

JEE Main 2023 Jan 29 Shift 1 Physics Question Paper

Total Time Allowed : 60 minutes	Maximum Marks : 100	Total Questions : 30	Questions to be answered :30
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General Instructions

Read the following instructions very carefully and strictly follow them:

- (1) The test is of 1 hour duration.
- (2) The question paper consists of 30 questions. The maximum marks are 100.
- (3) This is the question paper of Physics having 30 questions in each part of equal weightage.
- (4) Each part 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.

Section-A

Question 1: Match List I with List II:

List I (Physical Quantity)	List II (Dimensional Formula)
A. Pressure gradient	(IV) $[M^0 L^2 T^{-2}]$
B. Energy density	(II) $[M^1 L^{-1} T^{-2}]$
C. Electric field	(III) $[M^1 L^1 T^{-3} A^{-1}]$
D. Latent heat	(I) $[M^1 L^{-2} T^{-2}]$

Choose the correct answer from the options given below:

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

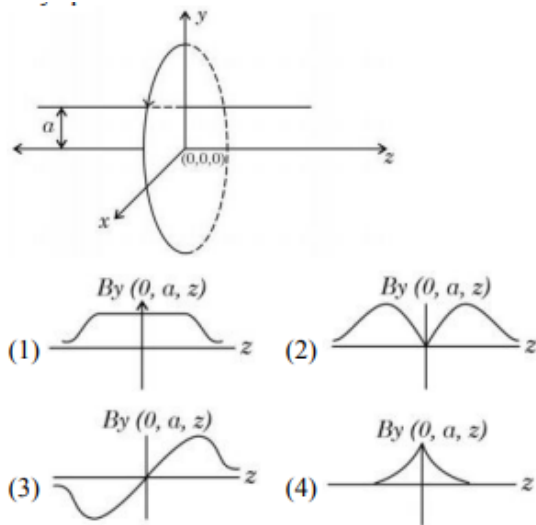
Question 2: In a cuboid of dimensions $2L \times 2L \times L$, a charge q is placed at the center of the surface S having area $4L^2$. The flux through the opposite surface to S is:

- (1) $\frac{q}{12\epsilon_0}$
 (2) $\frac{q}{3\epsilon_0}$
 (3) $\frac{q}{2\epsilon_0}$
 (4) $\frac{q}{6\epsilon_0}$

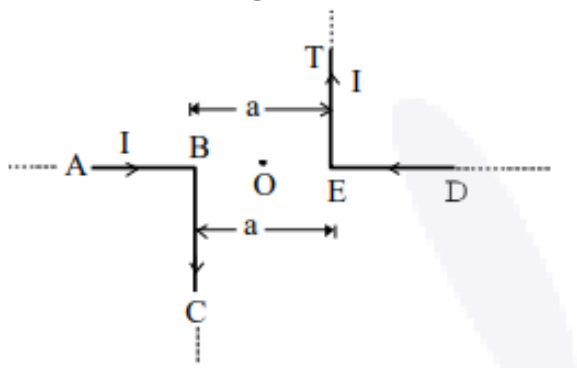
Question 3: Ratio of thermal energy released in two resistors R and $3R$ connected in parallel in an electric circuit is:

- (1) 3:1
 (2) 1:1
 (3) 1:3
 (4) 1:27

Question 4: A single current-carrying loop of wire carrying current I flows in the anticlockwise direction (seen from the $+z$ direction) and lies in the xy plane. The plot of $\hat{j}$ component of magnetic field (B_y) at a distance a (less than radius of the coil) and on the yz plane vs z coordinate looks like:

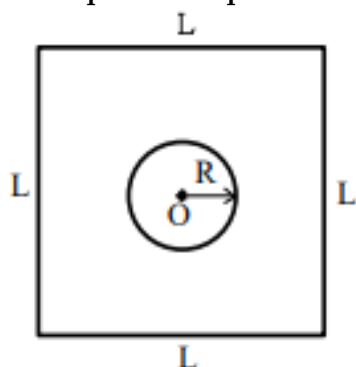


Question 5: The magnitude of magnetic induction at the mid-point O due to the current arrangement shown in the figure is:



- (1) $\frac{\mu_0 I}{2\pi a}$
 (2) 0
 (3) $\frac{\mu_0 I}{4\pi a}$
 (4) $\frac{\mu_0 I}{\pi a}$

Question 6: Find the mutual inductance in the arrangement, when a small circular loop of radius R is placed inside a large square loop of side L ($L \gg R$). The loops are coplanar and their centers coincide:



- (1) $M = \frac{\sqrt{2}\mu_0 R^2}{L}$
 (2) $M = \frac{2\sqrt{2}\mu_0 R}{L^2}$
 (3) $M = \frac{2\sqrt{2}\mu_0 R^2}{L}$
 (4) $M = \frac{\sqrt{2}\mu_0 R}{L^2}$

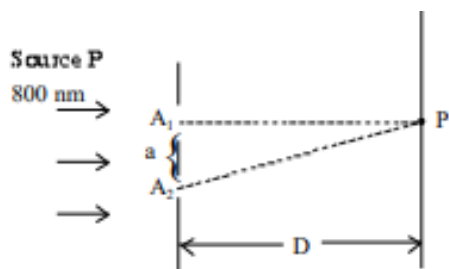
Question 7: Which of the following are true?

- A. Speed of light in vacuum depends on the direction of propagation.
 B. Speed of light in a medium is independent of the wavelength of light.
 C. Speed of light is independent of the motion of the source.
 D. Speed of light in a medium is independent of intensity.

Choose the correct answer from the options given below :

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

Question 8: In a Young's double slit experiment, two slits are illuminated with light of wavelength 800 nm. The first minimum is detected at P . The value of slit separation a is:



- (1) 0.4 mm
- (2) 0.5 mm
- (3) 0.2 mm
- (4) 0.1 mm

Question 9: A stone is projected at an angle of 30° to the horizontal. The ratio of kinetic energy at projection to its kinetic energy at the highest point is:

- (1) 1:2
- (2) 1:4
- (3) 4:1
- (4) 4:3

Question 10: A block of mass m slides down a plane inclined at an angle of 30° with an acceleration of $\frac{g}{4}$. The coefficient of kinetic friction is:

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

Question 11: A car is moving on a horizontal curved road with radius 50 m. The approximate maximum speed of the car will be, if the friction coefficient between tyres and road is 0.34. (Take $g = 10 \text{ m/s}^2$):

- (1) 13.4 m/s
- (2) 22.4 m/s
- (3) 13 m/s
- (4) 17 m/s

Question 12: Two particles of equal mass m move in a circle of radius r under the action of their mutual gravitational attraction. The speed of each particle will be:

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

Question 13: The surface tension of a soap bubble is 2×10^{-2} N/m. Work done to increase the radius of the bubble from 3.5 cm to 7 cm will be:

- (1) 4.072×10^{-3} J
- (2) 5.76×10^{-3} J
- (3) 1.848×10^{-3} J
- (4) 9.24×10^{-3} J

Question 14: Assertion A: If dQ and dW represent the heat supplied to the system and the work done on the system respectively, then according to the first law of thermodynamics $dQ = dU - dW$.

Reason R: First law of thermodynamics is based on the law of conservation of energy.

In the light of the above statements, choose the correct answer from the option 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, and R is the correct explanation of A
- (4) Both A and R are correct, but R is not the correct explanation of A

Question 15: A bicycle tyre is filled with air at a pressure of 270 kPa at 27°C . The approximate pressure of the air in the tyre when the temperature increases to 36°C is:

- (1) 270 kPa
- (2) 262 kPa
- (3) 278 kPa
- (4) 360 kPa

Question 16: A person observes two moving trains, A reaching the station and B leaving the station with equal speed of 30 m/s. If both trains emit sounds with frequency 300 Hz, the approximate difference of frequencies heard by the person will be:

- (1) 33 Hz
- (2) 55 Hz

- (3) 80 Hz
- (4) 10 Hz

Question 17: If the height of transmitting and receiving antennas are 80 m each, the maximum line of sight distance will be:

- (1) 32 km
- (2) 28 km
- (3) 36 km
- (4) 64 km

Question 18: The threshold wavelength for photoelectric emission from a material is $5500 \text{ \AA}$. Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from:

- A. 75 W infra-red lamp
- B. 10 W infra-red lamp
- C. 75 W ultra-violet lamp
- D. 10 W ultra-violet lamp

Choose the correct answer from the options given below :

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

Question 19: If a radioactive element with a half-life of 30 min undergoes beta decay. The fraction of the radioactive element that remains undecayed after 90 min is:

- (1) $\frac{1}{8}$
- (2) $\frac{1}{16}$
- (3) $\frac{1}{4}$
- (4) $\frac{1}{2}$

Question 20: Which of the following statements is not correct in the case of light emitting diodes (LEDs)?

- A. It is a heavily doped p-n junction.
- B. It emits light only when it is forward biased.
- C. It emits light only when it is reverse biased.
- D. The energy of the light emitted is equal to or slightly less than the energy gap of the semiconductor used.

Choose the correct answer from the options given below :

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

Section-B

Question 21: A radioactive element ${}_{92}^{242}\text{X}$ emits two α -particles, one electron, and two positrons. The product nucleus is represented by ${}^P_Z\text{Y}$. The value of P is —.

Question 22: Two simple harmonic waves having equal amplitudes of 8 cm and equal frequency of 10 Hz are moving along the same direction. The resultant amplitude is also 8 cm. The phase difference between the individual waves is — degrees.

Question 23: A body cools from 60°C to 40°C in 6 minutes. If the temperature of the surroundings is 10°C , then after the next 6 minutes, its temperature will be — $^\circ\text{C}$.

Question 24: A solid sphere of mass 2 kg is making pure rolling on a horizontal surface with kinetic energy 2240 J. The velocity of the center of mass of the sphere will be — ms^{-1} .

Question 25: A 0.4 kg mass takes 8s to reach the ground when dropped from a certain height P above the surface of Earth. The loss of potential energy in the last second of fall is — J. (Take $g = 10 \text{ m/s}^2$)

Question 26: A tennis ball is dropped onto the floor from a height of 9.8 m. It rebounds to a height of 5.0 m. The ball comes in contact with the floor for 0.2 s. The average acceleration during contact is — m/s^2 . (Given $g = 10 \text{ m/s}^2$)

Question 27: A point charge $q_1 = 4q_0$ is placed at the origin. Another point charge $q_2 = -q_0$ is placed at $x = 12 \text{ cm}$. The proton is placed on the x -axis so that the electrostatic force on the proton is zero. In this situation, the position of the proton from the origin is — cm.



Question 28: In a metre bridge experiment, the balance point is obtained if the gaps are closed by 2Ω and 3Ω . A shunt of $X\Omega$ is added to the 3Ω resistor to shift the balancing point by 22.5 cm. The value of X is —.

Question 29: A certain elastic conducting material is stretched into a circular loop. It is placed with its plane perpendicular to a uniform magnetic field $B = 0.8\text{ T}$. When released, the radius of the loop starts shrinking at a constant rate of 2 cm/s . The induced emf in the loop at an instant when the radius of the loop is 10 cm will be — mV.

Question 30: Three identical polaroids P_1 , P_2 , and P_3 are placed one after another. The pass axis of P_2 and P_3 are inclined at angles of 60° and 90° with respect to the axis of P_1 . The source S has an intensity of $\frac{256\text{ W}}{\text{m}^2}$. The intensity of light at point O is — $\frac{\text{W}}{\text{m}^2}$.

