JEE Main 2023 April 6 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

Question 1: The kinetic energy of an electron, an α-particle, and a proton are given as 4K, 2K, and K respectively. The de-Broglie wavelength associated with electron (λ_e), α-particle (λ_α), and the proton (λ_p) are as follows:

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

(2) $\lambda_\alpha = \lambda_p > \lambda_e$

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

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

Question 2: Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Earth has atmosphere whereas moon doesn't have any atmosphere.

Reason R: The escape velocity on moon is very small as compared to that on earth.

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

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

(2) A is false but R is true

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

(4) A is true but R is false

Question 3: A source supplies heat to a system at the rate of 1000 W. If the system performs work at a rate of 200 W. The rate at which internal energy of the system increase is

(1) 500 W

(2) 600 W

(3) 800 W

(4) 1200 W

Question 4: A small ball of mass M and density ρ is dropped in a viscous liquid of density ρ_o. After some time, the ball falls with a constant velocity. What is the viscous force on the ball?

(1) $F = Mg(1 + \frac{\rho_o}{\rho})$

(2) $F = Mg(1 + \frac{\rho}{\rho_o})$

(3) $F = Mg(1 - \frac{\rho_o}{\rho})$

(4) $F = Mg(1 + \rho\rho_o)$

Question 5: A small block of mass 100 g is tied to a spring of spring constant 7.5 N/m and length 20 cm. The other end of spring is fixed at a particular point A. If the block moves in a circular path on a smooth horizontal surface with constant angular velocity 5 rad/s about point A, then tension in the spring is –

(1) 0.75 N

(2) 1.5 N

(3) 0.25 N

(4) 0.50 N

Question 6: A particle is moving with constant speed in a circular path. When the particle turns by an angle 90°, the ratio of instantaneous velocity to its average velocity is $\pi : x\sqrt{2}$. The value of x will be -

(1) 7

(2) 2

(3) 1

(4) 5

Question 7: Two resistances are given as $R_1 = (10 \pm 0.5)\,\Omega$ and $R_2 = (15 \pm 0.5)\,\Omega$. The percentage error in the measurement of equivalent resistance when they are connected in parallel is -

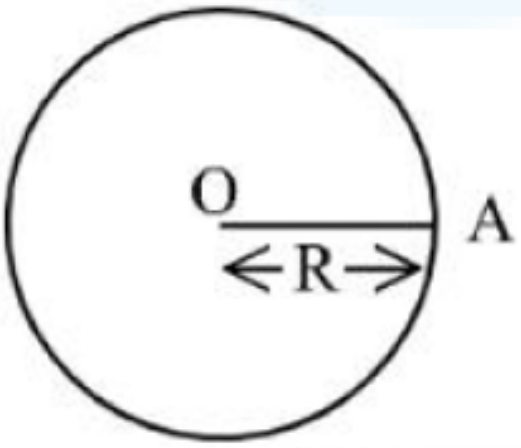
(1) 2.33

(2) 4.33

(3) 5.33

(4) 6.33

Question 8: For a uniformly charged thin spherical shell, the electric potential (V) radially away from the entire (O) of shell can be graphically represented as –



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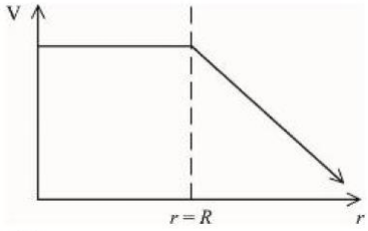

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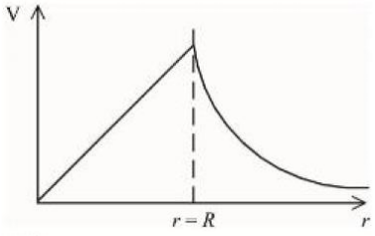

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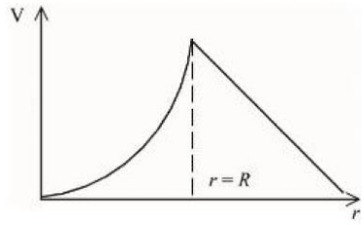

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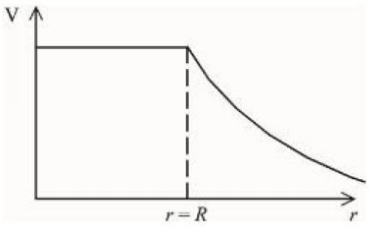

Question 9: A long straight wire of circular cross-section (radius a) is carrying steady current I. The current I is uniformly distributed across this cross-section. The magnetic field is

(1) zero in the region r < a and inversely proportional to r in the region r > a

(2) inversely proportional to r in the region r $<$ a and uniform throughout in the region r $>$ a

(3) directly proportional to r in the region r $<$ a and inversely proportional to r in the region r $>$ a

(4) uniform in the region r $<$ a and inversely proportional to distance r from the axis, in the region r $>$ a

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Question 10: By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%?

(1) 12%

(2) 15%

(3) 14%

(4) 10%

Question 11: The number of air molecules per cm^3 increased from 3×10^{19} to 12×10^{19}. The ratio of collision frequency of air molecules before and after the increase in the number respectively is :

(1) 0.25

(2) 0.75

(3) 1.25

(4) 0.50

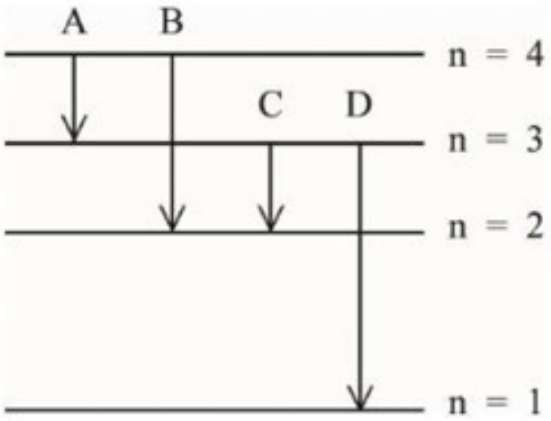
Question 12: The energy levels of an hydrogen atom are shown below. The transition corresponding to emission of shortest wavelength is

(1) A

(2) D

(3) C

(4) B



Question 13: For the plane electromagnetic wave given by $E = E_0 \sin(\omega t - kx)$ and $B = B_0 \sin(\omega t - kx)$, the ratio of average electric energy density to average magnetic energy density is

(1) 2

(2) 1/2

(3) 1

(4) 4

Question 14: A planet has double the mass of the earth. Its average density is equal to that of the earth. An object weighing W on earth will weigh on that planet:

(1) $2^{1/3}$ **W**

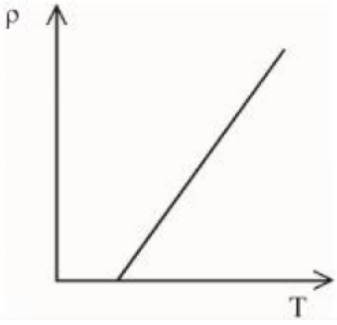
(2) 2 W

(3) W

(4) $2^{2/3}$ **W**

Question 15: The resistivity (ρ) of semiconductor varies with temperature. Which of the following curve represents the correct behavior

(1)



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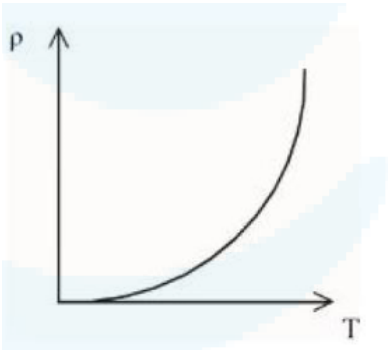

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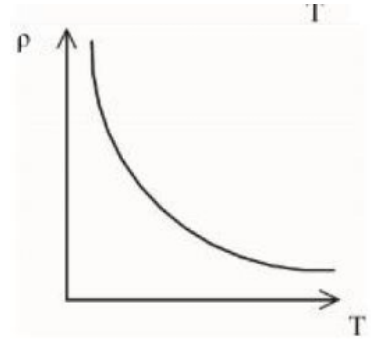

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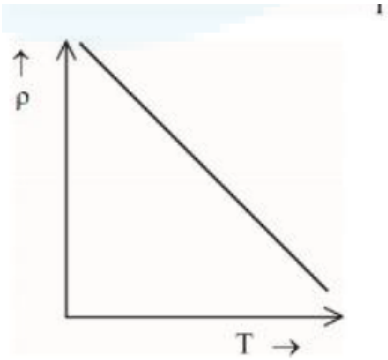


Question 16: A monochromatic light wave with wavelength λ_1 and frequency ν_1, in air, enters another medium. If the angle of incidence and angle of refraction at the interface are 45° and 30° respectively, then the wavelength λ_2 and frequency ν_2 of the refracted wave are:

(1) $\lambda_2 = \frac{1}{\sqrt{2}}\lambda_1$, $\nu_2 = \nu_1$

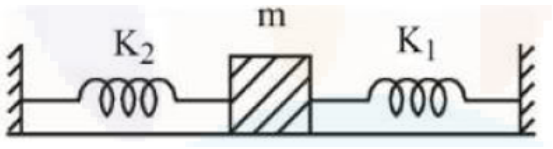
(2) $\lambda_2 = \lambda_1$, $\lambda_2 = \frac{1}{\sqrt{2}}\nu_1$

(3) $\lambda_2 = \lambda_1$, $\nu_2 = \sqrt{2}\nu_1$

(4) $\lambda_2 = \sqrt{2}\lambda_1$, $\nu_2 = \nu_1$

Question 17: A mass m is attached to two strings as shown in figure. The spring constants of two springs are K_1 and K_2. For the frictionless surface, the time period of

oscillation of mass m is



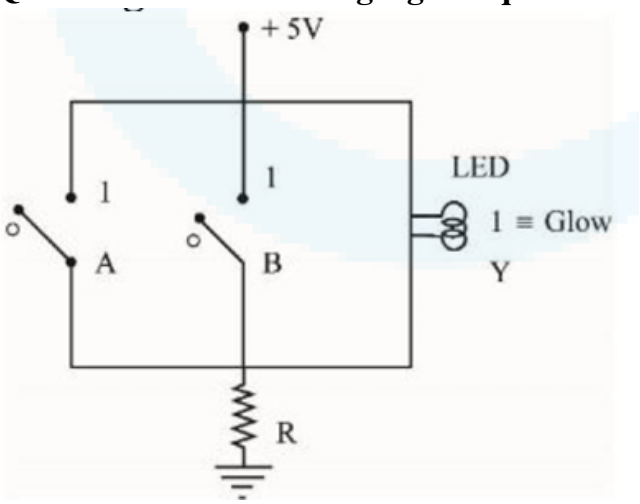
(1) $2\pi\sqrt{\frac{m}{K_1-K_2}}$

(2) $\frac{1}{2\pi}\sqrt{\frac{K_1-K_2}{m}}$

(3) $\frac{1}{2\pi}\sqrt{\frac{K_1+K_2}{m}}$

(4) $2\pi\sqrt{\frac{m}{K_1+K_2}}$

Question 18: Name the logic gate equivalent to the diagram attached



(1) NOR

(2) OR

(3) NAND

(4) AND

Question 19: The induced emf can be produced in a coil by

A. moving the coil with uniform speed inside uniform magnetic field

B. moving the coil with non uniform speed inside uniform magnetic field

C. rotating the coil inside the uniform magnetic field

D. changing the area of the coil inside the uniform magnetic field

Choose the correct answer from the options given below :

(1) B and D only

(2) C and D only

(3) B and C only

(4) A and C only

Question 20: Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : When a body is projected at an angle 45°, it's range is maximum.

Reason R : For maximum range, the value of $\sin 2\theta$ should be equal to one.

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

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

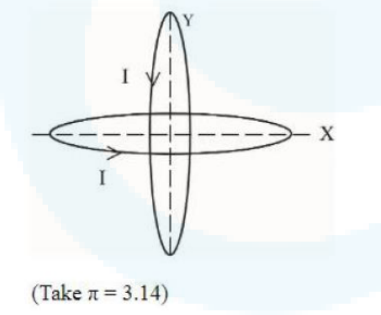
(2) A is false but R is true

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

(4) A is true but R is false

Section B

Question 21: Two identical circular wires of radius 20 cm and carrying current $\sqrt{2}$ A are placed in perpendicular planes as shown in figure. The net magnetic field at the centre of the circular wires is ____ $\times$ 10^{-8} T.



(Take $\pi = 3.14$)

Question 22: A steel rod has a radius of 20 mm and a length of 2.0 m. A force of 62.8 kN stretches it along its length. Young's modulus of steel is 2.0×10^{11} N/m^2. The longitudinal strain produced in the wire is ____ $\times$ 10^{-5}.

Question 23: The length of a metallic wire is increased by 20% and its area of cross section is reduced by 4%. The percentage change in resistance of the metallic wire is ____.

Question 24: The radius of fifth orbit of the Li^{++} is ____ $\times$ 10^{-12} m.
Take : radius of hydrogen atom = 0.51 Å

Question 25: A particle of mass 10 g moves in a straight line with retardation 2x, where x is the displacement in SI units. Its loss of kinetic energy for above displacement is $\left(\frac{10}{x}\right)^{-n}$ J. The value of n will be ____.

Question 26: An ideal transformer with purely resistive load operates at 12 kV on the primary side. It supplies electrical energy to a number of nearby houses at 120 V. The average rate of energy consumption in the houses served by the transformer is 60 kW. The value of resistive load (R_s) required in the secondary circuit will be _____ mΩ.

Question 27: A parallel plate capacitor with plate area A and plate separation d is filled with a dielectric material of dielectric constant K = 4. The thickness of the dielectric material is x, where x $<$ d.

[scale=0.6] [fill=black] (0,2) rectangle (4,3); at (5,2.5) Plate-1; [pattern=north west lines] (0,0) rectangle (4,1); at (5,0.5) Plate-2; [fill=gray] (0,1) rectangle (4,2); at (2,1.5) Dielectric; [—-—] (-1,0) – (-1,3); at (-1.3,1.5) d; [—-—] (-0.5,0) – (-0.5,2); at (-0.8,1) x;

Let C_1 and C_2 be the capacitance of the system for $x = \frac{1}{3}d$ and $x = \frac{2}{3}d$, respectively. If $C_1 = 2\mu$F, the value of C_2 is _____ μF.

Question 28: Two identical solid spheres each of mass 2 kg and radii 10 cm are fixed at the ends of a light rod. The separation between the centres of the spheres is 40 cm. The moment of inertia of the system about an axis perpendicular to the rod passing through its middle point is _____ $\times$ 10^{-3} kg-m^2.

Question 29: A person driving car at a constant speed of 15 m/s is approaching a

vertical wall. The person notices a change of 40 Hz in the frequency of his car's horn upon reflection from the wall. The frequency of horn is _____ Hz.

Question 30: A pole is vertically submerged in swimming pool, such that it gives a length of shadow 2.15 m within water when sunlight is incident at an angle of 30° with the surface of water. If swimming pool is filled to a height of 1.5 m, then the height of the pole above the water surface in centimeters is (n_w = 4/3) _____.
