JEE Main 2023 24th Jan Shift 2 Question Paper

Time Allowed :3 Hours	**Maximum Marks :**300	**Total Questions :**90

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. 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. The electric potential at the centre of two concentric half rings of radii R_1 and R_2, having the same linear charge density λ is:

(1) $\frac{2\lambda}{\epsilon_0}$

(2) $\frac{\lambda}{2\epsilon_0}$

(3) $\frac{\lambda}{4\epsilon_0}$

(4) $\frac{\lambda}{\epsilon_0}$

2. Let γ_1 be the ratio of molar specific heat at constant pressure and molar specific heat at constant volume of a monoatomic gas and γ_2 be the similar ratio of diatomic gas. Considering the diatomic gas molecule as a rigid rotator, the ratio $\frac{\gamma_1}{\gamma_2}$ is:

(1) $\frac{27}{35}$

(2) $\frac{35}{27}$

(3) $\frac{21}{25}$

(4) $\frac{25}{21}$

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3. An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their De-Broglie wavelength:

(1) $\lambda_\alpha > \lambda_p > \lambda_e$

(2) $\lambda_\alpha < \lambda_p < \lambda_e$

(3) $\lambda_\alpha = \lambda_p = \lambda_e$

(4) $\lambda_\alpha > \lambda_p < \lambda_e$

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4. If the distance of the earth from Sun is 1.5×10^6 km, then the distance of an imaginary planet from Sun, if its period of revolution is 2.83 years, is:

(1) 6×10^7 km

(2) 6×10^6 km

(3) 3×10^6 km

(4) 3×10^7 km

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5. Match List I with List II:

LIST I	LIST II
A. AM Broadcast	I. 88-108 MHz
B. FM Broadcast	II. 540-1600 KHz
C. Television	III. 3.7-4.2 GHz
D. Satellite Communication	IV. 54 MHz, 590 MHz

Choose the correct answer from the options given below:

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

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

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

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

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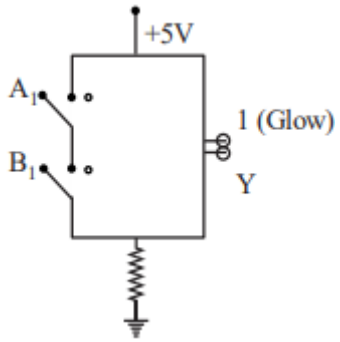
6. The logic gate equivalent to the given circuit diagram is:



(1) OR

(2) NAND

(3) NOR

(4) AND

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7. A long solenoid is formed by winding 70 turns cm^{-1}. If 2.0 A current flows, then the magnetic field produced inside the solenoid is:

(1) $1232 \times 10^{-4}\,T$

(2) $176 \times 10^{-4}\,T$

(3) $352 \times 10^{-4}\,T$

(4) $88 \times 10^{-4}\,T$

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8. Given below are two statements:

Statement I: Acceleration due to earth's gravity decreases as you go 'up' or 'down' from earth's surface.

Statement II: Acceleration due to earth's gravity is the same at a height h and depth d from earth's surface, if $h = d$.

In the light of above statements, choose the most appropriate answer from the options given below:

(1) Statement I is incorrect but Statement II is correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Both Statement I and Statement II are correct

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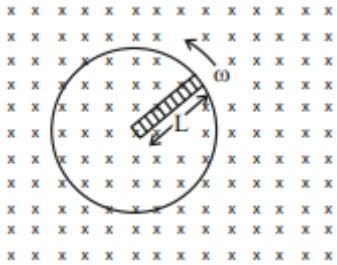
9. A metallic rod of length L is rotated with an angular speed of ω normal to a uniform magnetic field B about an axis passing through one end of the rod as shown in the figure. The induced emf will be:



(1) $\frac{1}{4}B^2L\omega$

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

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

(4) $\frac{1}{2}B^2L^2\omega$

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10. When a beam of white light is allowed to pass through a convex lens parallel to the principal axis, the different colours of light converge at different points on the principal axis after refraction. This is called:

(1) Scattering

(2) Chromatic aberration

(3) Spherical aberration

(4) Polarisation

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11. The frequency (v) of an oscillating liquid drop may depend upon radius (r) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as:

$$v = r^a \rho^b s^c$$

The values of a, b, and c respectively are:

(1) $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

(2) $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$

(3) $\left(\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$

(4) $\left(\frac{3}{2}, -\frac{1}{2}, -\frac{1}{2}\right)$

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12. A body of mass 200g is tied to a spring of spring constant 12.5 N/m, while the other end of the spring is fixed at point O. If the body moves about O in a circular path on a smooth horizontal surface with constant angular speed 5 rad/s, then the ratio of extension in the spring to its natural length will be:

(1) 1:2

(2) 1:1

(3) 2:3

(4) 2:5

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13. A cell of emf 90 V is connected across a series combination of two resistors each of 100 Ω resistance. A voltmeter of resistance 400 Ω is used to measure the potential difference across each resistor. The reading of the voltmeter will be:

(1) 40 V

(2) 45 V

(3) 80 V

(4) 90 V

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14. The electric field and magnetic field components of an electromagnetic wave going through vacuum is described by:

$$E_x = E_0 \sin(kz - \omega t)$$

$$B_y = B_0 \sin(kz - \omega t)$$

Then the correct relation between E_0 and B_0 is given by:

(1) $kE_0 = B_0$

(2) $E_0 B_0 = ck$

(3) $\omega E_0 = kB_0$

(4) $E_0 = kB_0$

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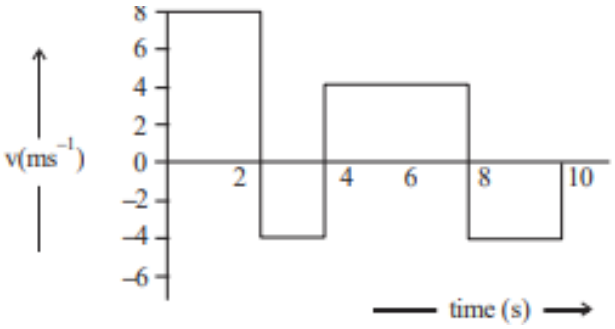
15. The velocity-time graph of a body moving in a straight line is shown in the figure.



The ratio of displacement to distance travelled by the body in time 0 to 10s is:

(1) 1:1

(2) 1:4

(3) 1:2

(4) 1:3

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

Assertion A: Steel is used in the construction of buildings and bridges.

Reason R: Steel is more elastic and its elastic limit is high.

In the light of above statements, choose the most appropriate answer from the options given below:

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

(2) A is not correct but R is correct

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

(4) A is correct but R is not correct

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

Assertion A: A pendulum clock when taken to Mount Everest becomes fast.

Reason R: The value of g (acceleration due to gravity) is less at Mount Everest than its value on the surface of the Earth.

In the light of the above statements, choose the most appropriate answer from the options given below:

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

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

(3) A is not correct but R is correct

(4) A is correct but R is not correct

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18. A photon is emitted in transition from $n = 4$ to $n = 1$ level in hydrogen atom. The corresponding wavelength for this transition is (given, $h = 4 \times 10^{-15}$ eV $\cdot$ s):

(1) 94.1 nm

(2) 941 nm

(3) 97.4 nm

(4) 99.3 nm

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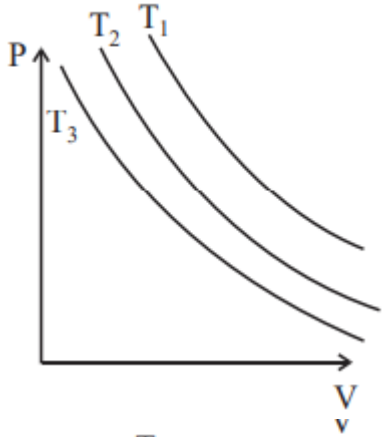
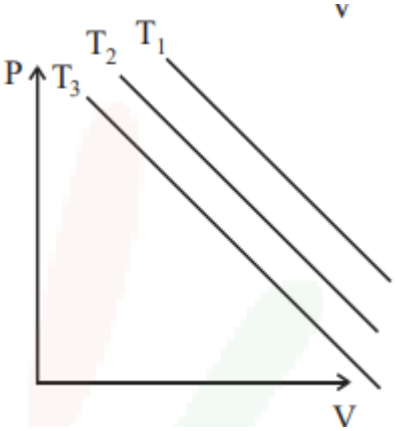
19. In an Isothermal change, the change in pressure and volume of a gas can be represented for three different temperatures; $T_3 > T_2 > T_1$ as:

(1)



(2)



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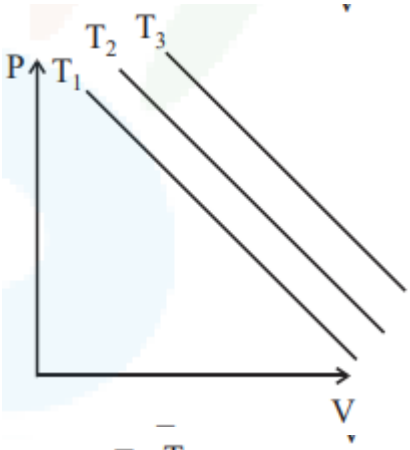
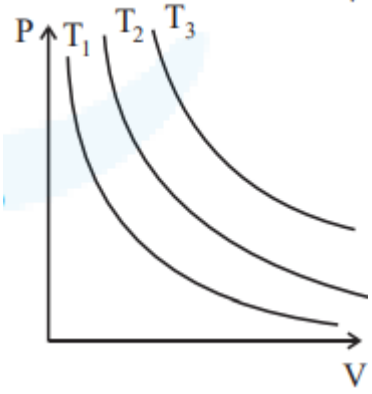


(4)



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20. If two vectors P $= \hat{i} + 2\hat{j} + m\hat{k}$ and Q $= 4\hat{i} - 2\hat{j} + \hat{k}$ are perpendicular to each other, then the value of m will be:

(1) 1

(2) -1

(3) 3

(4) 2

Section - B

21. A uniform solid cylinder with radius R and length L has moment of inertia I_1, about the axis of the cylinder. A concentric solid cylinder of radius $R' = \frac{R}{2}$ and length $L' = \frac{L}{2}$ is carved out of the original cylinder. If I_2 is the moment of inertia of the carved-out portion of the cylinder, then $\frac{I_1}{I_2}$ is:

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22. A mass m attached to the free end of a spring executes SHM with a period of 1s. If the mass is increased by 3 kg, the period of oscillation increases by one second, the

value of mass m is:

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23. The energy released per fission of nucleus of ^{240}X is 200 MeV. The energy released if all the atoms in 120g of pure ^{240}X undergo fission is:

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24. A parallel plate capacitor with air between the plates has a capacitance of 15 pF. The separation between the plates becomes twice and the space between them is filled with a material of dielectric constant 3.5. Then the capacitance becomes:

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25. A body of mass 1 kg begins to move under the action of a time dependent force $\mathbf{F} = \hat{i} + 3t\hat{j}$ N. where $\hat{i}$ and $\hat{j}$ are the unit vectors along x and y axis. The power developed by above force, at the time $t = 2$ s will be:

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26. If a copper wire is stretched to increase its length by 20%. The percentage increase in resistance of the wire is:

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27. A single turn current loop in the shape of a right angle triangle with sides 5 cm, 12 cm, 13 cm is carrying a current of 2A. The loop is in a uniform magnetic field of magnitude 0.75 T whose direction is parallel to the current in the 13 cm side of the loop. The magnitude of the magnetic force on the 5 cm side will be:

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28. Three identical resistors with resistance $R = 12\,\Omega$ and two identical inductors with self inductance $L = 5$ mH are connected to an ideal battery with emf of 12 V as shown in figure. The current through the battery long after the switch has been closed will be:

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29. A convex lens of refractive index 1.5 and focal length 18 cm in air is immersed in water. The change in focal length of the lens will be: (Given refractive index of water $= \frac{4}{3}$)

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30. A spherical ball of radius 1mm and density 10.5 g/cc is dropped in glycerine of coefficient of viscosity 9.8 poise and density 1.5 g/cc. Viscous force on the ball when it attains constant velocity is 3696 $\times 10^{-7}$ N. The value of x is:
