

JEE Main 2023 31 Jan Shift 1 Physics 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

PHYSICS

Section-A

1. A bar magnet with a magnetic moment 5.0 Am^2 is placed in parallel position relative to a magnetic field of 0.4 T . The amount of required work done in turning the magnet from parallel to antiparallel position relative to the field direction is:

- (1) 4 J
- (2) 1 J
- (3) 2 J

(4) Zero

2. If a source of electromagnetic radiation having power 15 kW produces 10^{16} photons per second, the radiation belongs to a part of spectrum is:

- (1) Micro waves
 - (2) Ultraviolet rays
 - (3) Gamma rays
 - (4) Radio waves
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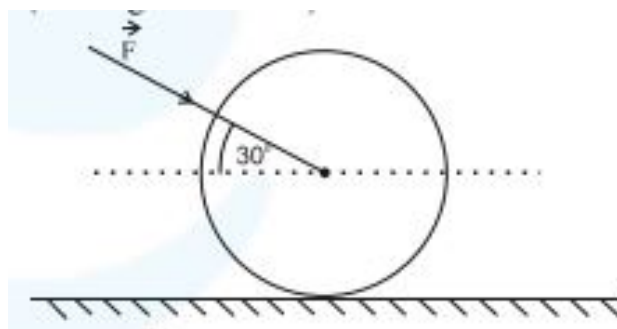
3. The amplitude of $15 \sin(1000\pi t)$ is modulated by $10 \sin(4\pi t)$ signal. The amplitude modulated signal contains frequency(ies) of:

- (A) 500 Hz
- (B) 2 Hz
- (C) 250 Hz
- (D) 498 Hz
- (E) 502 Hz

Choose the correct answer from the options given below:

- (1) A only
 - (2) A,D and E only
 - (3) B only
 - (4) A and B only
-

4. As shown in figure, a 70 kg garden roller is pushed with a force of $F = 200 \text{ N}$ at an angle of 30° with horizontal. The normal reaction on the roller is: (Given $g = 10 \text{ m/s}^2$)



- (1) $800\sqrt{2} \text{ N}$

- (2) 600 N
 - (3) 800 N
 - (4) $200\sqrt{3}$ N
-

5. The initial speed of a projectile fired from ground is u . At the highest point during its motion, the speed of the projectile is $\frac{\sqrt{5}}{2}u$. The time of flight of the projectile is:

- (1) $\frac{u}{2g}$
 - (2) $\frac{u}{g}$
 - (3) $\frac{2u}{g}$
 - (4) $\frac{\sqrt{5}u}{g}$
-

6. Spherical insulating ball and a spherical metallic ball of the same size and mass are dropped from the same height. Choose the correct statement out of the following (Assume negligible air friction):

- (1) Time taken by them to reach the earth's surface will be independent of the properties of their materials
 - (2) Insulating ball will reach the earth's surface earlier than the metal ball
 - (3) Both will reach the earth's surface simultaneously
 - (4) Metal ball will reach the earth's surface earlier than the insulating ball
-

7. A free neutron decays into a proton but a free proton does not decay into neutron. This is because:

- (1) Neutron is an uncharged particle
 - (2) Proton is a charged particle
 - (3) Neutron is a composite particle made of a proton and an electron
 - (4) Neutron has larger rest mass than proton
-

8. The effect of increase in temperature on the number of electrons in conduction band (n_e) and resistance of a semiconductor will be:

- (1) Both n_e and resistance decrease
- (2) Both n_e and resistance increase

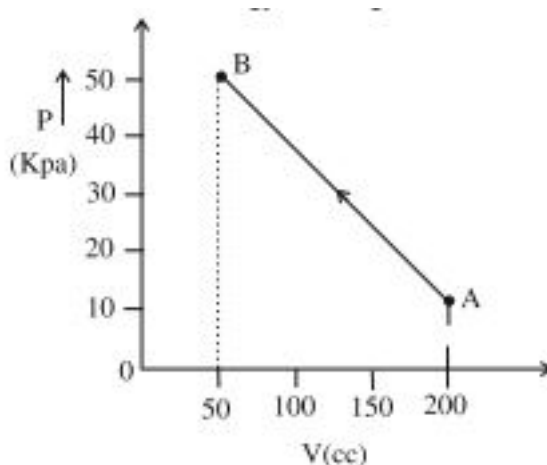
- (3) n_e increases, resistance decreases
(4) n_e decreases, resistance increases
-

9. The maximum potential energy of a block executing simple harmonic motion is 25 J.

A is amplitude of oscillation. At $\frac{A}{2}$, the kinetic energy of the block is:

- (1) 37.5 J
(2) 9.75 J
(3) 18.75 J
(4) 12.5 J
-

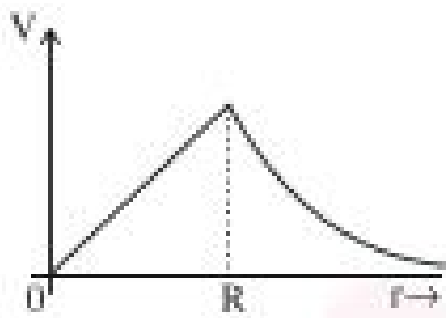
10. The pressure of a gas changes linearly with volume from A to B as shown in the figure. If no heat is supplied to or extracted from the gas, then change in the internal energy of the gas will be:



- (1) 6 J
(2) Zero
(3) -4.5 J
(4) 4.5 J
-

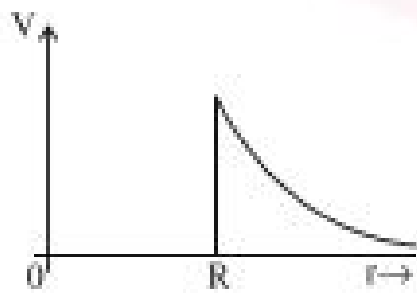
11. Which of the following correctly represents the variation of electric potential (V) of a charged spherical conductor of radius (R) with radial distance (r) from the centre?

(1)



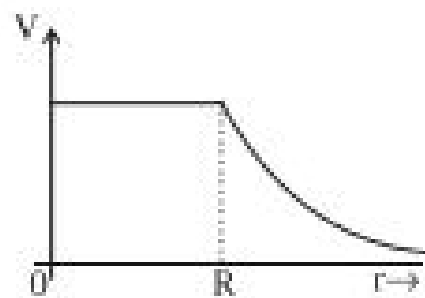
(1)

(2)



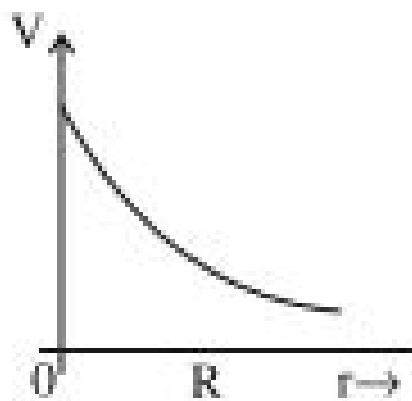
(2)

(3)



(3)

(4)



(4)

12. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R Assertion A: The beam of electrons shows wave nature and exhibits interference and diffraction. Reason R: Davisson Germer experimentally verified the wave nature of electrons. In the light of the above statements, choose the most appropriate answer from the options given below:

- (1) A is correct but R is not correct
 - (2) A is not correct but R is correct
 - (3) Both A and R are correct but R is not the correct explanation of A
 - (4) Both A and R are correct and R is the correct explanation of A
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13. The drift velocity of electrons for a conductor connected in an electrical circuit is V_d . The conductor is now replaced by another conductor with the same material and same length but double the area of cross-section. The applied voltage remains the same. The new drift velocity of electrons will be:

- (1) V_d
 - (2) $\frac{V_d}{2}$
 - (3) $\frac{V_d}{4}$
 - (4) $2V_d$
-

14. At a certain depth d below the surface of the Earth, the value of acceleration due to gravity becomes four times that of its value at a height $3R$ above the Earth's surface. Where R is the radius of Earth (Take $R = 6400$ km). The depth d is equal to:

- (1) 5260 km
 - (2) 640 km
 - (3) 2560 km
 - (4) 4800 km
-

15. If 1000 droplets of water of surface tension 0.07 N/m, having same radius 1 mm each, combine to form a single drop. In the process, the released surface energy is: (Take $\pi = \frac{22}{7}$)

- (1) $7.92 \times 10^{-6} \text{ J}$
 - (2) $7.92 \times 10^{-4} \text{ J}$
 - (3) $9.68 \times 10^{-4} \text{ J}$
 - (4) $8.8 \times 10^{-5} \text{ J}$
-

16. A rod with circular cross-section area 2 cm^2 and length 40 cm is wound uniformly with 400 turns of an insulated wire. If a current of 0.4 A flows in the wire windings, the total magnetic flux produced inside the windings is $4 \times 10^{-6} \text{ Wb}$. The relative permeability of the rod is: (Given: Permeability of vacuum $\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$)

- (1) 12.5
 - (2) $\frac{32}{5}$
 - (3) 125
 - (4) $\frac{5}{16}$
-

17. The correct relation between $\gamma = \frac{C_p}{C_v}$ and temperature T is:

- (1) $\gamma \propto \frac{1}{\sqrt{T}}$
 - (2) $\gamma \propto T^0$
 - (3) $\gamma \propto \frac{1}{T}$
 - (4) $\gamma \propto T$
-

18. Two polaroids A and B are placed in such a way that the pass-axis of polaroids are perpendicular to each other. Now, another polaroid C is placed between A and B bisecting the angle between them. If intensity of unpolarised light is I_0 , then intensity of transmitted light after passing through polaroid B will be:

- (1) $\frac{I_0}{4}$
 - (2) $\frac{I_0}{2}$
 - (3) $\frac{I_0}{8}$
 - (4) Zero
-

19. If R , X_L , and X_C represent resistance, inductive reactance, and capacitive reactance, then which of the following is dimensionless:

(1) RX_LX_C

(2) $\frac{R}{\sqrt{X_LX_C}}$

(3) $\frac{R}{X_LX_C}$

(4) $\frac{X_L}{X_C}$

20. 100 balls each of mass m moving with speed v simultaneously strike a wall normally and are reflected back with the same speed, in time t . The total force exerted by the balls on the wall is:

(1) $\frac{100mv}{t}$

(2) $\frac{200mv}{t}$

(3) $\frac{200mvt}{t}$

(4) $\frac{mv}{100t}$

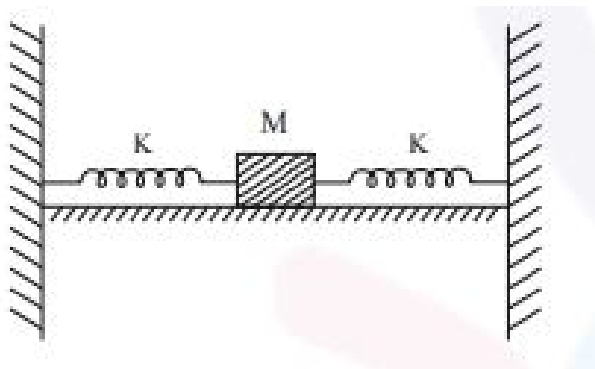
SECTION-B

21. A thin rod having a length of 1 m and area of cross-section $3 \times 10^{-6} \text{ m}^2$ is suspended vertically from one end. The rod is cooled from 210°C to 160°C . After cooling, a mass M is attached at the lower end of the rod such that the length of the rod again becomes 1 m. Young's modulus and the coefficient of linear expansion of the rod are $2 \times 10^{11} \text{ N/m}^2$ and $2 \times 10^{-5} \text{ K}^{-1}$, respectively. The value of M is _____kg. (Take $g = 10 \text{ m/s}^2$)

22. The speed of a swimmer is 4 km/h in still water. If the swimmer makes his strokes normal to the flow of the river of width 1 km, he reaches a point 750 m down the stream on the opposite bank. The speed of the river water is km/h.

23. In the figure given below, a block of mass $M = 490 \text{ g}$ is placed on a frictionless table is connected with two springs having the same spring constant ($K = 2 \text{ N/m}$). If the block is horizontally displaced through $X \text{ m}$, then the number of complete oscillations it will make in $14t$ seconds will be:

24. In a medium, the speed of light wave decreases to 0.2 times its speed in free space. The ratio of relative permittivity to the refractive index of the medium is $x : 1$. The

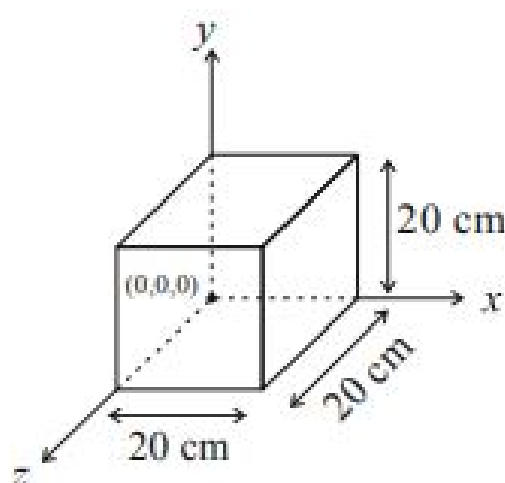


value of x is (Given speed of light in free space $c = 3 \times 10^8$ m/s and for the given medium $\mu_r = 1$)

25. A solid sphere of mass 1 kg rolls without slipping on a plane surface. Its kinetic energy is 7×10^3 J. The speed of the centre of mass of the sphere is cm/s.

26. An inductor of 0.5 mH, a capacitor of 20 F, and resistance of 20 are connected in series with a 220 V AC source. If the current is in phase with the emf, the amplitude of current of the circuit is $\sqrt{K}$ A. The value of x is:

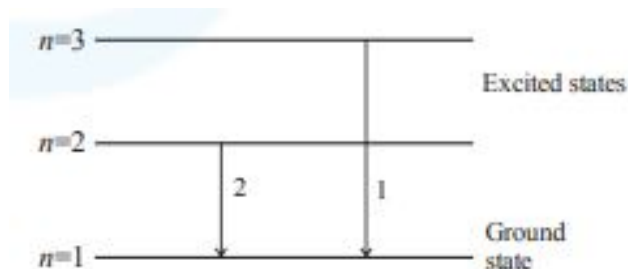
27. Expression for an electric field is given by $\vec{E} = 4000\hat{i}$ V/m. The electric flux through the cube of side 20 cm when placed in the electric field (as shown in the figure) is Vcm.



28. A lift of mass $M = 500$ kg is descending with a speed of 2 m/s. Its supporting cable

begins to slip, thus allowing it to fall with a constant acceleration of 2 m/s^2 . The kinetic energy of the lift at the end of fall through a distance of 6 m will be kJ.

29. For hydrogen atom, λ_1 and λ_2 are the wavelengths corresponding to the transitions 1 and 2, respectively, as shown in the figure. The ratio of λ_1 and λ_2 is $\frac{x}{32}$. The value of x is:



30. Two identical cells, when connected either in parallel or in series, give the same current in an external resistance of 5. The internal resistance of each cell will be Ω .
