

JEE Main 2023 Physics Question Paper Jan 29 Shift 2

Time Allowed :3 Hour	Maximum Marks :120	Total Questions :30
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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 30 questions. The maximum marks are 120.
3. The question paper consists of topics from Physics, having 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. 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.

1. At 300 K, the rms speed of oxygen molecules is $\sqrt{\frac{\alpha+5}{\alpha}}$ times to that of its average speed in the gas. Then, the value of α will be (used $\pi = \frac{22}{7}$)

- (A) 24
(B) 27
(C) 32
(D) 28

2. The time taken by an object to slide down a 45° rough inclined plane is n times as it takes to slide down a perfectly smooth 45° incline plane. The coefficient of kinetic friction between the object and the incline plane is:

- (A) $1 - \frac{1}{n^2}$
(B) $1 + \frac{1}{n^2}$
(C) $\frac{1}{1-n^2}$
(D) $\sqrt{1 - \frac{1}{n^2}}$

3. The ratio of de-Broglie wavelength of an α particle and a proton accelerated from rest by the same potential is $\frac{1}{\sqrt{m}}$, the value of m is:

- (A) 8
 - (B) 4
 - (C) 2
 - (D) 16
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4. A point charge 2×10^{-2} C is moved from P to S in a uniform electric field of 30 NC^{-1} directed along positive x-axis. If coordinates of P and S are (1, 2, 0) m and (0, 0, 0) m respectively, the work done by electric field will be:

- (A) -600 mJ
 - (B) -1200 mJ
 - (C) 1200 mJ
 - (D) 600 mJ
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5. A square loop of area 25 cm^2 has a resistance of 10Ω . The loop is placed in a uniform magnetic field of magnitude 40.0 T . The plane of loop is perpendicular to the magnetic field. The work done in pulling the loop out of the magnetic field slowly and uniformly in 1.0 sec , will be:

- (A) $1.0 \times 10^{-3} \text{ J}$
 - (B) $5 \times 10^{-3} \text{ J}$
 - (C) $2.5 \times 10^{-3} \text{ J}$
 - (D) $1.0 \times 10^{-4} \text{ J}$
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6. A fully loaded boeing aircraft has a mass of $5.4 \times 10^5 \text{ kg}$. Its total wing area is 500 m^2 . It is in level flight with a speed of 1080 km/h . If the density of air ρ is 1.2 kg m^{-3} , the fractional increase in the speed of the air on the upper surface of its wing relative to the lower surface in percentage will be ($g = 10 \text{ m s}^{-2}$).

- (A) 16
 - (B) 6
 - (C) 8
 - (D) 10
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7. A heat energy of 184 kJ is given to ice of mass 600 g at -12°C . Specific heat of ice is $2222.3 \text{ J kg}^{-1}^\circ\text{C}^{-1}$ and latent heat of ice is 336 kJ/kg^{-1} . A. Final temperature of system will be 0°C . B. Final temperature of the system will be greater than 0°C . C. The final system will have a mixture of ice and water in the ratio of 5:1. D. The

final system will have a mixture of ice and water in the ratio of 1:5. E. The final system will have water only. Choose the correct answer from the options given below:

- (A) A and E Only
- (B) A and C Only
- (C) B and D Only
- (D) A and D Only

8. Substance A has atomic mass number 16 and half life of 1 day. Another substance B has atomic mass number 32 and half life of 1/2 day. If both A and B simultaneously start to undergo radio activity at the same time with initial mass 320 g each, how many total atoms of A and B combined would be left after 2 days.

- (A) 1.69×10^{24}
- (B) 6.76×10^{23}
- (C) 3.38×10^{24}
- (D) 6.76×10^{24}

9. Given below are two statements:

Statement I: Electromagnetic waves are not deflected by electric and magnetic field.

Statement II: The amplitude of electric field and the magnetic field in electromagnetic waves are related to each other as $E_0 = cB_0$.

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

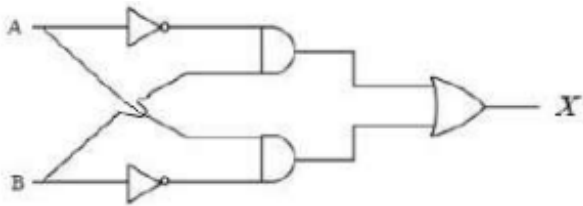
- (A) Both Statement I and Statement II are true
- (B) Statement I is false but statement II is true
- (C) Statement I is true but statement II is false
- (D) Both Statement I and Statement II are false

10. The electric current in a circular coil of four turns produces a magnetic induction 32 T at its centre. The coil is unwound and is rewound into a circular coil of single turn, the magnetic induction at the centre of the coil by the same current will be:

- (A) 4 T
- (B) 2 T
- (C) 8 T

(D) 16 T

11. For the given logic gates combination, the correct truth table will be



(A)

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

(B)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

(C)

A	B	X
0	0	1
0	1	0
1	0	1
1	1	0

(D)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

12. The modulation index for an A.M. wave having maximum and minimum peak-to-peak voltages of 14 mV and 6 mV respectively is:

- (A) 0.6
- (B) 0.4
- (C) 0.2
- (D) 1.4

13. The time period of a satellite of earth is 24 hours. If the separation between the earth and the satellite is decreased to one fourth of the previous value, then its new time period will become.

- (A) 4 hours
- (B) 6 hours
- (C) 12 hours
- (D) 3 hours

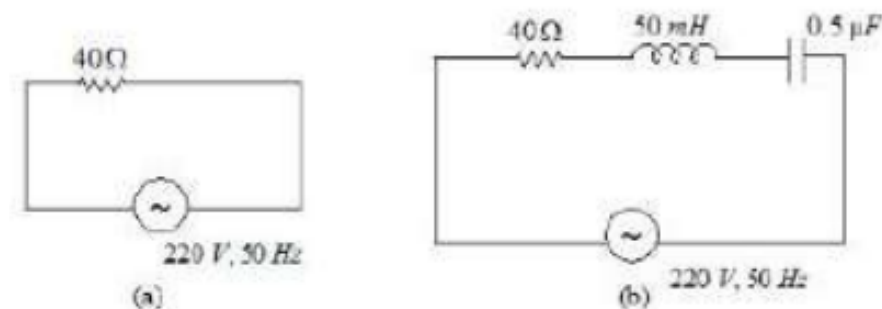
14. With the help of potentiometer, we can determine the value of emf of a given cell. The sensitivity of the potentiometer is

- (A) directly proportional to the length of the potentiometer wire
- (B) directly proportional to the potential gradient of the wire
- (C) inversely proportional to the potential gradient of the wire
- (D) inversely proportional to the length of the potentiometer wire

Choose the correct option for the above statements:

- (A) A and C only
- (B) B and D only
- (C) C only
- (D) A only

15. For the given figures, choose the correct options:



- (A) At resonance, current in (b) is less than that in (a)
 - (B) The rms current in circuit (b) can be larger than that in (a)
 - (C) The rms current in figure(a) is always equal to that in figure (b)
 - (D) The rms current in circuit (b) can never be larger than that in (a)
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16. The equation of a circle is given by $x^2 + y^2 = a^2$, where a is the radius. If the equation is modified to change the origin other than $(0, 0)$, then find out the correct dimensions of A and B in a new equation : $(x - At)^2 + (y - \frac{B}{t})^2 = a^2$. The dimensions of t is given as $[T^{-1}]$.

- (A) $A=[L^{-1}T^{-1}]$, $B=[LT]$
 - (B) $A=[L^{-1}T]$, $B=[LT^{-1}]$
 - (C) $A=[L^{-1}T^{-1}]$, $B=[LT^{-1}]$.
 - (D) $A=[LT]$, $B=[L^{-1}T^{-1}]$.
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17. A scientist is observing a bacteria through a compound microscope. For better analysis and to improve its resolving power he should. (Select the best option)

- (A) Increase the wave length of the light
 - (B) Decrease the diameter of the objective lens
 - (C) Decrease the focal length of the eye piece.
 - (D) Increase the refractive index of the medium between the object and objective lens
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18. A force acts for 20 s on a body of mass 20 kg, starting from rest, after which the force ceases and then body describes 50 m in the next 10 s. The value of force will be:

- (A) 5 N
 - (B) 20 N
 - (C) 40 N
 - (D) 10 N
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19. Identify the correct statements from the following:

- A. Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket is negative.
- B. Work done by gravitational force in lifting a bucket out of a well by a rope tied to the bucket is negative.
- C. Work done by friction on a body sliding down an inclined plane is positive.

D. Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity is zero.
 E. Work done by the air resistance on an oscillating pendulum is negative.
 Choose the correct answer from the options given below:

- (A) A and C Only
- (B) B, D and E only
- (C) B and E only
- (D) B and D only

20. An object moves at a constant speed along a circular path in a horizontal plane with center at the origin. When the object is at $x = +2$ m, its velocity is $-4\hat{j}$ m/s. The object's velocity ($\vec{v}$) and acceleration ($\vec{a}$) at $x = -2$ m will be

- (A) $\vec{v} = -4\hat{j}$ m/s, $\vec{a} = 8\hat{i}$ m/s²
- (B) $\vec{v} = 4\hat{i}$ m/s, $\vec{a} = 8\hat{j}$ m/s²
- (C) $\vec{v} = -4\hat{i}$ m/s, $\vec{a} = -8\hat{j}$ m/s²
- (D) $\vec{v} = 4\hat{j}$ m/s, $\vec{a} = 8\hat{i}$ m/s²

21. In an experiment of measuring the refractive index of a glass slab using travelling microscope in physics lab, a student measures real thickness of the glass slab as 5.25 mm and apparent thickness of the glass slab as 5.00 mm. Travelling microscope has 20 divisions in one cm on main scale and 50 divisions on vernier scale is equal to 49 divisions on main scale. The estimated uncertainty in the measurement of refractive index of the slab is $x \times 10^{-3}$, where x is

22. A car is moving on a circular path of radius 600 m such that the magnitudes of the tangential acceleration and centripetal acceleration are equal. The time taken by the car to complete first quarter of revolution, if it is moving with an initial speed of 54 km/hr is $t(1 - e^{-\pi/2})$ s. The value of t is

23. Unpolarised light is incident on the boundary between two dielectric media, whose dielectric constants are 2.8 (medium-1) and 6.8 (medium-2), respectively. To satisfy the condition, so that the reflected and refracted rays are perpendicular to each other, the angle of incidence should be $\tan^{-1} \left(\sqrt{1 + \frac{10}{\theta}} \right)$. The value of θ is

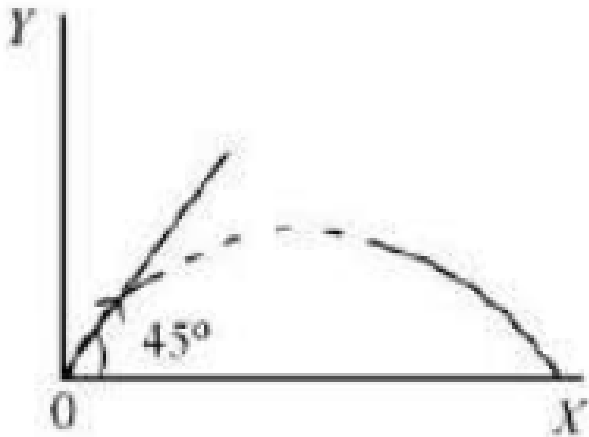
(Given for dielectric media, $\mu_r = 1$)

24. A null point is found at 200 cm in potentiometer when cell in secondary circuit is shunted by 5Ω . When a resistance of 15Ω is used for shunting, null point moves to 300 cm. The internal resistance of the cell is _____ Ω .

25. An inductor of inductance $2\ \mu\text{H}$ is connected in series with a resistance, a variable capacitor and an AC source of frequency 7 kHz. The value of capacitance for which maximum current is drawn into the circuit is $\frac{1}{x}\text{ F}$, where the value of x is _____.

(Take $\pi = 22/7$)

26. A particle of mass 100 g is projected at time $t = 0$ with a speed 20 ms^{-1} at an angle 45° to the horizontal as given in the figure. The magnitude of the angular momentum of the particle about the starting point at time $t = 2\text{ s}$ is found to be $\sqrt{K}\text{ kg m}^2/\text{s}$. The value of K is _____. (Take $g = 10\text{ ms}^{-2}$)



27. A particle of mass 250 g executes a simple harmonic motion under a periodic force $F = (-25x)\text{ N}$. The particle attains a maximum speed of 4 m/s during its oscillation. The amplitude of the motion is _____ cm.

28. For a charged spherical ball, electrostatic potential inside the ball varies with r as $V = 2ar^2 + b$. Here, a and b are constant and r is the distance from the center. The volume charge density inside the ball is $-\lambda a\epsilon_0$. The value of λ is _____. $\epsilon_0 =$ permittivity of the medium

29. When two resistances R_1 and R_2 connected in series and introduced into the left gap of a meter bridge and a resistance of $10\ \Omega$ is introduced into the right gap, a null point is found at 60 cm from left side. When R_1 and R_2 are connected in parallel and introduced into the left gap, a resistance of $3\ \Omega$ is introduced into the right-gap to get null point at 40 cm from left end. The product of $R_1 R_2$ is Ω^2 .

30. A metal block of base area $0.20\ \text{m}^2$ is placed on a table, as shown in figure. A liquid film of thickness $0.25\ \text{mm}$ is inserted between the block and the table. The block is pushed by a horizontal force of $0.1\ \text{N}$ and moves with a constant speed. If the viscosity of the liquid is $5.0 \times 10^{-3}\ \text{Pl}$, the speed of block is $\times 10^{-3}\ \text{m/s}$.

