JEE Main 2023 25 Jan Shift 1 Physics Question Paper

Time Allowed :180 minutes	**Maximum Marks :**300	**Total questions :**90

General Instructions

Read the following instructions very carefully and strictly follow them:

(A) The test is of 3 hours duration.

(B) The question paper consists of 90 questions. The maximum marks are 300.

(C) There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.

(D) Each part (subject) has two sections.

(i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.

(ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

Section-A

1. Electron beam used in an electron microscope, when accelerated by a voltage of 20 kV, has a de-Broglie wavelength of λ_0. If the voltage is increased to 40 kV, then the de-Broglie wavelength associated with the electron beam would be:

(A) $3\lambda_0$

(B) $9\lambda_0$

(C) $\frac{\lambda_0}{2}$

(D) $\frac{\lambda_0}{\sqrt{2}}$

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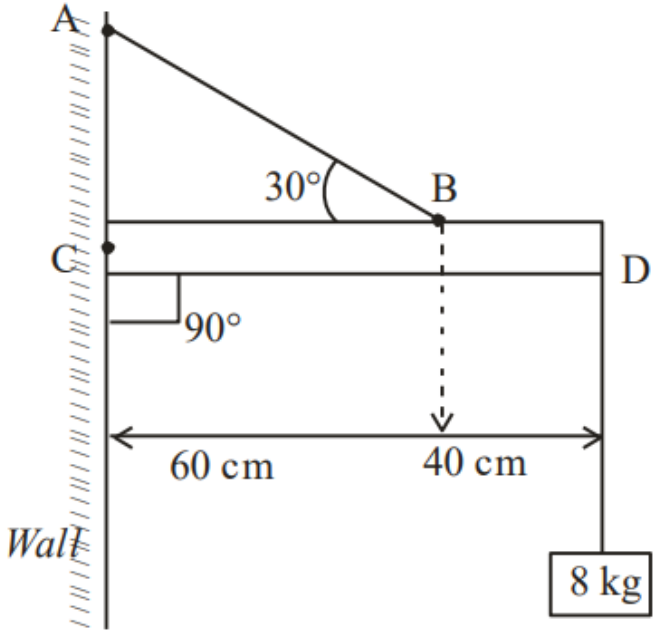
2. An object of mass 8 kg is hanging from one end of a uniform rod CD of mass 2 kg and length 1 m pivoted at its end C on a vertical wall. It is supported by a cable AB such that the system is in equilibrium. The tension in the cable is:



(A) 240 N

(B) 90 N

(C) 300 N

(D) 30 N

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3. A Carnot engine with efficiency 50% takes heat from a source at 600 K. In order to increase the efficiency to 70%, keeping the temperature of the sink the same, the new

temperature of the source will be:

(A) 360 K

(B) 1000 K

(C) 900 K

(D) 300 K

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4. T is the time period of a simple pendulum on the Earth's surface. Its time period becomes $x\,T$ when taken to a height R (equal to Earth's radius) above the Earth's surface. Then, the value of x will be:

(A) 4

(B) 2

(C) $\frac{1}{2}$

(D) $\frac{1}{4}$

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5. Assume that the Earth is a solid sphere of uniform density and a tunnel is dug along its diameter. When a particle is released in this tunnel, it executes a simple harmonic motion. The mass of the particle is 100 g. The time period of the motion of the particle will be (approximately):

(A) 24 hours

(B) 1 hour 24 minutes

(C) 1 hour 40 minutes

(D) 12 hours

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6. A car travels a distance of 'x' with speed V_1 and then the same distance 'x' with speed V_2 in the same direction. The average speed of the car is:

(A) $\frac{V_1 V_2}{2(V_1+V_2)}$

(B) $\frac{V_1+V_2}{2}$

(C) $\frac{2x}{V_1+V_2}$

(D) $\frac{2V_1V_2}{V_1+V_2}$

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7. A parallel plate capacitor has plate area $40\,\text{cm}^2$ and plate separation $2\,\text{mm}$. The

space between the plates is filled with a dielectric medium of thickness 1 mm and dielectric constant 5. The capacitance of the system is:

(A) $24\varepsilon_0$ F

(B) $\frac{3}{10}\varepsilon_0$ F

(C) $\frac{10}{3}\varepsilon_0$ F

(D) $10\varepsilon_0$ F

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8. The root mean square velocity of molecules of gas is:

(A) Proportional to square root of temperature (T^2).

(B) Inversely proportional to square root of temperature ($\frac{1}{\sqrt{T}}$).

(C) Proportional to square root of temperature ($\sqrt{T}$).

(D) Proportional to temperature (T).

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9. Match List I with List II:

List I	List II
A. Surface tension	I. Kg s^{-2}
B. Pressure	II. Kg $m^{-1}s^{-2}$
C. Viscosity	III. Kg $m^{-1}s^{-1}$
D. Impulse	IV. Kg m s^{-1}

Choose the correct answer from the options given below :

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

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

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

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

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10. In an LC oscillator, if values of inductance and capacitance become twice and eight times, respectively, then the resonant frequency of oscillator becomes x times its initial resonant frequency ω_0. The value of x is:

(A) $1/4$

(B) 16

(C) $1/16$

(D) 4

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11. The ratio of the density of oxygen nucleus ($16O$) and helium nucleus ($4He$) is:

(A) 4:1

(B) 8:1

(C) 1:1

(D) 2:1

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12. A message signal of frequency 5 kHz is used to modulate a carrier signal of frequency 2 MHz. The bandwidth for amplitude modulation is:

(A) 1 kHz

(B) 20 kHz

(C) 10 kHz

(D) 2.5 kHz

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13. An electromagnetic wave is transporting energy in the negative z-direction. At a certain point and certain time, the direction of the electric field of the wave is along the positive y-direction. What will be the direction of the magnetic field at that point and instant?

(A) Positive direction of x

(B) Negative direction of x

(C) Negative direction of y

(D) Negative direction of z

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14. In Young's double-slit experiment, the position of the 5^{th} bright fringe from the central maximum is 5 cm. The distance between slits and screen is 1 m, and the wavelength of used monochromatic light is 600 nm. The distance between the slits is:

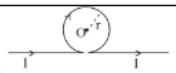
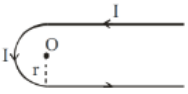
(A) 48 μm

(B) 12 μm

(C) 36 μm

(D) 46 μm

15. Match List I with List II:

List I (Current configuration)	List II (Magnetic field at point O)
A 	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 2]$
B 	$B_0 = \frac{\mu_0}{4}\frac{I}{r}$
C 	$B_0 = \frac{\mu_0 I}{2\pi r}[\pi - 1]$
D 	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 1]$

Choose the correct answer from the option given below:

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

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

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

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

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16. Given below are two statements: one is labeled as Assertion A and the other is labeled as Reason R.

- **Assertion A:** Photodiodes are used in forward bias usually for measuring the light intensity.
- **Reason R:** For a p-n junction diode, at applied voltage V the current in the forward bias is more than the current in the reverse bias for $|V_z| > \pm V_0|$, where V_0 is the threshold voltage and V_z is the breakdown voltage.

Options:

(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true but R is NOT the correct explanation of A

(C) A is false but R is true

(D) A is true but R is false

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17. A solenoid of 1200 turns is wound uniformly in a single layer on a glass tube 2 m long and 0.2 m in diameter. The magnetic intensity at the center of the solenoid when a

current of 2 A flows through it is:

(A) 2.4×10^3 A m^{-1}

(B) 1.2×10^3 A m^{-1}

(C) 1 A m^{-1}

(D) 4.2×10^3 A m^{-1}

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18. A uniform metallic wire carries a current 2 A. When a 3.4 V battery is connected across it, the mass of the wire is 8.92×10^{-3} kg, density is 8.92×10^3 kg/m^3, and resistivity is $1.7 \times 10^{-8}\,\Omega$ m. The length of the wire is:

(A) 6.8 m

(B) 10 m

(C) 5 m

(D) 100 m

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19. A bowl filled with very hot soup cools from $98°C$ to $86°C$ in 2 minutes when the room temperature is $22°C$. How long will it take to cool from $75°C$ to $69°C$?

(A) 2 minutes

(B) 1.4 minutes

(C) 3 minutes

(D) 1 minute

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20. A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40 m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be:

(A) $45°$

(B) $30°$

(C) $53°$

(D) $60°$

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21. A ray of light is incident from air on a glass plate having thickness $\sqrt{5}$ cm and refractive index $\sqrt{2}$. The angle of incidence of a ray is equal to the critical angle for

glass-air interface. The lateral displacement of the ray when it passes through the plate is $< 10^{-2}$ cm:

(Given $\sin 15^\circ = 0.26$**)**

(A) 0.52 cm

(B) 0.45 cm

(C) 0.48 cm

(D) 0.50 cm

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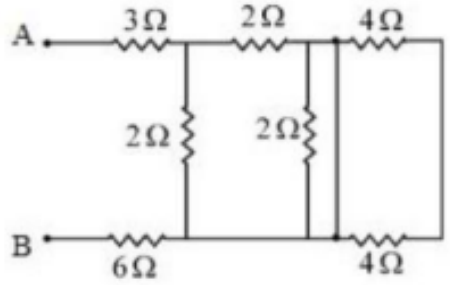
22. In the given circuit, the equivalent resistance between the terminal A and B is ____ Ω.



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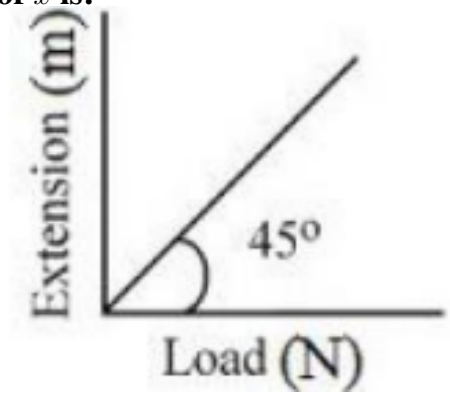
23. As shown in the figure, in an experiment to determine Young's modulus of a wire, the extension-load curve is plotted. The curve is a straight line passing through the origin and makes an angle of 45° with the load axis. The length of the wire is 62.8 cm and its diameter is 4 mm. The Young's modulus is found to be $x \times 10^{10}$ Nm^{-2}. The value of x is:



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24. An object of mass m initially at rest on a smooth horizontal plane starts moving under the action of force $F = 2N$. In the process of its linear motion, the angle θ between the direction of force and horizontal varies as $\theta = kx$, where k is a constant and

x is the distance covered by the object from its initial position. The expression of kinetic energy of the object will be $E = \frac{n}{k}\sin\theta$. The value of n is:

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25. The wavelength of the radiation emitted is λ_0 when an electron jumps from the second excited state to the first excited state of the hydrogen atom. If the electron jumps from the third excited state to the second orbit of the hydrogen atom, the wavelength of the radiation emitted will be $\frac{20}{x}\lambda_0$. The value of x is:

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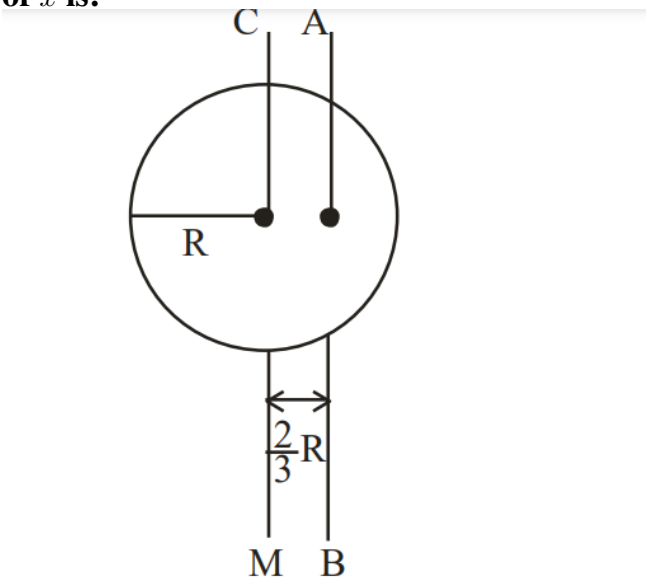
26. I_{CM} is the moment of inertia of a circular disc about an axis (CM) passing through its center and perpendicular to the plane of the disc. I_{AB} is its moment of inertia about an axis AB perpendicular to the plane and parallel to axis CM at a distance $\frac{2}{3}R$ from the center, where R is the radius of the disc. The ratio of I_{AB} and I_{CM} is $x : 9$. The value of x is:



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27. The distance between two consecutive points with phase difference of 60° in a wave of frequency 500 Hz is 6.0 m. The velocity with which the wave is traveling is ___ km/s:

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28. A uniform electric field of 10 N/C is created between two parallel charged plates (as shown in figure). An electron enters the field symmetrically between the plates with a kinetic energy of 5 eV. The length of each plate is 10 cm. The angle (θ) of deviation of the path of the electron as it comes out of the field is ____ (in degrees).

29. An LCR series circuit of capacitance $62.5\,$nF and resistance of $50\,\Omega$ is connected to an A.C. source of frequency $2.0\,$kHz. For maximum value of amplitude of current in the circuit, the value of inductance is ____ mH.

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30. If $\vec{P} = 3\hat{i} + \sqrt{3}\hat{j} + 2\hat{k}$ and $\vec{Q} = 4\hat{i} + \sqrt{3}\hat{j} + 2.5\hat{k}$, the unit vector in the direction of $\vec{P} \times \vec{Q}$ is $\frac{1}{x}\left(\sqrt{3}\hat{i} + \hat{j} - 2\sqrt{3}\hat{k}\right)$. The value of x is:
