JEE Main Physics Sample Paper-4

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. Particle moves in xy-plane with $\vec{v} = (a\hat{i} + bx\hat{j})$. Trajectory: [JEE Main 2024]

(A) $\frac{b}{2a}x^2$

(B) $\frac{a}{2b}x^2$

(C) $\frac{b}{a}x$

(D) $\frac{2b}{a}x^2$

Q2. Diatomic gas heated at constant pressure. Fraction of heat used for internal energy: [JEE Main 2023]

(A) 5/7

(B) 3/5

(C) 2/5

(D) 2/7

Q3. Gravitational potential at surface V_0. Potential at height R: [JEE Main 2022]

(A) $V_0/2$

(B) $2V_0$

(C) $V_0/4$

(D) $V_0/\sqrt{2}$

Q4. Monochromatic light 600 nm enters medium $n = 1.5$. Wavelength in medium: [JEE Main 2025]

(A) 400 nm

(B) 900 nm

(C) 300 nm

(D) 600 nm

Q5. Binding energy of satellite mass m orbit radius r:

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

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

(C) $-\frac{GMm}{2r}$

(D) $\frac{2GMm}{r}$

Q6. Magnetic needle in non-uniform field experiences:

(A) Torque but not force

(B) Force but not torque

(C) Both force and torque

(D) Neither

Q7. Speeds of electron in 1st and 2nd hydrogen orbits: [JEE Main 2021]

(A) 1 : 2

(B) 2 : 1

(C) 1 : 4

(D) 4 : 1

Q8. Coil area 100 cm^2, 500 turns, $B = 0.1$ T $\rightarrow$ 0 in 0.1 s. Induced emf: [JEE Main 2022]

(A) 5 V

(B) 0.5 V

(C) 50 V

(D) 0.05 V

Q9. Two capacitors 10 μF, 20 μF in series across 120 V. Voltage across 10 μF: [JEE Main 2025]

(A) 40 V

(B) 80 V

(C) 60 V

(D) 120 V

Q10. Logic gate equivalent (2 NOT $\rightarrow$ OR): [JEE Main 2024]

(A) AND

(B) NAND

(C) NOR

(D) XOR

Q11. Wire length L, radius r, resistance R. Wire $L/2$, radius $2r$: resistance: [JEE Main 2021]

(A) $R/8$

(B) $R/4$

(C) $R/2$

(D) $R/16$

Q12. Photon wavelength 4000 Å. Energy: [JEE Main 2023]

(A) 2.0 eV

(B) 3.1 eV

(C) 4.5 eV

(D) 1.5 eV

Q13. SHM $x = 10\sin(20t + 0.5)$. Phase constant: [JEE Main 2022]

(A) 0.5 rad

(B) 20 rad

(C) 10 rad

(D) 0 rad

Q14. de-Broglie wavelength λ, KE $K \to K/4$. New wavelength:

(A) $\lambda/2$

(B) 2λ

(C) 4λ

(D) $\lambda/\sqrt{2}$

Q15. Convex lens +5 D, concave -3 D. Focal length combination:

(A) 50 cm

(B) 20 cm

(C) 10 cm

(D) 33.3 cm

Q16. Radioactive nuclei reduces to 1/16 in 40 days. Half-life:

(A) 20 days

(B) 10 days

(C) 5 days

(D) 2.5 days

Q17. Intensity of wave proportional to:

(A) Square of amplitude

(B) Square root of amplitude

(C) Amplitude

(D) Reciprocal

Q18. Purely inductive AC circuit, current: [JEE Main 2025]

(A) Leads $\pi/2$

(B) Lags $\pi/2$

(C) In phase

(D) Lags π

Q19. Threshold frequency 10^{15} Hz, light 2×10^{15} Hz. Max KE: [JEE Main 2025]

(A) 6.6×10^{-19}

(B) 3.3×10^{-19}

(C) 13.2×10^{-19}

(D) 0

Q20. Range maximum when angle is: [JEE Main 2024]

(A) 30°

(B) 45°

(C) 60°

(D) 90°

Section B — Numerical Questions

Q21. Block mass 2 kg, force 20 N at 60° over 10 m. Work X J: [JEE Main 2024]

Q22. Capillary rise 10 cm radius r, new radius r/2, height X cm: [JEE Main 2023]

Q23. Ratio of intensities 9:1. Max/min intensity X: [JEE Main 2025]

Q24. Solenoid length 0.5 m, 500 turns, current 2 A. Magnetic field X$\pi \times 10^{-4}$ T: [JEE Main 2022]

Q25. Black body temp 300 K $\rightarrow$ 600 K. Ratio emissive power X: [JEE Main 2024]

Detailed Solutions

Q1.

Solution

Concept: Velocity components give differential relation → integrate to get trajectory.

Formula:

$$v_x = \frac{dx}{dt}, \quad v_y = \frac{dy}{dt}, \quad \frac{dy}{dx} = \frac{v_y}{v_x}$$

Solution: Given: $\vec{v} = a\hat{i} + bx\hat{j}$

$$\frac{dx}{dt} = a, \quad \frac{dy}{dt} = bx \quad \Rightarrow \frac{dy}{dx} = \frac{bx}{a}$$

Integrate:

$$dy = \frac{b}{a}x dx \quad \Rightarrow \quad y = \frac{b}{2a}x^2$$

Answer: (A)

Q2.

Solution

Concept: At constant pressure: heat splits into internal energy + work.

Formula:

$$Q = nC_p\Delta T, \quad \Delta U = nC_v\Delta T, \quad \frac{\Delta U}{Q} = \frac{C_v}{C_p}$$

For diatomic gas: $C_v = \frac{5}{2}R$, $C_p = \frac{7}{2}R$

Solution:

$$\frac{\Delta U}{Q} = \frac{5/2}{7/2} = \frac{5}{7}$$

Answer: (A)

Q3.

Solution

Concept: Gravitational potential inversely proportional to distance.

Formula: $V = -\frac{GM}{r}$

Solution: At surface: $V_0 = -\frac{GM}{R}$ At height R above surface: $r = 2R$

$$V = -\frac{GM}{2R} = \frac{V_0}{2}$$

Answer: (A)

Q4.

Solution

Concept: Wavelength decreases in medium.
Formula: $\lambda' = \frac{\lambda}{n}$
Solution:

$$\lambda' = \frac{600}{1.5} = 400\,\text{nm}$$

Answer: (A)

Q5.

Solution

Concept: Binding energy = total energy of orbiting satellite.
Formula: $E = -\frac{GMm}{2r}$
Solution: Binding energy is:

$$E = -\frac{GMm}{2r}$$

Answer: (C)

Q6.

Solution

Concept: Non-uniform magnetic field produces both force and torque.
Solution: Torque aligns dipole, force acts due to field gradient.

Answer: (C)

Q7.

Solution

Concept: Speed of electron in orbit: $v_n \propto \frac{1}{n}$
Solution:

$$v_1 : v_2 = 1/1 : 1/2 = 2 : 1$$

Answer: (B)

Q8.

Solution

Concept: Induced emf = rate of change of magnetic flux.
Formula: $E = N\frac{\Delta\Phi}{\Delta t}$, $\Phi = BA$
Solution: Given: $A = 100\,\text{cm}^2 = 10^{-2}\,\text{m}^2$, $B = 0.1\,\text{T}$, $N = 500$, $\Delta t = 0.1\,\text{s}$

$$\Delta\Phi = BA = 0.1 \times 10^{-2} = 10^{-3} \quad \Rightarrow \quad E = 500 \times 10^{-3}/0.1 = 5\,\text{V}$$

Answer: (A)

Q9.

Solution

Concept: Voltage divides inversely in series capacitors.
Formula: $V_1 = \frac{C_2}{C_1+C_2}V$
Solution: $C_1 = 10\,\mu F$, $C_2 = 20\,\mu F$, $V = 120\,\text{V}$

$$V_1 = \frac{20}{10+20} \times 120 = \frac{20}{30} \times 120 = 80\,\text{V}$$

Answer: (B)

Q10.

Solution

Concept: NOR logic: $(A' + B') = (AB)'$

Answer: (C)

Q11.

Solution

Concept: Resistance depends on length and cross-sectional area: $R = \rho L/A$
Solution: Wire stretched to 2L, area $A' = A/4$

$$R' = \rho(2L)/(A/4) = 8R$$

Answer: (A)

Q12.

Solution

Concept: Photon energy from wavelength: $E = \frac{hc}{\lambda}$
Solution: $\lambda = 4000\,\text{Å} = 4 \times 10^{-7}\,\text{m}$

$$E \approx 3.1\,\text{eV}$$

Answer: (B)

Q13.

Solution

Concept: Phase constant in SHM is the constant term in argument of sine.
Solution: Given $x = 10\sin(20t + 0.5)$, phase constant $= 0.5$ rad

Answer: (A)

Q14.

Solution

Concept: $\lambda \propto 1/K$, lattice constant relation.
Solution: $K \to 4K \Rightarrow \lambda' = 2\lambda$

Answer: (B)

Q15.

Solution

Concept: Power adds for thin lenses in contact: $P = P_1 + P_2$
Solution: $P = 5 - 3 = 2D$, $f = 1/P = 0.5\,\text{m} = 50\,\text{cm}$

Answer: (A)

Q16.

Solution

Concept: Radioactive decay: $N = N_0(1/2)^n$
Solution: Given $1/16 = (1/2)^n \Rightarrow n = 4$, total time $T = 40/4 = 10$ days

Answer: (B)

Q17.

Solution

Concept: Intensity $\propto$ square of amplitude

Answer: (A)

Q18.

Solution

Concept: In inductor, current lags voltage by $\pi/2$.

Answer: (B)

Q19.

Solution

Concept: Photoelectric equation: $K_{\max} = h(\nu - \nu_0)$
Solution: Given $\nu = 2 \times 10^{15}\,\text{Hz}$, $\nu_0 = 1 \times 10^{15}\,\text{Hz}$

$$K = 6.6 \times 10^{-34} \times (2-1) \times 10^{15} = 6.6 \times 10^{-19}\,\text{J}$$

Answer: (A)

Q20.

Solution

Concept: Maximum range at 45°.

Answer: (B)

Q21.

Solution

Concept: Work done by a force along displacement: $W = Fd\cos\theta$
Solution: Given $F = 20\,\text{N}, d = 10\,\text{m}, \theta = 60^\circ$

$$W = 20 \times 10 \times \cos 60^\circ = 200 \times 0.5 = 100\,\text{J}$$

Answer: (100)

Q22.

Solution

Concept: Capillary rise $h \propto 1/r$

Solution: $h_1 = 10\,\text{cm}, r_1 = r, r_2 = r/2$

$$h_2 = h_1 \frac{r_1}{r_2} = 10 \times \frac{r}{r/2} = 20\,\text{cm}$$

Answer: (20)

Q23.

Solution

Concept: Interference: $I_{\max} \propto (I_1 + I_2)^2$, $I_{\min} \propto (I_1 - I_2)^2$

Solution: $I_1 : I_2 = 9 : 1 \Rightarrow 3 : 1$

$$\frac{I_{\max}}{I_{\min}} = \frac{(3+1)^2}{(3-1)^2} = \frac{16}{4} = 4$$

Answer: (4)

Q24.

Solution

Concept: Magnetic field inside solenoid: $B = \mu_0 n I$

Solution: Given $L = 0.5\,\text{m}, N = 500, I = 2\,\text{A}, \mu_0 = 4\pi \times 10^{-7}$

$$n = \frac{N}{L} = \frac{500}{0.5} = 1000\,\text{turns/m}, \quad B = \mu_0 n I = 8\pi \times 10^{-4}\,\text{T}$$

Answer: ($8\pi \times 10^{-4}$)

Q25.

Solution

Concept: Emissive power $E \propto T^4$ (Stefan-Boltzmann law)

Solution: $T_1 = 300\,\text{K}, T_2 = 600\,\text{K}$

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{600}{300}\right)^4 = 16$$

Answer: (16)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	100	22	20
23	4	24	$8\pi \times 10^{-4}$
25	16		