

JEE Main 2023 Jan 30 Shift 1 Physics Question Paper

Total Time Allowed : 180 minutes	Maximum Marks : 300	Total Questions : 90	Questions to be answered : 90
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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**Section A**

Question 1: The charge flowing in a conductor changes with time as

$$Q(t) = \alpha t - \beta t^2 + \gamma t^3,$$

where α, β, γ are constants. The minimum value of current is:

Options:

- (1) $\alpha - \frac{3\beta^2}{\gamma}$
- (2) $\alpha - \frac{\gamma^2}{3\beta}$
- (3) $\beta - \frac{\alpha^2}{3\gamma}$
- (4) $\alpha - \frac{\beta^2}{3\gamma}$

Question 2: The pressure (P) and temperature (T) relationship of an ideal gas obeys the equation $PT^2 = \text{constant}$. The volume expansion coefficient of the gas will be:

Options:

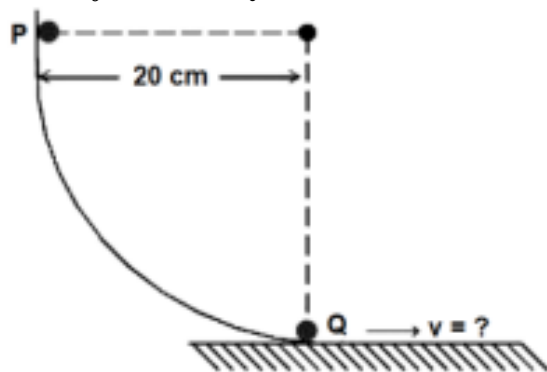
- (1) $3T^2$
 - (2) $\frac{3}{T^2}$
 - (3) $\frac{3}{T^3}$
 - (4) $\frac{3}{T}$
-

Question 3: A person has been using spectacles of power -1.0 diopter for distant vision and a separate reading glass of power 2.0 diopters. What is the least distance of distinct vision for this person?

Options:

- (1) 10 cm
 - (2) 40 cm
 - (3) 30 cm
 - (4) 50 cm
-

Question 4: As per the given figure, a small ball P slides down the quadrant of a circle and hits the other ball Q of equal mass which is initially at rest. Neglecting the effect of friction and assume the collision to be elastic, the velocity of ball Q after collision will be: ($g = 10 \text{ m/s}^2$)



Options:

- (1) 0
 - (2) 0.25 m/s
 - (3) 2 m/s
 - (4) 4 m/s
-

Question 5: Choose the correct relationship between Poisson ratio (σ), bulk modulus (K) and modulus of rigidity (η) of a given solid object:

Options:

- (1) $\sigma = \frac{3K-2\eta}{6K+2\eta}$
 - (2) $\sigma = \frac{6K+2\eta}{3K-2\eta}$
 - (3) $\sigma = \frac{3K+2\eta}{6K+2\eta}$
 - (4) $\sigma = \frac{6K-2\eta}{3K+2\eta}$
-

Question 6: The magnetic moments associated with two closely wound circular coils A and B of radius $r_A = 10$ cm and $r_B = 20$ cm respectively are equal if: (Where N_A, I_A and N_B, I_B are number of turns and current of A and B respectively)

Options:

- (1) $2N_AI_A = N_BI_B$
 - (2) $N_A = 2N_B$
 - (3) $N_AI_A = 4N_BI_B$
 - (4) $4N_AI_A = N_BI_B$
-

Question 7: A small object at rest absorbs a light pulse of power 20 mW and duration 300 ns. Assuming speed of light as 3×10^8 m/s, the momentum of the object becomes equal to:

Options:

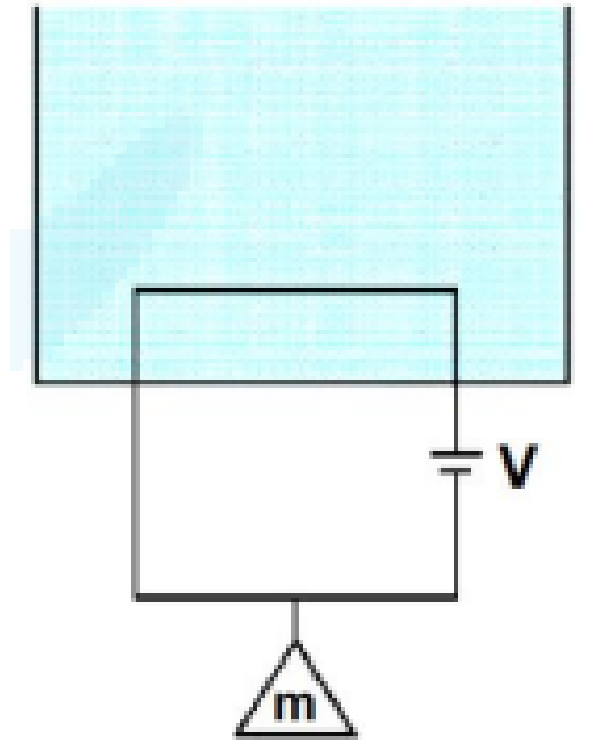
- (1) 0.5×10^{-17} kg m/s
 - (2) 2×10^{-17} kg m/s
 - (3) 3×10^{-17} kg m/s
 - (4) 1×10^{-17} kg m/s
-

Question 8: Speed of an electron in Bohr's 7th orbit for Hydrogen atom is 3.6×10^6 m/s. The corresponding speed of the electron in the 3rd orbit, in m/s, is:

Options:

- (1) 1.8×10^6 m/s
 - (2) 7.5×10^6 m/s
 - (3) 3.6×10^6 m/s
 - (4) 8.4×10^6 m/s
-

Question 9: A massless square loop, of wire resistance $10\ \Omega$, supporting a mass of 1 g , hangs vertically with one of its sides in a uniform magnetic field of 10^3 G , directed outwards in the shaded region. A dc voltage V is applied to the loop. For what value of V will the magnetic force exactly balance the weight of the supporting mass of 1 g ? (If sides of the loop = 10 cm , $g = 10\text{ m/s}^2$)



Options:

- (1) $\frac{1}{10}\text{ V}$
- (2) 100 V
- (3) 1 V
- (4) 10 V

Question 10: Two isolated metallic solid spheres of radii R and $2R$ are charged such that both have the same charge density σ . The spheres are then connected by a thin conducting wire. If the new charge density of the bigger sphere is σ' , the ratio $\frac{\sigma'}{\sigma}$ is:

Options:

- (1) $\frac{9}{4}$
- (2) $\frac{4}{3}$
- (3) $\frac{5}{3}$
- (4) $\frac{5}{6}$

Question 11: Heat is given to an ideal gas in an isothermal process.

- A. Internal energy of the gas will decrease.
- B. Internal energy of the gas will increase.
- C. Internal energy of the gas will not change.
- D. The gas will do positive work.
- E. The gas will do negative work.

Choose the correct answer from the options given below:

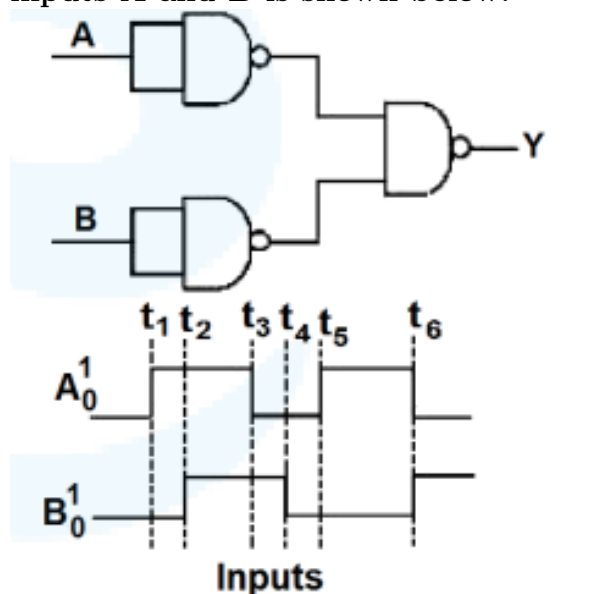
- (1) A and E only
- (2) B and D only
- (3) C and E only
- (4) C and D only

Question 12: Electric field in a certain region is given by $\mathbf{E} = \left(\frac{A}{x^2} \hat{i} + \frac{B}{y^3} \hat{j} \right)$. The SI unit of A and B are:

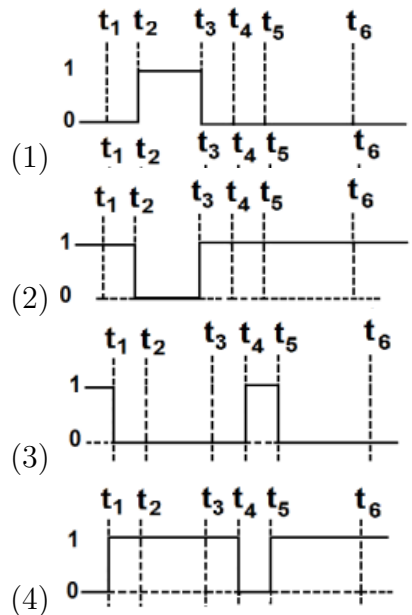
Options:

- (1) Nm^2C^{-1} , Nm^2C^{-1}
- (2) Nm^2C^{-1} , Nm^3C^{-1}
- (3) Nm^3C , Nm^3C
- (4) Nm^2C^{-1} , Nm^3C

Question 13: The output waveform of the given logical circuit for the following inputs A and B is shown below:



Options:



Question 14: The height of the liquid column raised in a capillary tube of certain radius when dipped in liquid A vertically is 5 cm. If the tube is dipped in a similar manner in another liquid B of surface tension and density double the values of liquid A, the height of the liquid column raised in liquid B would be:

Options:

- (1) 0.20
- (2) 0.5
- (3) 0.10
- (4) 0.05

Question 15: A sinusoidal carrier voltage is amplitude modulated. The resultant amplitude modulated wave has maximum and minimum amplitude of 120 V and 80 V respectively. The amplitude of each sideband is:

Options:

- (1) 15 V
- (2) 10 V
- (3) 20 V
- (4) 5 V

Question 16: In a series LR circuit with $X_L = R$, the power factor is P_1 . If a capacitor of capacitance C with $X_C = X_L$ is added to the circuit, the power factor becomes P_2 . The ratio of P_1 to P_2 will be:

Options:

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

Question 17: If the gravitational field in the space is given as $-\frac{K}{r^2}$, taking the reference point to be at $r = 2$ cm with gravitational potential $V = 10$ J/kg, find the gravitational potential at $r = 3$ cm in SI units. (Given that $K = 6$ J cm/kg)

Options:

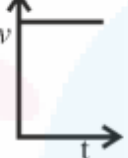
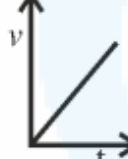
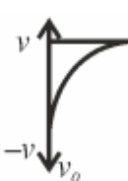
- (1) 9
 - (2) 11
 - (3) 12
 - (4) 10
-

Question 18: A ball of mass 200 g rests on a vertical post of height 20 m. A bullet of mass 10 g, travelling in horizontal direction, hits the centre of the ball. After collision both travel independently. The ball hits the ground at a distance of 30 m and the bullet at a distance of 120 m from the foot of the post. The value of initial velocity of the bullet will be (if $g = 10$ m/s²):

Options:

- (1) 120 m/s
 - (2) 60 m/s
 - (3) 400 m/s
 - (4) 360 m/s
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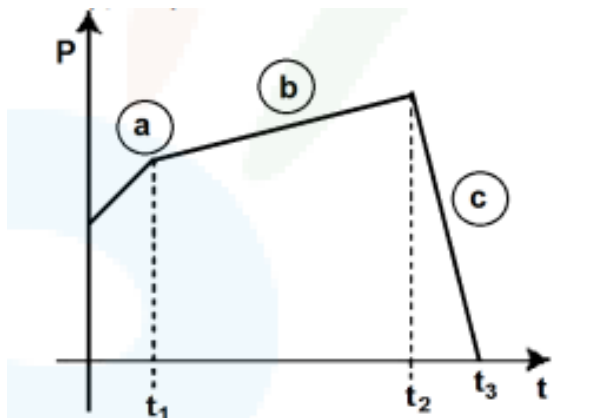
Question 19: Match Column-I with Column-II:

Column-I (x-t graphs)		Column-II (v-t graphs)	
A.		I.	
B.		II.	
C.		III.	
D.		IV.	

Options:

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

Question 20: The figure represents the momentum time ($p - t$) curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively? If $t_3 - t_2 < t_1$:



Options:

- (1) c and a
- (2) b and c
- (3) c and b
- (4) a and b

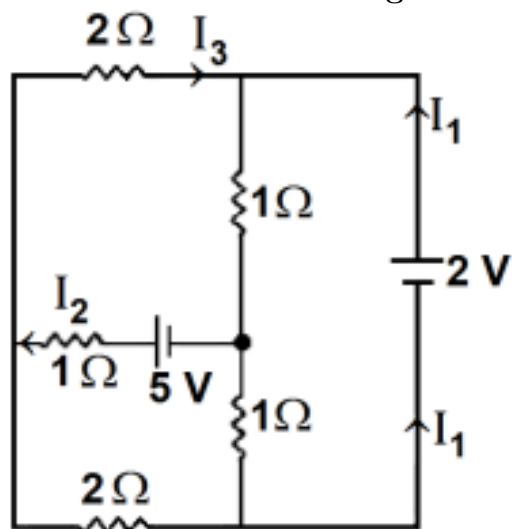
Section - B

Question 21: The general displacement of a simple harmonic oscillator is $x = A \sin(\omega t)$. Let T be its time period. The slope of its potential energy (U) - time (t) curve will be maximum when $t = \frac{T}{\beta}$. The value of β is:

Question 22: A capacitor of capacitance $900 \mu\text{F}$ is charged by a 100 V battery. The capacitor is disconnected from the battery and connected to another uncharged identical capacitor such that one plate of the uncharged capacitor is connected to the positive plate and another plate of the uncharged capacitor is connected to the negative plate of the charged capacitor. The loss of energy in this process is measured as $x \times 10^{-2} \text{ J}$. The value of x is:

Question 23: In Young's double slit experiment, two slits S_1 and S_2 are 'd' distance apart and the separation from slits to screen is D (as shown in figure). Now if two transparent slabs of equal thickness 0.1 mm but refractive index 1.51 and 1.55 are introduced in the path of beam ($\lambda = 4000 \text{ \AA}$) from S_1 and S_2 respectively. The central bright fringe spot will shift by ____ number of fringes.

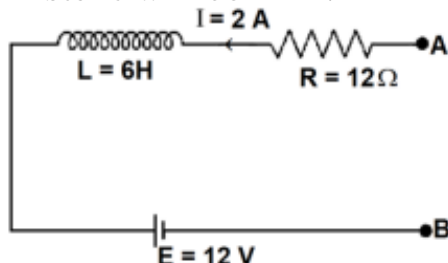
Question 24: In the following circuit, the magnitude of current I_1 is ____ A.



Question 25: A horse rider covers half the distance with 5 m/s speed. The remaining part of the distance was travelled with speed 10 m/s for half the time and with speed 15 m/s for other half of the time. The mean speed of the rider averaged over the whole time of motion is $\frac{x}{7}$ m/s. The value of x is:

Question 26: A point source of light is placed at the centre of curvature of a hemispherical surface. The source emits a power of 24 W. The radius of curvature of the hemisphere is 10 cm and the inner surface is completely reflecting. The force on the hemisphere due to the light falling on it is ____ $\times 10^{-8}$ N.

Question 27: As per the given figure, if $\frac{dI}{dt} = -1$ A/s, then the value of V_{AB} at this instant will be ____ V.



Question 28: In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by 0.5 mm on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation

when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while the 46th division of the circular scale coincide with the reference line. The diameter of the wire is $\text{-----} \times 10^{-2}$ mm.

Question 29: In an experiment for estimating the value of focal length of a converging mirror, image of an object placed at 40 cm from the pole of the mirror is formed at a distance 120 cm from the pole of the mirror. These distances are measured with a modified scale in which there are 20 small divisions in 1 cm. The value of error in measurement of focal length of the mirror is $1/K$ cm. The value of K is ----- .

Question 30: A thin uniform rod of length 2m, cross-sectional area 'A' and density 'd' is rotated about an axis passing through the center and perpendicular to its length with angular velocity ω . If value of ω in terms of its rotational kinetic energy E is:

$$E = \frac{\alpha E}{Ad}$$

Then the value of α is ----- .
