Brown = 1, Black = 0, Green = multiplier

$$10^5$$

Therefore resistance is

$$10 \times 10^5 = 10^6\ \Omega = 1\ \text{M}\Omega$$

Final Answer: (B)

**Answer: (B)**

## Q9.

### Solution

**Concept:** In a meter bridge at balance point,

$$\frac{X}{Y} = \frac{l}{100 - l}$$

**Solution:** Given null point is at 20 cm from one end and

$$X < Y$$

So the smaller resistance corresponds to the smaller wire length:

$$\frac{X}{Y} = \frac{20}{80} = \frac{1}{4}$$

Hence,

$$X : Y = 1 : 4$$

Final Answer: (A)

**Answer: (A)**

## Q10.

### Solution

**Concept:** Drift velocity is given by

$$I = neAv_d$$

**Solution:** Given,

$$I = 2 \text{ A}, \quad A = 2 \text{ mm}^2 = 2 \times 10^{-6} \text{ m}^2$$

$$n = 8 \times 10^{28} \text{ m}^{-3}, \quad e = 1.6 \times 10^{-19} \text{ C}$$

So,

$$v_d = \frac{I}{neA} = \frac{2}{(8 \times 10^{28})(1.6 \times 10^{-19})(2 \times 10^{-6})}$$

$$v_d = 7.8125 \times 10^{-5} \text{ m/s}$$

Converting into mm/s,

$$v_d = 0.078 \text{ mm/s}$$

Final Answer: (A)

**Answer: (A)**

## Q11.

### Solution

**Concept:** Magnetic field inside a long solenoid is

$$B = \mu_0 nI$$

**Solution:** Given,

$$n = 1000 \text{ turns/m}, \quad I = 1 \text{ A}$$

So,

$$B = 4\pi \times 10^{-7} \times 1000 \times 1 = 4\pi \times 10^{-4} \text{ T}$$

Final Answer: (A)

**Answer: (A)**

## Q12.

### Solution

**Concept:** Maximum induced emf in a rotating loop is

$$E_{\max} = NBA\omega$$

**Solution:** For a single circular loop,

$$N = 1, \qquad A = \pi r^2$$

Hence

$$E_{\max} = B\pi r^2\omega$$

Final Answer: (A)

**Answer: (A)**

## Q13.

### Solution

**Concept:** In an LCR series circuit,

$$\tan\phi = \frac{X_L - X_C}{R}$$

**Solution:** Given

$$\phi = \frac{\pi}{4}, \qquad R = 100\ \Omega$$

So,

$$\tan\frac{\pi}{4} = 1 = \frac{X}{R}$$

where

$$X = X_L - X_C$$

Thus

$$X = R = 100\ \Omega$$

Final Answer: (A)

**Answer: (A)**

## Q14.

### Solution

**Concept:** Mirror formula is

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

**Solution:** For a convex mirror,

$$f = +30 \text{ cm}$$

Object distance:

$$u = -30 \text{ cm}$$

Using mirror formula,

$$\frac{1}{30} = \frac{1}{v} - \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{30} + \frac{1}{30} = \frac{2}{30} = \frac{1}{15}$$

Hence

$$v = 15 \text{ cm}$$

Positive sign means image is behind the mirror.
Final Answer: (A)

**Answer: (A)**

## Q15.

### Solution

**Concept:** Fringe width in a medium becomes

$$\beta' = \frac{\beta}{n}$$

**Solution:** Given original fringe width

$$\beta = 0.4 \text{ mm}, \qquad n = \frac{4}{3}$$

So,

$$\beta' = \frac{0.4}{4/3} = 0.4 \times \frac{3}{4} = 0.3 \text{ mm}$$

Final Answer: (A)

**Answer: (A)**

## Q16.

### Solution

**Concept:** Unpolarized light after first polaroid becomes half. Then apply Malus' law.

**Formula:**

$$I = \frac{I_0}{2}\cos^2\theta$$

**Solution:** After first polaroid,

$$I_1 = \frac{I_0}{2}$$

Angle between polaroids is

$$\theta = 60^\circ$$

Therefore

$$I = I_1\cos^2 60^\circ = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^2 = \frac{I_0}{8}$$

Final Answer: (C)

**Answer: (C)**

## Q17.

### Solution

**Concept:** Average translational kinetic energy of one gas molecule is

$$\frac{3}{2}kT$$

**Solution:** This is a standard result from kinetic theory of gases. Therefore the required average translational kinetic energy is

$$\frac{3}{2}kT$$

Final Answer: (B)

**Answer: (B)**

## Q18.

### Solution

**Concept:** Carnot efficiency is

$$\eta = 1 - \frac{T_2}{T_1}$$

**Solution:** Convert temperatures to Kelvin:

$$T_1 = 127^\circ\text{C} = 400 \text{ K}$$

$$T_2 = 27^\circ\text{C} = 300 \text{ K}$$

So,

$$\eta = 1 - \frac{300}{400} = 1 - \frac{3}{4} = \frac{1}{4} = 25\%$$

Final Answer: (A)

**Answer: (A)**

## Q19.

### Solution

**Concept:** Centripetal acceleration is

$$a = \omega^2 r$$

where

$$\omega = \frac{2\pi}{T}$$

**Solution:** Given,

$$r = 5 \text{ cm} = 0.05 \text{ m}$$

$$T = 0.2\pi \text{ s}$$

So,

$$\omega = \frac{2\pi}{0.2\pi} = 10 \text{ rad/s}$$

Hence,

$$a = \omega^2 r = (10)^2(0.05) = 5 \text{ m/s}^2$$

Final Answer: (A)

**Answer: (A)**

## Q20.

### Solution

**Concept:** Just before impact, both bodies have same speed if dropped from same height.
**Formula:**

$$p = mv$$

**Solution:** Since both are dropped from the same height, their speed before impact is same:

$$v = \sqrt{2gh}$$

Therefore momentum ratio depends only on masses:

$$p_1 : p_2 = m_1 : m_2 = 1 : 4$$

Final Answer: (B)

**Answer: (B)**

## Q21.

### Solution

**Concept:** Resonant frequency of series LCR circuit is

$$f = \frac{1}{2\pi\sqrt{LC}}$$

**Solution:** Given,

$$L = 2 \text{ H}, \qquad C = 32 \times 10^{-6} \text{ F}$$

So,

$$LC = 64 \times 10^{-6} = 6.4 \times 10^{-5}$$

$$\sqrt{LC} = 8 \times 10^{-3}$$

Hence,

$$f = \frac{1}{2 \times 3.14 \times 8 \times 10^{-3}} \approx \frac{1}{0.05024} \approx 19.9 \text{ Hz}$$

So,

$$X \approx 20$$

Final Answer: $X = 20$

**Answer: (20)**

## Q22.

### Solution

**Concept:** In SHM,

$$v_{\max} = A\omega$$

**Solution:** Given

$$y = 5\sin(20t + 0.5) \text{ cm}$$

So amplitude is

$$A = 5 \text{ cm} = 0.05 \text{ m}$$

and angular frequency is

$$\omega = 20 \text{ rad/s}$$

Thus,

$$v_{\max} = A\omega = 0.05 \times 20 = 1 \text{ m/s}$$

Final Answer: $X = 1$

**Answer: (1)**

## Q23.

### Solution

**Concept:** Coefficient of restitution is the ratio of rebound speed to impact speed. For vertical motion,

$$e = \sqrt{\frac{h_2}{h_1}}$$

**Solution:** Given rebound height

$$h_2 = 0.64h_1$$

So,

$$e = \sqrt{0.64} = 0.8$$

Thus

$$e = 0.x = 0.8$$

Hence,

$$x = 8$$

Final Answer: $x = 8$

**Answer: (8)**

## Q24.

### Solution

**Concept:** Time period of a satellite in a given orbit depends only on orbital radius and central mass, not on satellite mass.

**Solution:** Since both satellites are in the same orbit, their orbital radius is same. Therefore their time periods are equal:

$$T_1 = T_2$$

Hence,

$$\frac{T_1}{T_2} = 1$$

Final Answer: $T_1/T_2 = 1$

**Answer: (1)**

## Q25.

### Solution

**Concept:** When a uniform wire is bent into a circle, the endpoints of a diameter divide it into two equal semicircles in parallel.

**Solution:** Total resistance of the wire is

$$R$$

Each semicircle has resistance

$$\frac{R}{2}$$

These two semicircles are in parallel. Therefore equivalent resistance is

$$R_{\text{eq}} = \frac{(R/2)(R/2)}{(R/2) + (R/2)} = \frac{R}{4}$$

Given,

$$R_{\text{eq}} = \frac{R}{x}$$

So,

$$\frac{R}{x} = \frac{R}{4} \Rightarrow x = 4$$

Final Answer: $x = 4$

**Answer: (4)**

## Answer Key — Section A

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | D | 2 | B | 3 | A | 4 | B | 5 | C |
| 6 | B | 7 | C | 8 | B | 9 | A | 10 | A |
| 11 | A | 12 | A | 13 | A | 14 | A | 15 | A |
| 16 | C | 17 | B | 18 | A | 19 | A | 20 | B |

## Answer Key — Section B

| Q | Ans | Q | Ans |
|---|---|---|---|
| 21 | 20 | 22 | 1 |
| 23 | 8 | 24 | 1 |
| 25 | 4 | | |