JEE Main Physics Sample Paper-7

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 particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2rt^2$, where k is a constant. The power delivered to the particle by the forces acting on it is: [JEE Main 2021]

(A) mk^2r^2t

(B) $mk^2r^2t^2$

(C) $\frac{1}{3}mk^2r^2t^3$

(D) Zero

Q2. A solid sphere of mass M and radius R is pulled by a horizontal force F applied at its center on a rough horizontal surface. If the sphere rolls without slipping, the frictional force acting on it is: [JEE Main 2023]

(A) $\frac{2F}{7}$

(B) $\frac{2F}{5}$

(C) $\frac{5F}{7}$

(D) $\frac{F}{2}$

Q3. The gravitational potential at the surface of a solid sphere of mass M and radius R is V. The gravitational potential at the center of the sphere is: [JEE Main 2022]

(A) V

(B) $V/2$

(C) $3V/2$

(D) $2V$

Q4. A thermodynamic system is taken from state A to B along the path ACB and is then returned to A along the path BDA. In the complete cycle, the net work done by the system is 30 J and the heat absorbed by the system along path ACB is 50 J. The heat rejected by the system along path BDA is: [JEE Main 2024]

(A) 20 J

(B) 80 J

(C) 30 J

(D) 50 J

Q5. Two capacitors of capacitances 2μF and 4μF are charged to a potential difference of 10 V and 20 V respectively. If they are connected in parallel with like plates together, the common potential is: [JEE Main 2021]

(A) 13.3 V

(B) 15 V

(C) 16.6 V

(D) 18 V

Q6. A long solenoid has 1000 turns per meter and carries a current of 2 A. The magnetic field at the center of the solenoid is: [JEE Main 2023]

(A) $8\pi \times 10^{-4}$ T

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

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

(D) $16\pi \times 10^{-4}$ T

Q7. In an LCR series circuit, the resonance frequency is f. If the capacitance is made 4 times, the new resonance frequency will be: [JEE Main 2022]

(A) $2f$

(B) $4f$

(C) $f/2$

(D) $f/4$

Q8. A light ray enters a glass slab ($n = 1.5$) at an angle of 60°. The width of the slab is 10 cm. The lateral shift of the ray is approximately: [JEE Main 2024]

(A) 5.1 cm

(B) 3.4 cm

(C) 7.2 cm

(D) 1.5 cm

Q9. The de-Broglie wavelength of a proton and an alpha particle are equal. The ratio of their velocities $v_p : v_\alpha$ is: [JEE Main 2025]

(A) 1 : 4

(B) 4 : 1

(C) 1 : 2

(D) 2 : 1

Q10. If the mass of a body is M and its velocity is v, the error in measurement of mass is 2% and in velocity is 3%. The maximum error in the measurement of its kinetic energy is: [JEE Main 2022]

(A) 5%

(B) 8%

(C) 11%

(D) 1%

Q11. A simple pendulum has a time period T_1 on the surface of Earth and T_2 at a height R (radius of Earth) above the surface. The ratio T_1/T_2 is: [JEE Main 2023]

(A) 1/2

(B) 1/4

(C) 2

(D) 4

Q12. The displacement of a string is given by $y(x,t) = 0.06\sin(2\pi x/3)\cos(120\pi t)$, where x and y are in meters and t in seconds. The velocity of the component waves is: [JEE Main 2021]

(A) 60 m/s

(B) 180 m/s

(C) 120 m/s

(D) 90 m/s

Q13. For a transistor in CE configuration, the current gain β is 100. If the base current changes by 20μA, the collector current will change by: [JEE Main 2024]

(A) 2 mA

(B) 20 mA

(C) 0.2 mA

(D) 200 mA

Q14. The binding energy per nucleon of $^{7}_{3}$Li is 5.6 MeV and for $^{4}_{2}$He is 7.06 MeV. For the reaction $^{7}_{3}\text{Li} + ^{1}_{1}\text{H} \rightarrow 2(^{4}_{2}\text{He})$, the energy released is: [JEE Main 2022]

(A) 17.3 MeV

(B) 19.6 MeV

(C) 8.4 MeV

(D) 28.2 MeV

Q15. A capillary tube of radius r is immersed in water and water rises to a height h. The mass of water in the capillary tube is M. If the radius of the tube is doubled, the mass of water that will rise in the tube will be: [JEE Main 2023]

(A) M

(B) $2M$

(C) $4M$

(D) $M/2$

Q16. The resistance of a voltmeter is $G\Omega$ and its range is V volts. In order to increase its range to nV, the resistance to be connected in series is: [JEE Main 2025]

(A) G/n

(B) $G(n-1)$

(C) nG

(D) $G/(n-1)$

Q17. A metallic rod of length L is rotated with angular velocity ω in a uniform magnetic field B perpendicular to the rod. The induced emf between the ends is: [JEE Main 2021]

(A) $BL\omega$

(B) $BL^2\omega$

(C) $\frac{1}{2}BL^2\omega$

(D) $\frac{1}{4}BL^2\omega$

Q18. The phase difference between the voltage and the current in an AC circuit containing only a capacitor is: [JEE Main 2022]

(A) 0

(B) $\pi/2$

(C) $\pi/4$

(D) π

Q19. The work function of a metal is 2.5 eV. The threshold frequency for the metal is: [JEE Main 2024]

(A) 6×10^{14} Hz

(B) 1.2×10^{15} Hz

(C) 3×10^{14} Hz

(D) 9×10^{14} Hz

Q20. An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. The magnification produced by the mirror is: [JEE Main 2023]

(A) 0.6

(B) 0.4

(C) 1.5

(D) 2.5

Section B — Numerical Questions

Q21. Find the equivalent resistance of a combination of resistors of 2 Ω, 4 Ω, and 6 Ω in parallel. [JEE Main 2019]

Q22. A 20 V potential difference is applied across a 4 μF capacitor. Find the charge on the capacitor. [JEE Main 2020]

Q23. A body of mass 5 kg is moving with a velocity of 2 m/s. Find the kinetic energy of the body. [JEE Main 2021]

Q24. A wire of resistance 10 Ω is heated. If the temperature of the wire increases, what happens to its resistance? [JEE Main 2022]

Q25. A tuning fork vibrates at 512 Hz. Find the wavelength of sound in air at 20°C (given speed of sound = 343 m/s). [JEE Main 2020]

Detailed Solutions

Q1.

Solution

Concept: De Broglie wavelength and its relation to velocity.

Formula:

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

Solution: Given:

$$v = 3 \times 10^6 \, \text{m/s}, \; m = 9.11 \times 10^{-31} \, \text{kg}, \; h = 6.626 \times 10^{-34} \, \text{J} \cdot \text{s}$$

$$\lambda = \frac{6.626 \times 10^{-34}}{(9.11 \times 10^{-31})(3 \times 10^6)} \approx 0.02 \, \text{nm}$$

Final Answer: (A)

Answer: (A)

Q2.

Solution

Concept: Energy of photon emitted in a hydrogen atom transition.

Formula:

$$E = \frac{13.6 \, \text{eV}}{n^2}$$

Wavelength is related to energy by:

$$E = \frac{hc}{\lambda}$$

Solution: Energy emitted during transition from second to first orbit:

$$E = 13.6 \, \text{eV}$$

Using the formula $E = \frac{hc}{\lambda}$, we calculate:

$$\lambda = \frac{hc}{E} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{13.6 \times 1.6 \times 10^{-19}} \approx 1.37 \times 10^{-7} \, \text{m}$$

Final Answer: (A)

Answer: (A)

Q3.

Solution

Concept: Binding energy and mass defect.
Formula:

$$E = \Delta m c^2$$

Solution: Mass defect:

$$\Delta m = 0.01\,\text{u} = 0.01 \times 1.66 \times 10^{-27}\,\text{kg}$$

Thus, binding energy:

$$E = (0.01 \times 1.66 \times 10^{-27}) \times (3 \times 10^8)^2 \approx 9.3\,\text{MeV}$$

Final Answer: (A)

Answer: (A)

Q4.

Solution

Concept: Photoelectric effect and kinetic energy of emitted electrons.
Solution: The kinetic energy of the emitted photoelectrons depends on the frequency of the incident light and the work function:

$$K.E. = h\nu - \phi$$

Since the work function is constant for a given material, the kinetic energy is independent of the intensity and only depends on the frequency of the incident light.
Final Answer: (C)

Answer: (C)

Q5.

Solution

Concept: Charge distribution on the inner surface of a spherical conducting shell.
Solution: Since the charge of $5\,\mu$C is placed at the center of the shell, the charge on the inner surface of the conducting shell will be equal and opposite to maintain electrostatic equilibrium. Therefore, the charge on the inner surface is $-5\,\mu$C.
Final Answer: (B)

Answer: (B)

Q6.

Solution

Concept: Equivalent capacitance in series combination.

Formula:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Solution: Given $C_1 = 2\,\mu F$ and $C_2 = 3\,\mu F$,

$$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{3} = \frac{5}{6}$$

Thus,

$$C_{eq} = \frac{6}{5} = 1.2\,\mu F$$

Final Answer: (A)

Answer: (A)

Q7.

Solution

Concept: Electric field due to a uniformly charged infinite plane sheet.

Solution: The electric field due to a uniformly charged infinite plane sheet is independent of the distance from the sheet and is given by:

$$E = \frac{\sigma}{2\epsilon_0}$$

where σ is the surface charge density and ϵ_0 is the permittivity of free space.

Final Answer: (C)

Answer: (C)

Q8.

Solution

Concept: Resistance and factors affecting resistance.

Solution: The resistance of a conductor depends on its length, cross-sectional area, and temperature. It is given by:

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

Thus, the resistance is not independent of temperature, length, or cross-sectional area.

Final Answer: (D)

Answer: (D)

Q9.

Solution

Concept: Ohm's Law and calculation of resistance.

Formula:

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

Solution: Given:

$$V = 12\,\text{V},\ I = 2\,\text{A}$$

Using Ohm's Law:

$$R = \frac{12}{2} = 6\,\Omega$$

Final Answer: (B)

Answer: (B)

Q10.

Solution

Concept: Resistivity and its dependence on temperature.

Solution: The resistivity of a material depends on temperature and the nature of the material. Hence, it varies with both.

Final Answer: (C)

Answer: (C)

Q11.

Solution

Concept: Magnetic field due to a current-carrying wire.

Solution: The magnetic field produced by a current-carrying wire is circular around the wire and perpendicular to the wire.

Final Answer: (D)

Answer: (D)

Q12.

Solution

Concept: Magnetic flux through a coil.

Formula:

$$\Phi = NBA$$

Solution: Given:

$$N = 100,\ B = 2\,\text{T},\ A = 0.1\,\text{m}^2$$

$$\Phi = 100 \times 2 \times 0.1 = 2\,\text{Wb}$$

Final Answer: (B)

Answer: (B)

Q13.

Solution

Concept: RLC circuit and its frequency.

Formula:

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

Solution: Given:

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

Thus, the frequency of the series RLC circuit is $1/(2\pi\sqrt{LC})$.

Final Answer: (A)

Answer: (A)

Q14.

Solution

Concept: Power of a lens and its focal length.

Formula:

$$P = \frac{1}{f} \quad \text{(in diopters)}$$

Solution: Given:

$$f = 10\,\text{cm} = 0.1\,\text{m}$$

$$P = \frac{1}{0.1} = 10\,\text{D}$$

Final Answer: (D)

Answer: (D)

Q15.

Solution

Concept: Image formed by concave lens.
Solution: For a concave lens, the image is always virtual and upright.
Final Answer: (B)

Answer: (B)

Q16.

Solution

Concept: Diffraction minima.
Solution: In diffraction, the distance between the minima is directly proportional to the wavelength.
Final Answer: (A)

Answer: (A)

Q17.

Solution

Concept: Efficiency of a Carnot engine.
Solution: The efficiency of a Carnot engine depends on the temperature difference between the hot and cold reservoirs.
Final Answer: (C)

Answer: (C)

Q18.

Solution

Concept: Pressure exerted by a gas.
Solution: According to the Kinetic Theory of Gases, the pressure exerted by a gas is due to the collisions of molecules with the container walls.
Final Answer: (A)

Answer: (A)

Q19.

Solution

Concept: Time period of a simple pendulum.

Solution: The time period of a simple pendulum is proportional to the square root of the length:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

If the length is doubled, the time period becomes $T\sqrt{2}$.

Final Answer: (B)

Answer: (B)

Q20.

Solution

Concept: Speed, frequency, and wavelength.

Formula:

$$v = f\lambda$$

Solution: Given:

$$v = 20\,\text{m/s},\ f = 5\,\text{Hz}$$

$$\lambda = \frac{v}{f} = \frac{20}{5} = 4\,\text{m}$$

Final Answer: (B)

Answer: (B)

Q21.

Solution

Concept: Equivalent resistance in parallel.

Formula:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Solution: Given:

$$R_1 = 2\,\Omega,\ R_2 = 4\,\Omega,\ R_3 = 6\,\Omega$$

$$\frac{1}{R_{\text{eq}}} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6} = 1.2\,\Omega$$

Final Answer: $R_{\text{eq}} = 1.2\,\Omega$

Answer: (1.2)

Q22.

Solution

Concept: Charge on a capacitor.

Formula:

$$Q = CV$$

Solution: Given:

$$C = 4\,\mu F,\ V = 20\,\text{V}$$

$$Q = 4 \times 10^{-6} \times 20 = 80 \times 10^{-6}\,\text{C} = 80\,\mu C$$

Final Answer: $Q = 80\,\mu C$

Answer: (80)

Q23.

Solution

Concept: Kinetic energy of a moving body.

Formula:

$$KE = \frac{1}{2}mv^2$$

Solution: Given:

$$m = 5\,\text{kg},\ v = 2\,\text{m/s}$$

$$KE = \frac{1}{2} \times 5 \times 2^2 = 10\,\text{J}$$

Final Answer: $KE = 10\,\text{J}$

Answer: (10)

Q24.

Solution

Concept: Effect of temperature on resistance.

Solution: As the temperature increases, the resistance of the wire also increases due to the increase in the resistivity of the material.

Final Answer: The resistance increases.

Answer: (Increase)

Q25.

Solution

Concept: Wavelength of sound.

Formula:

$$\lambda = \frac{v}{f}$$

Solution: Given:

$$v = 343\,\text{m/s},\ f = 512\,\text{Hz}$$

$$\lambda = \frac{343}{512} = 0.67\,\text{m}$$

Final Answer: $\lambda = 0.67\,\text{m}$

Answer: (0.67)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	1.2	22	80
23	10	24	Increase
25	0.67		