

JEE Main 2023 24 Jan Shift 1 Physics Question Paper

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :90
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The Duration of test is 3 Hours.
2. This Question paper consists of 90 Questions.
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..
 5. (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.

Question 1. Two long straight wires P and Q carrying equal currents of 10A each were kept parallel to each other at a distance of 5cm. The magnitude of the magnetic force experienced by a 10cm length of wire P is F_1 . If the distance between the wires is halved and the currents in them are doubled, the force F_2 on a 10cm length of wire P will be:

- (1) $8F_1$
 - (2) $10F_1$
 - (3) $\frac{F_1}{8}$
 - (4) $\frac{F_1}{10}$
-

Question 2. Given below are two statements:

Statement-I : An elevator can go up or down with uniform speed when its weight is balanced with the tension of its cable.

Statement-II : Force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

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

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

Question 3. From the photoelectric effect experiment, the following observations are made. Identify which of these are correct:

A. The stopping potential depends only on the work function of the metal.

B. The saturation current increases as the intensity of incident light increases.

C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.

D. Photoelectric effect can be explained using wave theory of light. Choose the correct answer from the options given below:

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

Question 4. The weight of a body at the surface of Earth is 18 N. The weight of the body at an altitude of 3200 km above the Earth's surface is (given, radius of Earth $R_e = 6400$ km):

- (1) 9.8N
 - (2) 4.9N
 - (3) 19.6N
 - (4) 8N
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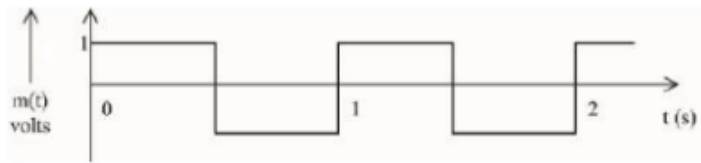
Question 5. A 100 m long wire having cross-sectional area $6.25 \times 10^{-4} \text{ m}^2$ and Young's modulus is 10^{10} Nm^{-2} is subjected to a load of 250 N, then the elongation in the wire will be :

- (1) $6.25 \times 10^{-3} \text{ m}$
 - (2) $4 \times 10^{-4} \text{ m}$
 - (3) $6.25 \times 10^{-6} \text{ m}$
 - (4) $4 \times 10^{-3} \text{ m}$
-

Question 6. 1 g of a liquid is converted to vapour at $3 \times 10^5 \text{ Pa}$ pressure. If 10% of the heat supplied is used for increasing the volume by 1600 cm^3 during this phase change, then the increase in internal energy in the process will be :

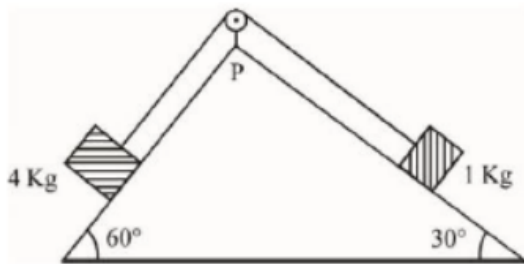
- (1) 4320 J
 - (2) 432000 J
 - (3) 4800 J
 - (4) $4.32 \times 10^8 \text{ J}$
-

Question 7. A modulating signal is a square wave, as shown in the figure. If the carrier wave is given as $c(t) = 2 \sin(8\pi t)$ volts, the modulation index is :



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

Question 8: As per given figure, a weightless pulley P is attached on a double inclined frictionless surface. The tension in the string (massless) will be (if $g = 10 \text{ m/s}^2$):



- (1) $(4\sqrt{3} + 1) \text{ N}$
- (2) $4(\sqrt{3} + 1) \text{ N}$
- (3) $4(\sqrt{3} - 1) \text{ N}$
- (4) $(4\sqrt{3} + 1) \text{ N}$

Question 9: Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R :

Assertion (A): Photodiodes are preferably operated in reverse bias condition for light intensity measurement.

Reason (R): The current in the forward bias is more than the current in the reverse bias for a p–n junction diode.

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

- (1) A is false but R is true
 - (2) Both A and R are true but R is NOT the correct explanation of A
 - (3) A is true but R is false
 - (4) Both A and R are true and R is the correct explanation of A
-

Question 10: If $\vec{E}$ represents the electric field vector and $\vec{K}$ the propagation vector of electromagnetic waves in vacuum, then the magnetic field vector is given by (ω - angular frequency):

- (1) $\vec{B} = \frac{\vec{K} \times \vec{E}}{\omega}$
 - (2) $\vec{B} = \omega(\vec{E} \times \vec{K})$
 - (3) $\vec{B} = \omega(\vec{K} \times \vec{E})$
 - (4) $(\vec{K} \times \vec{E})$
-

Question 11: A circular loop of radius r is carrying current I A. The ratio of magnetic field at the center of the circular loop and at a distance r from the center of the loop on its axis is:

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

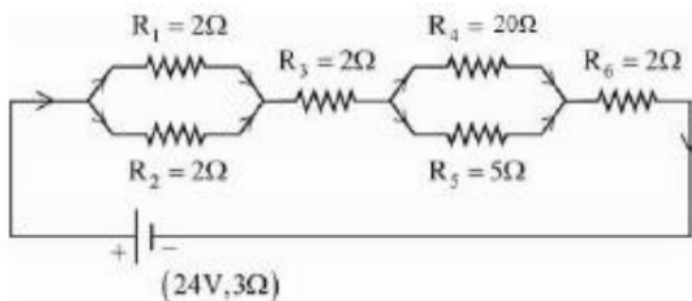
Question 12: A travelling wave is described by the equation:

$$y(x, t) = 0.05 \sin(8x - 4t) \text{ m}$$

The velocity of the wave is: (All quantities are in SI units.)

- (1) 4 ms^{-1}
- (2) 2 ms^{-1}
- (3) 0.5 ms^{-1}
- (4) 8 ms^{-1}

Question 13: As shown in the figure, a network of resistors is connected to a battery of 24 V with an internal resistance of $3\ \Omega$. The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are:



- (1) $I_4 = \frac{8}{5}\text{ A}$ and $I_5 = \frac{2}{5}\text{ A}$
- (2) $I_4 = \frac{24}{5}\text{ A}$ and $I_5 = \frac{6}{5}\text{ A}$
- (3) $I_4 = \frac{6}{5}\text{ A}$ and $I_5 = \frac{24}{5}\text{ A}$
- (4) $I_4 = \frac{2}{5}\text{ A}$ and $I_5 = \frac{8}{5}\text{ A}$

Question 14: Given below are two statements:

Statement I: If the Brewster's angle for the light propagating from air to glass is θ_b , then Brewster's angle for the light propagating from glass to air is:

$$\frac{\pi}{2} - \theta_b$$

Statement II: The Brewster's angle for the light propagating from glass to air is $\tan^{-1}(\mu_g)$, where μ_g is the refractive index of glass.

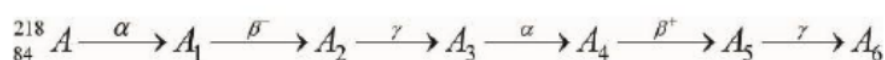
In the light of the above statements, choose the correct answer from the options given below:

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

Question 15: If two charges q_1 and q_2 are separated with distance d and placed in a medium of dielectric constant K , what will be the equivalent distance between charges in air for the same electrostatic force?

- (1) $d\sqrt{K}$
 - (2) $k\sqrt{d}$
 - (3) $1.5d\sqrt{K}$
 - (4) $2d\sqrt{K}$
-

Question 16: Consider the following radioactive decay process:



The mass number and the atomic number of A_6 are given by:

- (1) 210 and 82
 - (2) 210 and 84
 - (3) 210 and 80
 - (4) 211 and 80
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Question 17: Given below are two statements:

Statement I: The temperature of a gas is -73°C . When the gas is heated to 527°C , the root mean square speed of the molecules is doubled.

Statement II: The product of pressure and volume of an ideal gas will be equal to the translational kinetic energy of the molecules.

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

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

Question 18: The maximum vertical height to which a man can throw a ball is 136 m. The maximum horizontal distance up to which he can throw the same ball is:

- (1) 192 m
 - (2) 136 m
 - (3) 272 m
 - (4) 68 m
-

Question 19: A conducting loop of radius $\frac{10}{\sqrt{\pi}}$ cm is placed perpendicular to a uniform magnetic field of 0.5 T. The magnetic field is decreased to zero in 0.5 s at a steady rate. The induced emf in the circular loop at 0.25 s is:

- (1) 1 mV
 - (2) 10 mV
 - (3) 100 mV
 - (4) 5 mV
-

Question 20: Match List I with List II:

List I	List II
A. Planck's constant (h)	I. $M^1 L^2 T^{-2}$
B. Stopping potential (V_s)	II. $M^1 L^1 T^{-1}$
C. Work function (ϕ)	III. $M^1 L^2 T^{-1}$
D. Momentum (p)	IV. $M^1 L^2 T^{-3} A^{-1}$

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

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

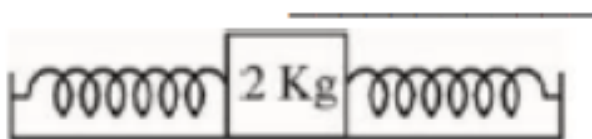
(3) A-II, B-IV, C-III, D-I

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

Section - B

Question 21: A spherical body of mass 2 kg starting from rest acquires a kinetic energy of 10000 J at the end of 5th second. The force acted on the body is ____ N.

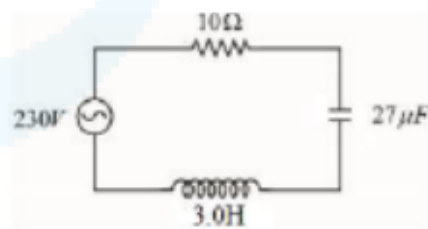
Question 22: A block of mass 2 kg is attached with two identical springs of spring constant 20 N/m each. The block is placed on a frictionless surface, and the ends of the springs are attached to rigid supports. When the mass is displaced from its equilibrium position, it executes simple harmonic motion. The time period of oscillation is given by $\frac{\pi}{\sqrt{x}}$ in SI units. The value of x is:



Question 23: A hole is drilled in a metal sheet. At 27°C, the diameter of the hole is 5 cm. When the sheet is heated to 177°C, the change in the diameter of the hole is Δd . The value of Δd will be, if the coefficient of linear expansion of the metal is $1.6 \times 10^{-5}/^\circ\text{C}$:

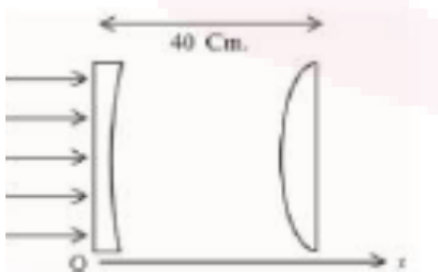
Correct Answer: $\Delta d = 0.12 \text{ cm}$

Question 24: In the circuit shown in the figure, the ratio of the quality factor and the bandwidth is ____ s.

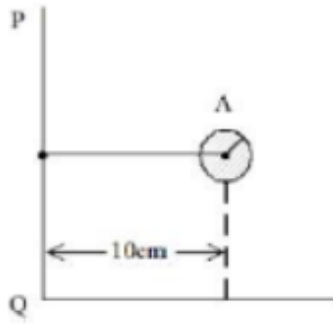


Question 25: A hollow cylindrical conductor has a length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm, respectively. The resistance of the conductor is $2 \times 10^{-3} \Omega$. If the resistivity of the material is $2.4 \times 10^{-8} \Omega \text{ m}$, the value of $n \times 10^{-3} \Omega$ is:

Question 26: As shown in the figure, a combination of a thin plano-concave lens and a thin plano-convex lens is used to image an object placed at infinity. The radius of curvature of both lenses is 30 cm, and the refractive index of the material for both lenses is 1.75. Both lenses are placed at a distance of 40 cm from each other. Due to the combination, the image of the object is formed at distance x cm, from the concave lens.



Question 27: A solid sphere A is rotating about an axis PQ . If the radius of the sphere is 5 cm, then its radius of gyration about PQ will be $\sqrt{x}$ cm. The value of x is:



Question 28: Vectors $\vec{a} = a\hat{i} + b\hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ are perpendicular to each other when $3a + 2b = 7$. The ratio of a to b is $\frac{x}{2}$. The value of x is:

Question 29: Assume that protons and neutrons have equal masses. The mass of a nucleon is 1.6×10^{-27} kg, and the radius of a nucleus is $1.5 \times 10^{-15} A^{1/3}$ m. The approximate ratio of nuclear density to water density is $n \times 10^{13}$. The value of n is:

Question 30: A stream of positively charged particles having $\frac{q}{m} = 2 \times 10^{11}$ C/kg and velocity $\vec{v}_0 = 3 \times 10^7 \hat{i}$ m/s is deflected by an electric field $\vec{E} = 1.8 \hat{j}$ kV/m. The electric field exists in a region of 10 cm along the x -direction. Due to the electric field, the deflection of the charged particles in the y -direction is ____ mm.
