JEE Main 2023 Physics Question Paper Jan 24 Shift 1

Time Allowed :3 Hour	Maximum Marks :120	Total Questions :30

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. From the photoelectric effect experiment, 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:

(A) A, B, D only
(B) B, C only
(C) B only
(D) A, C, D only

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2. Given below are two statements :
Statement I : If the Brewster's angle for the light propagating from air to glass is θ_B, then the 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:

(A) Statement I is true but Statement II is false
(B) Both Statement I and Statement II are false

(C) Both Statement I and Statement II are true
(D) Statement I is false but Statement II is true

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3. 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:

(A) A is false but R is true
(B) A is true but R is false
(C) Both A and R are true but R is NOT the correct explanation of A
(D) Both A and R are true and R is the correct explanation of A

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

(A) $1 : 3\sqrt{2}$
(B) $2\sqrt{2} : 1$
(C) $1 : \sqrt{2}$
(D) $3\sqrt{2} : 2$

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5. In $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by: (ω - angular frequency):

(A) $\vec{K} \times \vec{E}$
(B) $\frac{1}{\omega}(\vec{K} \times \vec{E})$
(C) $\omega(\vec{K} \times \vec{E})$
(D) $\omega(\vec{E} \times \vec{K})$

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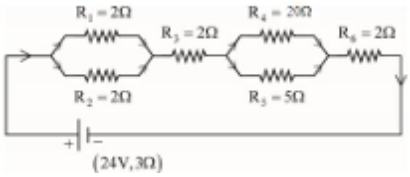
6. As shown in the figure, a network of resistors is connected to a battery of 24V with an internal resistance of 3Ω. The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are:

Given: $R_1 = 2\Omega, R_2 = 2\Omega, R_3 = 2\Omega, R_4 = 20\Omega, R_5 = 5\Omega, R_6 = 20\Omega$



(A) $I_4 = \frac{8}{5}$ A and $I_5 = \frac{2}{5}$ A
(B) $I_4 = \frac{6}{5}$ A and $I_5 = \frac{24}{5}$ A
(C) $I_4 = \frac{2}{5}$ A and $I_5 = \frac{8}{5}$ A
(D) $I_4 = \frac{24}{5}$ A and $I_5 = \frac{6}{5}$ A

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7. 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?

(A) $1.5d\sqrt{K}$
(B) $2d\sqrt{K}$
(C) $d\sqrt{K}$
(D) $k\sqrt{d}$

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

(A) 192 m
(B) 272 m
(C) 136 m
(D) 68 m

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9. 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 translational kinetic energy of the molecules.
In the light of the above statements, choose the correct answer from the options given below:

(A) Statement I is true but Statement II is false
(B) Statement I is false but Statement II is true

(C) Both Statement I and Statement II are true
(D) Both Statement I and Statement II are false

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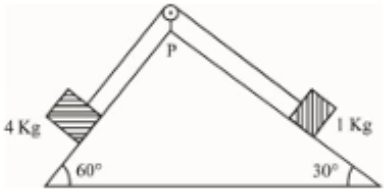
10. As per given figure, a weightless pulley P is attached on a double inclined frictionless surfaces. The tension in the string (massless) will be (if $g = 10$ m/s^2): Given: $m_1 = 4$ kg on 60° plane, $m_2 = 1$ kg on 30° plane.



(A) $4(\sqrt{3}+1)$ N
(B) $(4\sqrt{3}+1)$ N
(C) $4(\sqrt{3}-1)$ N
(D) $(4\sqrt{3}-1)$ N

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11. Consider the following radioactive decay process
$^{218}_{84}A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\gamma} A_3 \xrightarrow{\alpha} A_4 \xrightarrow{\beta^+} A_5 \xrightarrow{\gamma} A_6$
The mass number and the atomic number of A_6 are given by:

(A) 210 and 82
(B) 210 and 80
(C) 211 and 80
(D) 210 and 84

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12. 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):

(A) 9.8 N
(B) 19.6 N
(C) 4.9 N
(D) 8 N

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13. A conducting circular 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:

(A) emf = 5 mV
(B) emf = 10 mV
(C) emf = 1 mV
(D) emf = 100 mV

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

(A) $\frac{F_1}{10}$
(B) $\frac{F_1}{8}$
(C) $10F_1$
(D) $8F_1$

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15. 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:

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

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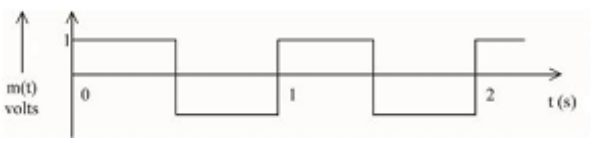
16. A modulating signal is a square wave, as shown in the figure.



If the carrier wave is given as $c(t) = 2\sin(8\pi t)$ volts, the modulation index is:

(A) $\frac{1}{4}$
(B) 1

(C) $\frac{1}{2}$
(D) $\frac{1}{3}$

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17. A travelling wave is described by the equation $y(x,t) = [0.05\sin(8x - 4t)]$ m. The velocity of the wave is : [all the quantities are in SI unit]

(A) 0.5 ms^{-1}
(B) 2 ms^{-1}
(C) 8 ms^{-1}
(D) 4 ms^{-1}

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18. A 100 m long wire having cross-sectional area 6.25×10^{-4} 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:

(A) 6.25×10^{-6} m
(B) 6.25×10^{-3} m
(C) 4×10^{-3} m
(D) 4×10^{-4} m

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19. 1 g of a liquid is converted to vapour at 3×10^5 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:

(A) 4.32×10^8 J
(B) 4800 J
(C) 4320 J
(D) 432000 J

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20. Match List I with List II

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

Choose the correct answer from the options given below:

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

21.

A block of a 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 (see figure). When the mass is displaced from its equilibrium position, it executes a simple harmonic motion. The time period of oscillation is $\frac{\pi}{\sqrt{x}}$ in SI unit. The value of x is _____.

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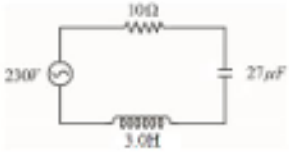
22. In the circuit shown in the figure, the ratio of the quality factor and the band width is _____ s.



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

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24. A hole is drilled in a metal sheet. At 27°C, the diameter of hole is 5 cm. When the sheet is heated to 177°C, the change in the diameter of hole is $d\times10^{-3}$ cm. The value of d will be _____ if coefficient of linear expansion of the metal is $1.6\times10^{-5}/^{\circ}$C.

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25. Assume that protons and neutrons have equal masses. Mass of a nucleon is 1.6×10^{-27} kg and radius of nucleus is $1.5\times10^{-15}A^{1/3}$ m. The approximate ratio of the nuclear density and water density is $n\times10^{13}$. The value of n is _____.

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26. A spherical body of mass 2 kg starting from rest acquires a kinetic energy of 10000 J at the end of 5^{th} second. The force acted on the body is _____ N.

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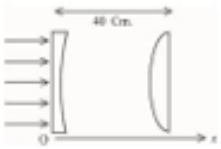
27. As shown in the figure, a combination of a thin plano concave lens and a thin plano convex lens is used to image an object placed at infinity. The radius of curvature of both the lenses is 30 cm and refraction index of the material for both the lenses is 1.75. Both the lenses are placed at distance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



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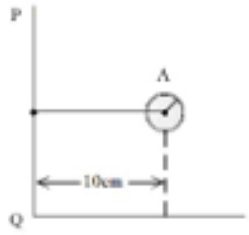
28. Solid sphere A is rotating about an axis PQ. If the radius of the sphere is 5 cm then its radius of gyration about PQ will be $\sqrt{x}$ cm. The value of x is _____.



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29. A stream of positively charged particles having $q/m = 2\times10^{11}$ C/kg and velocity $\vec{v}_0 = 3\times10^{7}\hat{i}$ m/s is deflected by an electric field 1.8 kV/m. The electric field exists in a region of 10 cm along x direction. Due to the electric field, the deflection of the charge particles in the y direction is _____ mm.

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30. A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of the conductor is $n\times10^{-3}\,\Omega$. If the resistivity of the material is $2.4\times10^{-8}\,\Omega$m. The value of n is _____.
