



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. A new unit (α) of length is chosen such that it is equal to the speed of light in vacuum. What is the distance between Venus and Earth in terms of α units if light takes 6 min. 40 s to cover this distance ?

- (A) 200α
- (B) 400α
- (C) 300α

(D) 500α

2. Consider the equation $H = \frac{x^p \epsilon^q E^r}{t^s}$

Where H = magnetic field; E = electric field, ϵ = permittivity, x = distance, t = time

The values of p, q, r and s respectively are :

(A) 1, 1, 1, 1

(B) -1, 1, 2, 1

(C) 1, -1, -2, 1

(D) -1, -2, -2, 1

3. A car moving with a speed of 54 km/h takes a turn of radius 20 m. A simple pendulum is suspended from the ceiling of the car. Determine the angle made by the string of the pendulum with the vertical during the turning. (Take $g = 10 \text{ m/s}^2$)

(A) $\tan^{-1}(0.5)$

(B) $\tan^{-1}(0.75)$

(C) $\tan^{-1}(1.125)$

(D) $\tan^{-1}(0.25)$

4. A gas balloon is going up with a constant velocity of 10 m/s. When this balloon reached a height of 75 m, a stone is dropped from it and balloon keeps moving up with the same velocity. The height of the balloon when the stone hits the ground is _____ m. (Take $g = 10 \text{ m/s}^2$)

(A) 85

(B) 150

(C) 129

(D) 125

5. A thin biconvex lens is prepared from the glass ($\mu = 1.5$) both curved surfaces of which have equal radii of 20 cm each. Left side surface of the lens is silvered from outside to make it reflecting. To have the position of image and object at the same place, the object should be

placed, from the lens at a distance of _____ cm.

- (A) 10
 - (B) 12.5
 - (C) 13
 - (D) 13.5
-

6. Two identical bodies, projected with the same speed at two different angles cover the same horizontal range R . If the time of flight of these bodies are 5 s and 10 s, respectively, then the value of R is _____ m. (Take $g = 10 \text{ m/s}^2$)

- (A) 250
 - (B) 25
 - (C) 500
 - (D) 125
-

7. A solid cylinder having radius R and length L is slipping on a rough horizontal plane. At time $t = 0$ the cylinder has a translational velocity $v_o = 49 \text{ m/s}$, perpendicular to its axis and a rotational velocity $v_o/4R$ about the centre. The time taken by the cylinder to start rolling is _____ seconds. (coefficient of kinetic friction $\mu_k = 0.25$ and $g = 9.8 \text{ m/s}^2$)

- (A) 15
 - (B) 5
 - (C) 10
 - (D) 7.5
-

8. A liquid of density 600 kg/m^3 flowing steadily in a tube of varying cross-section. The cross-section at a point A is 1.0 cm^2 and that at B is 20 mm^2 . Both the points A and B are in same horizontal plane, the speed of the liquid at A is 10 cm/s . The difference in pressures at A and B points is _____ Pa.

- (A) 18
- (B) 144

(C) 36

(D) 72

9. A spherical liquid drop of radius R acquires the terminal velocity v_1 when falls through a gas of viscosity η . Now the drop is broken into 64 identical droplets and each droplet acquires terminal velocity v_2 falling through the same gas. The ratio of terminal velocities v_1/v_2 is _____.

(A) 4

(B) 0.25

(C) 32

(D) 16

10. One mole of diatomic gas having rotational modes only is kept in a cylinder with a piston system. The cross-section area of the cylinder is 4 cm^2 . The gas is heated slowly to raise the temperature by 1.2°C during which the piston moves by 25 mm. The amount of heat supplied to the gas is _____ J. (Atmospheric pressure = 100 kPa, $R = 8.3 \text{ J/mol} \cdot \text{K}$) (Neglect mass of the piston)

(A) 24.8

(B) 25

(C) 15.04

(D) 29.98

11. Initial pressure and volume of a monoatomic ideal gas are P and V . The change in internal energy of this gas in adiabatic expansion to volume $V_{final} = 27V$ is _____ J.

(A) $-2PV(3\sqrt{3} - 1)$

(B) $\frac{4}{3}PV$

(C) $-\frac{4}{3}PV$

(D) $\frac{3}{4}PV$

12. The frequency of oscillation of a mass m suspended by a spring is ν_1 . If the length of the

spring is cut to half, the same mass oscillates with frequency ν_2 . The value of ν_2/ν_1 is _____.

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

13. A monochromatic source of light operating at 15 kW emits 2.5×10^{22} photons/s. The region of an electromagnetic spectrum to which the emitted electromagnetic radiation belongs to _____. (Take $h = 6.6 \times 10^{-34}$ J.s and $c = 3 \times 10^8$ m/s)

- (A) Microwave
 - (B) Infrared
 - (C) Visible
 - (D) Ultraviolet
-

14. A current carrying circular loop of radius 2 cm with unit normal $\hat{n} = \frac{\hat{k} + \hat{i}}{\sqrt{2}}$ is placed in a magnetic field, $\vec{B} = B_0(3\hat{i} + 2\hat{k})$. If $B_0 = 4 \times 10^{-3}$ T and current $I = 100\sqrt{2}$ A, the torque experienced by the loop is _____ Wb.A. ($\pi = 3.14$)

- (A) $16 \times 10^{-5} \hat{k}$
 - (B) $5024 \times 10^{-7} \hat{k}$
 - (C) $5024 \times 10^{-7} \hat{i}$
 - (D) $5024 \times 10^{-7} \hat{j}$
-

15. A 30 cm long solenoid has 10 turns per cm and area of 5 cm^2 . The current through the solenoid coil varies from 2 A to 4 A in 3.14 s. The e.m.f. induced in the coil is $\alpha \times 10^{-5}$ V. The value α is _____.

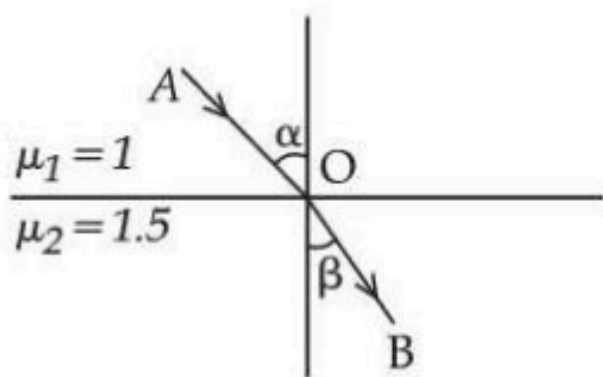
- (A) 60
- (B) 12
- (C) 120

(D) 34

16. Two point charges $q_1 = 3\mu\text{C}$ and $q_2 = -4\mu\text{C}$ are placed at points $(2\hat{i} + 3\hat{j} + 3\hat{k})$ and $(\hat{i} + \hat{j} + \hat{k})$ respectively. Force on charge q_2 is _____ N. (Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI Units)

- (A) $(12\hat{i} + 24\hat{j} + 24\hat{k}) \times 10^{-3}$
(B) $(4\hat{i} + 8\hat{j} + 8\hat{k}) \times 10^{-3}$
(C) $(3\hat{i} + 6\hat{j} + 6\hat{k}) \times 10^{-3}$
(D) $(-4\hat{i} - 8\hat{j} - 8\hat{k}) \times 10^{-3}$

17. Light ray incident along a vector $\vec{AO}(\vec{AO} = 2\hat{i} - 3\hat{j})$ emerges out along vector $\vec{OB}(\vec{OB} = C\hat{i} - 4\hat{j})$ as shown in the figure below. The value of C is _____.



- (A) 1.6
(B) 0.16
(C) 11.6
(D) 16

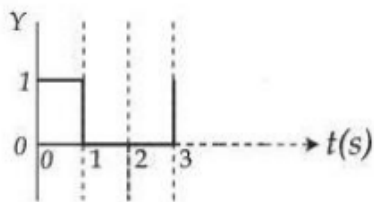
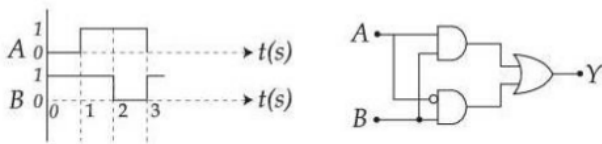
18. K_1 and K_2 be the maximum kinetic energies of photoelectrons emitted from a surface of a given material for the light of wavelength λ_1 and λ_2 , respectively. If $\lambda_1 = 2\lambda_2$ then the work function of material is given by :

- (A) $K_2 + 2K_1$
(B) $2K_2 - K_1$
(C) $K_1 - 2K_2$
(D) $K_2 - 2K_1$

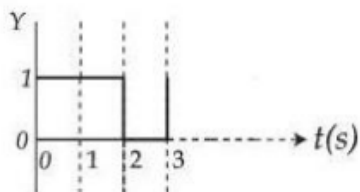
19. Two radioactive substances A and B of mass numbers 200 and 212 respectively, shows spontaneous α -decay with same Q value of 1 MeV. The ratio of energies of α -rays produced by A and B is _____.

- (A) $\frac{2548}{2650}$
 (B) $\frac{2706}{2646}$
 (C) $\frac{2597}{2600}$
 (D) $\frac{2862}{2499}$

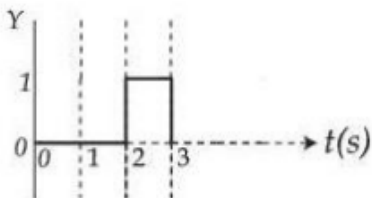
20. The output Y for the given inputs A and B to the circuit is :



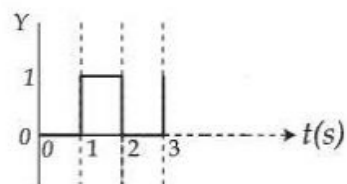
(A)



(B)



(C)



(D)

Physics Section - B

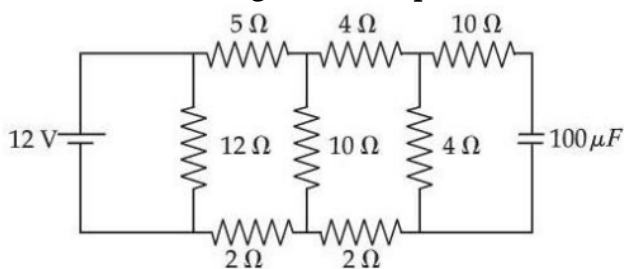
21. A parallel plate capacitor is having separation between plates 0.885 mm. It has a capacitance of $1\mu\text{F}$ when the space between the plates is filled with an insulating material of resistivity $1 \times 10^{13}\Omega\text{ m}$ and resistance $17.7 \times 10^{14}\Omega$. Relative permittivity of the insulating material is $\alpha \times 10^7$. The value of α is _____.

(Take permittivity of free space = $8.85 \times 10^{-12}\text{ F/m}$)

22. Some distant star is to be observed by some telescope of diameter of objective lens a , at an angular resolution of 3.0×10^{-7} radian. If the wavelength of light from the star reaching the telescope is 500 nm, the minimum diameter of the objective lens of the telescope is _____ cm. (nearest integer)

23. A 5 mg particle carrying a charge of $5\pi \times 10^{-6}\text{ C}$ is moving with velocity of $(3\hat{i} + 2\hat{k}) \times 10^{-2}\text{ m/s}$ in a region having magnetic field $\vec{B} = 0.1\hat{k}\text{ Wb/m}^2$. It moves a distance of α meter along $\hat{k}$ when it completes 5 revolutions. The value of α is _____.

24. The stored charge in the capacitor in steady state of the following circuit is _____ μC .



25. Two masses of 3.4 kg and 2.5 kg are accelerated from an initial speed of 5 m/s and 12 m/s, respectively. The distances traversed by the masses in the 5th second are 104 m and 129 m, respectively. The ratio of their momenta after 10 s is $\frac{x}{8}$. The value of x is _____.

