JEE Main 2024 April 5 Shift 1 Physics Question Paper

Time Allowed :1 Hour	Maximum Marks :100	Total Questions :30

General Instructions

Read the following instructions very carefully and strictly follow them:

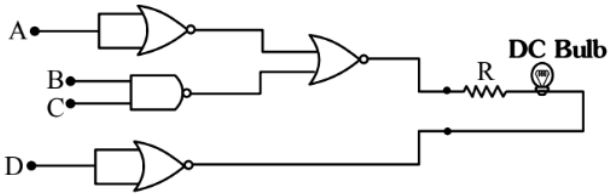
1. The test is of 3 hours duration.
2. The question paper consists of 90 questions. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (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.

Physics

Question 1: Light emerges out of a convex lens when a source of light is kept at its focus. The shape of the wavefront of the light is:

Options:
(1) Both spherical and cylindrical
(2) Cylindrical
(3) Spherical
(4) Plane

Question 2: Following gate section is connected in a complete suitable circuit. For which of the following combinations, the bulb will glow (ON):



Options:
(1) $A = 0, B = 1, C = 1, D = 1$

(2) $A = 1, B = 0, C = 0, D = 0$
(3) $A = 0, B = 0, C = 0, D = 1$
(4) $A = 1, B = 1, C = 1, D = 0$

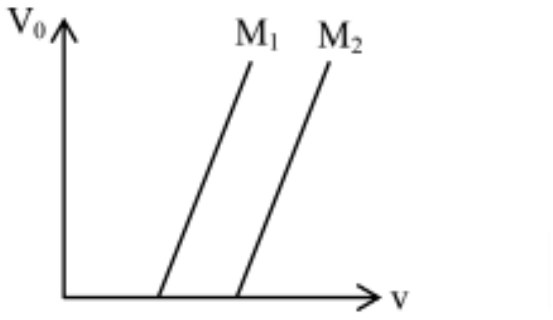
Question 3: If G be the gravitational constant and u be the energy density, then which of the following quantities has the same dimension as $\sqrt{uG}$:

Options:
(1) Pressure gradient per unit mass
(2) Force per unit mass
(3) Gravitational potential
(4) Energy per unit mass

Question 4: Given below are two statements:
Statement-I: When a capillary tube is dipped into a liquid, the liquid neither rises nor falls in the capillary. The contact angle may be 0°.
Statement-II: The contact angle between a solid and a liquid is a property of the material of the solid and liquid as well.
In the light of the above statements, choose the correct answer from the options given below.

Options:
(1) Statement-I is false but Statement-II is true.
(2) Both Statement-I and Statement-II are true.
(3) Both Statement-I and Statement-II are false.
(4) Statement-I is true and Statement-II is false.

Question 5: Given below are two statements:



Statement-I: Figure shows the variation of stopping potential with frequency (ν) for the two photosensitive materials M_1 and M_2. The slope gives the value of $\frac{h}{e}$, where h is Planck's constant, e is the charge of the electron.
Statement-II: M_2 will emit photoelectrons of greater kinetic energy for the incident radiation having the same frequency.
In the light of the above statements, choose the most appropriate answer from the options given below:

Options:
(1) Statement-I is correct and Statement-II is incorrect.
(2) Statement-I is incorrect but Statement-II is correct.
(3) Both Statement-I and Statement-II are incorrect.
(4) Both Statement-I and Statement-II are correct.

Question 6: The angle between vector $\vec{Q}$ and the resultant of $(2\vec{Q}+2\vec{P})$ and $(2\vec{Q}-2\vec{P})$ is:

Options:
(1) 0°
(2) $\tan^{-1}\left(\frac{2\vec{Q}-2\vec{P}}{2\vec{Q}+2\vec{P}}\right)$
(3) $\tan^{-1}\left(\frac{\vec{P}}{\vec{Q}}\right)$
(4) $\tan^{-1}\left(\frac{2\vec{Q}}{\vec{P}}\right)$

Question 7: In a hydrogen-like system, the ratio of Coulombian force and gravitational force between an electron and a proton is in the order of:

Options:
(1) 10^{39}
(2) 10^{19}
(3) 10^{29}
(4) 10^{36}

Question 8: In a co-axial straight cable, the central conductor and the outer conductor carry equal currents in opposite directions. The magnetic field is zero:

Options:
(1) inside the outer conductor
(2) in between the two conductors
(3) outside the cable
(4) inside the inner conductor

Question 9: An electron rotates in a circle around a nucleus having positive charge Ze. The correct relation between the total energy (E) of the electron to its potential energy (U) is:

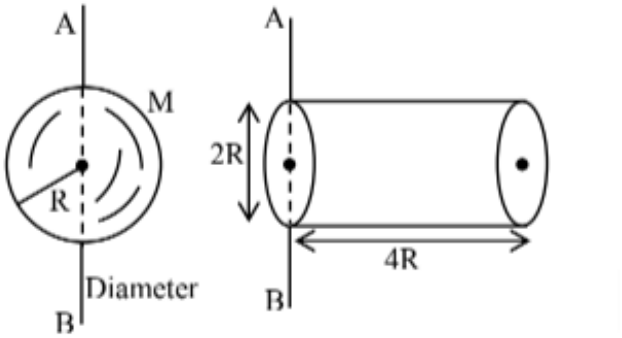
Options:
(1) $E = 2U$
(2) $2E = 3U$
(3) $E = U$

(4) $2E = U$

Question 10: If the collision frequency of hydrogen molecules in a closed chamber at $27°C$ is Z, then the collision frequency of the same system at $127°C$ is:

Options:
(1) $\frac{\sqrt{3}}{2}Z$
(2) $\frac{4}{3}Z$
(3) $\frac{2}{\sqrt{3}}Z$
(4) $\frac{3}{4}Z$

Question 11: Ratio of the radius of gyration of a hollow sphere to that of a solid cylinder of equal mass, for the moment of inertia about their diameter axis AB as shown in the figure is $\sqrt{\frac{8}{x}}$. The value of x is:



Options:
(1) 34
(2) 17
(3) 67
(4) 51

Question 12: Two conducting circular loops A and B are placed in the same plane with their centers coinciding as shown in the figure. The mutual inductance between them is:

Options:
(1) $\frac{\mu_0 \pi a^2}{2b}$
(2) $\frac{\mu_0 b^2}{2\pi a}$
(3) $\frac{\mu_0 \pi b^2}{2a}$
(4) $\frac{\mu_0}{2\pi}\frac{a^2}{b}$

Question 13: Match List-I with List-II:

List-I	List-II
(A) Kinetic energy of planet	(I) $-\frac{GMm}{a}$
(B) Gravitational potential energy of Sun-planet system	(II) $\frac{GMm}{2a}$
(C) Total mechanical energy of planet	(III) $\frac{GMm}{r}$
(D) Escape energy at the surface of planet for unit mass object	(IV) $\frac{GMm}{2a}$

(Where a = radius of planet orbit, r = radius of planet, M = mass of Sun, m = mass of planet)
Choose the correct answer from the options given below:

Options:
(1) (A) – II, (B) – I, (C) – IV, (D) – III
(2) (A) – III, (B) – IV, (C) – I, (D) – II
(3) (A) – I, (B) – IV, (C) – II, (D) – III
(4) (A) – I, (B) – II, (C) – III, (D) – IV

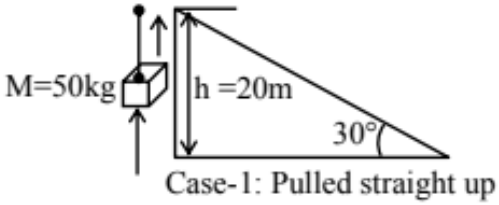
Question 14: A wooden block of mass 5 kg rests on a soft horizontal floor. When an iron cylinder of mass 25 kg is placed on top of the block, the floor yields, and the block and the cylinder together go down with an acceleration of $0.1\,\text{ms}^{-2}$. The action force of the system on the floor is equal to:

Options:
(1) 297 N
(2) 294 N
(3) 291 N
(4) 196 N

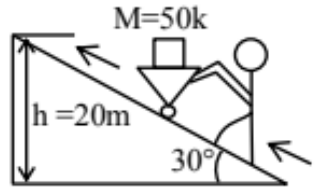
Question 15: A simple pendulum doing small oscillations at a place R height above Earth's surface has time period of $T_1 = 4\,\text{s}$. T_2 would be its time period if it is brought to a point which is at a height $2R$ from Earth's surface. Choose the correct relation [R = radius of Earth]:

Options:
(1) $T_1 = T_2$
(2) $2T_1 = 3T_2$
(3) $3T_1 = 2T_2$
(4) $2T_1 = T_2$

Question 16: A body of mass 50 kg is lifted to a height of 20 m from the ground in two different ways as shown in the figures. The ratio of work done against gravity in both respective cases will be:



Case-1: Pulled straight up



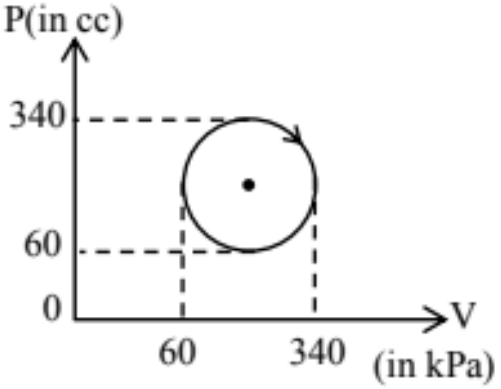
Case-2: Along the ramp

Options:
(1) 1 : 1
(2) 2 : 1
(3) $\sqrt{3}$: 2
(4) 1 : 2

Question 17: Time periods of oscillation of the same simple pendulum measured using four different measuring clocks were recorded as 4.62 s, 4.632 s, 4.6 s, and 4.64 s. The arithmetic mean of these readings in correct significant figures is:

Options:
(1) 4.623 s
(2) 4.62 s
(3) 4.6 s
(4) 5 s

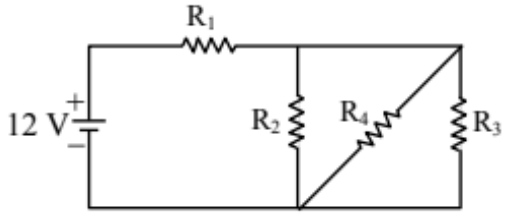
Question 18: The heat absorbed by a system in going through the given cyclic process is:



Options:
(1) 61.6 J

(2) 431.2 J
(3) 616 J
(4) 19.6 J

Question 19: In the given figure $R_1 = 10\,\Omega$, $R_2 = 8\,\Omega$, $R_3 = 4\,\Omega$, and $R_4 = 8\,\Omega$. The battery is ideal with an emf of $12\,\text{V}$. The equivalent resistance of the circuit and the current supplied by the battery are, respectively:



Options:
(1) $12\,\Omega$ and $1.14\,\text{A}$
(2) $10.5\,\Omega$ and $1.14\,\text{A}$
(3) $10.5\,\Omega$ and $1\,\text{A}$
(4) $12\,\Omega$ and $1\,\text{A}$

Question 20: An alternating voltage of amplitude 40 V and frequency 4 kHz is applied directly across a capacitor of $12\,\mu F$. The maximum displacement current between the plates of the capacitor is nearly:

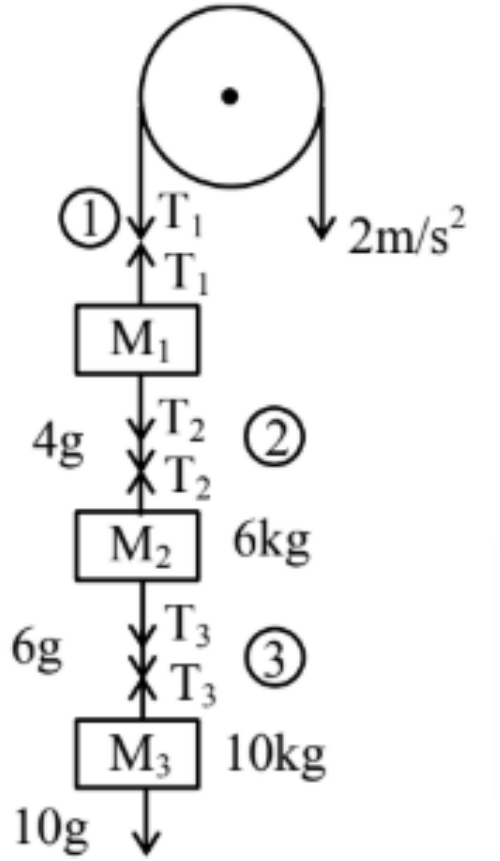
Options:
(1) 13 A
(2) 8 A
(3) 10 A
(4) 12 A

Question 21: In Young's double slit experiment, carried out with light of wavelength 5000Å, the distance between the slits is 0.3 mm and the screen is at 200 cm from the slits. The central maximum is at x = 0 cm. The value of x for the third maxima is ... mm.

Question 22: A 2A current carrying straight metal wire of resistance 1 Ω, resistivity 2×10^{-6} Ωm, area of cross-section 10 mm^2 and mass 500 g is suspended horizontally in mid-air by applying a uniform magnetic field $\vec{B}$. The magnitude of B is ... $\times 10^{-1}$ T (given, g = 10 m/s^2).

Question 23: The electric field between the two parallel plates of a capacitor of 1.5 μF capacitance drops to one-third of its initial value in 6.6 μs when the plates are connected by a thin wire. The resistance of this wire is ... Ω. (Given, log 3 = 1.1)

Question 24: Three blocks M_1, M_2, M_3 having masses 4 kg, 6 kg, and 10 kg respectively are hanging from a smooth pulley using ropes 1, 2, and 3 as shown in the figure. The tension in the rope 1, T_1, when they are moving upward with acceleration of 2 m/s^2 is ... N (if g = 10 m/s^2).

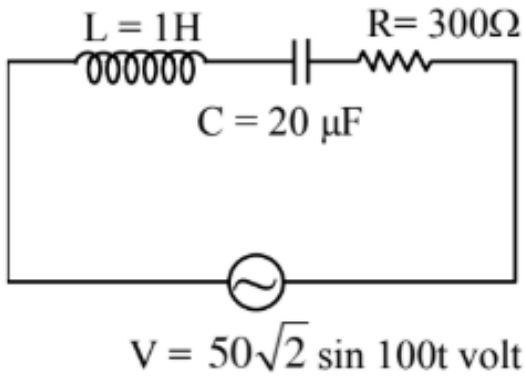


Question 25: The density and breaking stress of a wire are 6×10^4 kg/m^3 and 1.2×10^8 N/m^2 respectively. The wire is suspended from a rigid support on a planet where acceleration due to gravity is $\frac{1}{3}$ of the value on the surface of Earth. The maximum length of the wire with breaking is ... m (take, g = 10 m/s^2).

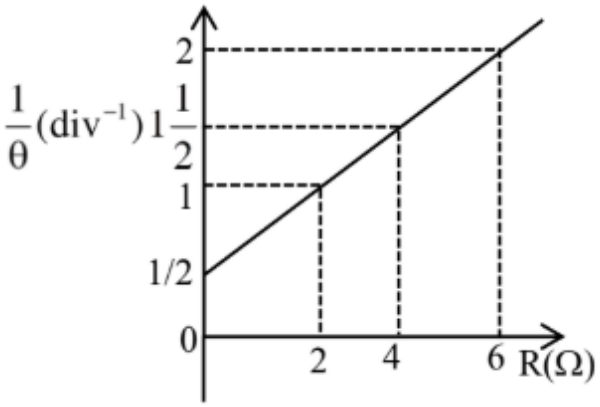
Question 26: A body moves on a frictionless plane starting from rest. If S_n is distance moved between t = n − 1 and t = n and S_{n-1} is distance moved between t = n − 2 and t = n − 1, then the ratio $\frac{S_{n-1}}{S_n}$ is $\left(1-\frac{2}{x}\right)$ for n = 10. The value of x is ...

Question 27: If three helium nuclei combine to form a carbon nucleus then the energy released in this reaction is ... $\times10^{-2}$ MeV. (Given 1 u = 931 MeV/c^2, atomic mass of helium = 4.002603 u)

Question 28: An ac source is connected in a given series LCR circuit. The rms potential difference across the capacitor of 20 μF is ... V.



Question 29: In the experiment to determine the galvanometer resistance by the half-deflection method, the plot of $\frac{1}{\theta}$ vs the resistance (R) of the resistance box is shown in the figure. The figure of merit of the galvanometer is ... $\times 10^{-1}$ A/division. [The source has emf 2V]



Question 30: Three capacitors of capacitances 25 μF, 30 μF, and 45 μF are connected in parallel to a supply of 100 V. Energy stored in the above combination is E. When these capacitors are connected in series to the same supply, the stored energy is $\frac{9}{x}$E. The value of x is ...
