



General Instructions

- (i) **Duration:** The total duration of the examination is 1 hours (60 minutes).
- (ii) **Total Marks:** The complete Physics paper carries a maximum of 100 marks.
- (iii) **Structure:** The paper consists of two sections:
 - **Section A:** 20 Multiple Choice Questions (MCQs).
 - **Section B:** 5 Numerical Value Type Questions.
- (iv) **Compulsory Questions:** All 25 questions are compulsory.
- (v) Each question has four options. Only **one** option is correct.
- (vi) **Correct Answer:** +4 marks.
- (vii) **Incorrect Answer:** –1 mark (Negative marking).
- (viii) **Unanswered/Marked for Review:** 0 marks.

Physics Section - A

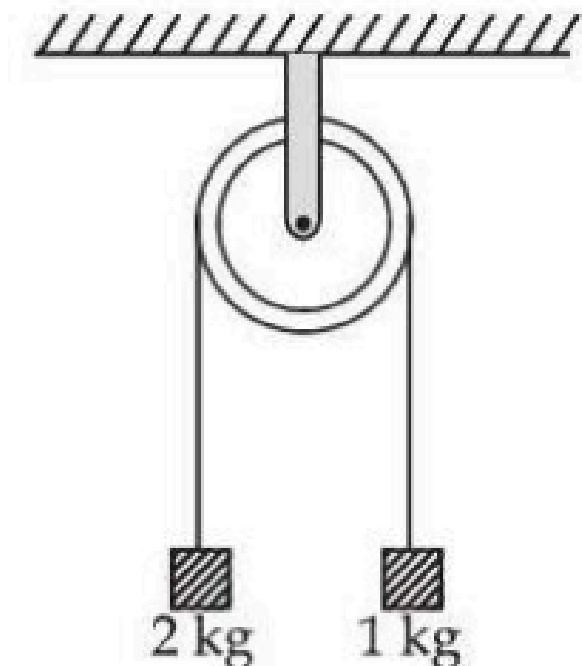
1. Dimensions of universal gravitational constant (G) in terms of Planck's constant (h), distance (L), mass (M) and time (T) are _____.

- (A) $[h T L M^{-2}]$
- (B) $[h T^{-1} L M^{-2}]$
- (C) $[h T L^2 M^{-2}]$
- (D) $[h^{-1} T^{-1} L M^{-2}]$

2. A 0.5 kg mass is in contact against the inner wall of a cylindrical drum of radius 4 m rotating about its vertical axis. The minimum rotational speed of the drum to enable the mass to remain stuck to the wall (without falling) is 5 rad/s. The coefficient of friction between the drum's inner wall surface and mass is _____. (Take $g = 10 \text{ m/s}^2$)

- (A) 0.1
(B) 0.5
(C) 0.7
(D) 0.3
-

3. Two blocks of masses 2 kg and 1 kg respectively, are tied to the ends of a string which passes over a light frictionless pulley as shown in the figure below. The masses are held at rest at the same horizontal level and then released. The distance traversed by the centre of mass in 2 s is _____ m. (Take $g = 10 \text{ m/s}^2$)



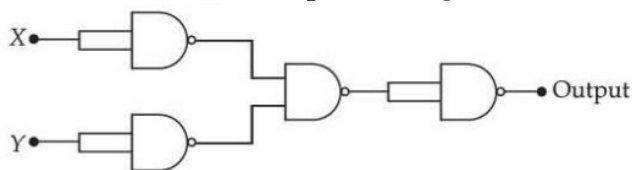
- (A) 3.33
(B) 3.12
(C) 2.22
(D) 1.42
-

4. A particle having charge 10^{-9} C moving in x - y plane in fields of $0.4\hat{j} \text{ N/C}$ and $4 \times 10^{-3}\hat{k} \text{ T}$ ex-

periences a force of $(4\hat{i} + 2\hat{j}) \times 10^{-10}$ N. The velocity of the particle at that instant is _____ m/s.

- (A) $50\hat{i} + 100\hat{j}$
 - (B) $100\hat{i} + 50\hat{j}$
 - (C) $-50\hat{i} + 100\hat{j}$
 - (D) $50\hat{i} - 100\hat{j}$
-

5. If X and Y are the inputs, the given circuit works as _____.



- (A) OR gate
 - (B) AND gate
 - (C) NAND gate
 - (D) NOR gate
-

6. If a body of mass 1 kg falls on the earth from infinity, it attains velocity (v) and kinetic energy (k) on reaching the surface of earth. The values of v and k respectively are _____. (Take radius of earth to be 6400 km and $g = 9.8 \text{ m/s}^2$)

- (A) 11.2 km/s; 6.27×10^7 J
 - (B) 11.2 km/s; 12.54×10^7 J
 - (C) 8.8 km/s; 6.27×10^7 J
 - (D) 8.8 km/s; 12.54×10^7 J
-

7. In a screw gauge the zero of main scale reference line coincides with the fifth division of the circular scale when two studs are in contact. There are 100 divisions in circular scale and pitch of screw gauge is 0.1 mm. When diameter of a sphere is measured, the reading of main scale is 5 mm and 50th division of circular scale coincides with the reference line of main scale. The diameter of sphere is _____ mm.

- (A) 5.045

- (B) 5.055
 - (C) 5.450
 - (D) 5.550
-

8. The surface tension of a soap bubble is 0.03 N/m . The work done in increasing the diameter of bubble from 2 cm to 6 cm is $\alpha\pi \times 10^{-4} \text{ J}$. The value of α is _____. (Take $\pi = 3.14$)

- (A) 0.86
 - (B) 0.64
 - (C) 1.92
 - (D) 7.68
-

9. A mixture of carbon dioxide and oxygen has volume 8310 cm^3 , temperature 300 K , pressure 100 kPa and mass 13.2 g . The number of moles of carbon dioxide and oxygen gases in the mixture respectively are _____. (Assume both carbon dioxide and oxygen gases behave like ideal gases) [$R = 8.31 \text{ J/mol.K}$]

- (A) 0.15 and 0.18
 - (B) 0.25 and 0.08
 - (C) 0.21 and 0.12
 - (D) 0.13 and 0.20
-

10. If an air bubble of diameter 2 mm rises steadily through a liquid of density 2000 kg/m^3 at a rate of 0.5 cm/s , then the coefficient of viscosity of liquid is _____ Poise. (Take $g = 10 \text{ m/s}^2$)

- (A) 0.88
 - (B) 8.8
 - (C) 88.8
 - (D) 0.088
-

11. A spherical ball of mass 2 kg falls from a height of 10 m and is brought to rest after penetrating 10 cm into sand. The average force exerted by sand on the ball is _____ N. (Take

$$g = 10 \text{ m/s}^2)$$

- (A) 1980
 - (B) 2020
 - (C) 2000
 - (D) 1000
-

12. An electromagnetic wave travels in free space along the x -direction. At a particular point in space and time, $\vec{B} = 2 \times 10^{-7} \hat{j} \text{ T}$ is associated with this wave. The value of corresponding electric field $\vec{E}$ at this point is _____ V/m.

- (A) $60\hat{k}$
 - (B) $-60\hat{k}$
 - (C) $30\hat{k}$
 - (D) $-600\hat{k}$
-

13. Two resistors of 200Ω and 400Ω are connected in series with a battery of 100 V. A bulb rated at 200 V, 100 W is connected across the 400Ω resistance. The potential drop across the bulb is _____ V.

- (A) 25
 - (B) 50
 - (C) 66.6
 - (D) 100
-

14. Two metal plates (A, B) are kept horizontally with separation of $\left(\frac{12}{\pi}\right) \text{ cm}$, with plate A on the top. An atomizer jet sprays oil (density 1.5 g/cm^3) droplets of radius 1 mm horizontally. All oil droplets carry a charge 5 nC. The potentials V_A and V_B are required on plates A and B respectively in order to ensure the droplets do not descend. The values of V_A and V_B are _____. (Neglect the air resistance to the droplets and take $g = 10 \text{ m/s}^2$)

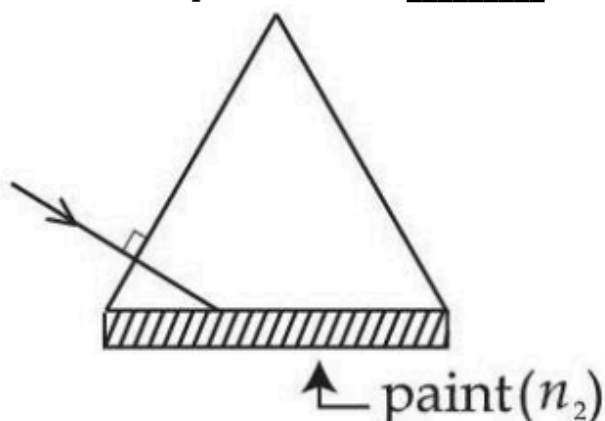
- (A) 100 V and 580 V
- (B) 580 V and 100 V

- (C) 60 V and 400 V
(D) 0 V and -200 V
-

15. Two point charges $8\ \mu\text{C}$ and $-2\ \mu\text{C}$ are located at $x = 2\text{ cm}$ and $x = 4\text{ cm}$, respectively on the x-axis. The ratio of electric flux due to these charges through two spheres of radii 3 cm and 5 cm with their centers at the origin is _____.

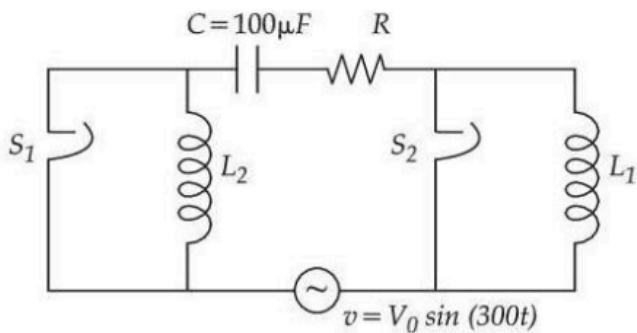
- (A) 4 : 1
(B) 3 : 4
(C) 4 : 3
(D) 4 : 5
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16. One side of an equilateral prism is painted by a transparent material of refractive index n_2 . The refractive index of prism is 1.6. The minimum value of n_2 required for total internal reflection from painted face is _____.



- (A) $3\sqrt{3}/1.6$
(B) $\sqrt{3}$
(C) $3.2/\sqrt{3}$
(D) $4\sqrt{3}/5$
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17. The figure given below shows an LCR series circuit with two switches S_1 and S_2 . When switch S_1 is closed keeping S_2 open, the phase difference (ϕ) between the current and source voltage is 30° and phase difference is 60° when S_2 is closed keeping S_1 open. The value of $(3L_1 - L_2)$ is _____ H. (Given $C = 100\ \mu\text{F}$, $v = V_0 \sin(300t)$)



- (A) $\frac{9}{2}$
 (B) $\frac{2}{9}$
 (C) $\frac{1}{3}$
 (D) 3

18. A circular current loop of radius R is placed inside square loop of side length L ($L \gg R$) such that they are co-planar and their centers coincide. The permeability of free space is μ_0 . The mutual inductance between circular loop and square loop is _____.

- (A) $2\sqrt{2}\mu_0 L^2/R$
 (B) $\sqrt{2}\mu_0 L^2/R$
 (C) $\sqrt{2}\mu_0 R^2/L$
 (D) $2\sqrt{2}\mu_0 R^2/L$

19. The binding energy per nucleon of $^{209}_{83}\text{Bi}$ is _____ MeV.

Take $m(^{209}_{83}\text{Bi}) = 208.980388 \text{ u}$, $m_p = 1.007825 \text{ u}$, $m_n = 1.008665 \text{ u}$, $1 \text{ u} = 931 \text{ MeV}/c^2$

- (A) 7.48
 (B) 7.84
 (C) 8.79
 (D) 6.94

20. The equation of motion of a particle is given by $x = a \sin(50t + \pi/3)$ cm. The particle will come to rest at time t_1 and it will have zero acceleration at time t_2 . The t_1 and t_2 respectively are _____.

- (A) $\frac{\pi}{300}$ s, $\frac{\pi}{75}$ s
(B) $\frac{\pi}{75}$ s, $\frac{\pi}{300}$ s
(C) $\frac{\pi}{300}$ s, $\frac{\pi}{25}$ s
(D) $\frac{\pi}{50}$ s, $\frac{\pi}{100}$ s
-

Physics Section - B

21. In a Young's double slit experiment, the intensity at some point on the screen is found to be $\frac{3}{4}$ times of the maximum of the interference pattern. The path difference between the interfering waves at this point is $\frac{\lambda}{x}$ where λ is wavelength of the incident light. The value of x is _____.

22. Using Bohr's model, calculate the ratio of the magnetic fields generated due to the motion of the electrons in the 2nd and 4th orbits of hydrogen atom _____.

23. 5 moles of unknown gas is heated at constant volume from 10 °C to 20 °C. The molar specific heat of this gas at constant pressure $c_p = 8$ cal/mol.°C and $R = 8.36$ J/mol.°C. The change in the internal energy of the gas is _____ calorie.

24. If sunlight is focused on a paper using convex lens, it starts burning the paper in shortest time when the lens is kept at 30 cm above the paper. If the radius of curvature of the lens is 60 cm then the refractive index of the lens material is $\frac{\alpha}{10}$. The value of α is _____.

25. Moment of inertia about an axis AB for a rod of mass 40 kg and length 3 m is same as that of a solid sphere of mass of 10 kg and radius R about an axis parallel to AB axis with separation of 3 m as shown in figure below. The value of R is given as $\sqrt{\frac{\alpha}{2}}$. The value of α is _____.

