

2026

**PHYSICS**

(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

*All the questions are compulsory.*

*The figures in the right margin indicate full marks for the questions.*

*Question Nos. 1 to 10 are 'Multiple Choice Type' questions carrying 1 mark each. Choose the correct answer out of the four alternatives and rewrite the correct answer.*

1. The SI unit of co-efficient of viscosity is – 1
- (A)  $\text{N m}^{-2} \text{s}$  (B)  $\text{Pa s}^{-1}$   
(C)  $\text{N m s}^{-1}$  (D)  $\text{Kg m s}^{-1}$
2. A body is projected along a rough horizontal surface with an initial velocity of 20 m/s. Due to the frictional resistance, it comes to rest after 5 seconds. What is the distance travelled by the body before coming to rest. 1
- (A) 60 m (B) 50 m  
(C) 30 m (D) 40 m

P.T.O.

3. A man of mass 60kg stands on a weighing machine in a lift moving upward with an acceleration of  $2\text{m/s}^2$ . The reading on the machine (apparent weight) will be ( $g=10\text{m/s}^2$ ) – 1
- (A) 480N (B) 600N  
(C) 720N (D) 840N
4. The work done by a conservative force around a closed path is – 1
- (A) Maximum (B) Zero  
(C) Minimum (D) Infinite
5. What is the depth at which the value of acceleration due to gravity becomes  $\frac{1}{n}$  times the value at the surface of the earth? ( $R$  = radius of the earth) 1
- (A)  $\frac{R}{n}$  (B)  $\frac{R}{n^2}$   
(C)  $\frac{R(n-1)}{n}$  (D)  $\frac{Rn}{n-1}$
6. The modulus of rigidity (shear modulus) of an ideal liquid is – 1
- (A) infinity  
(B) some finite small non zero constant value zero  
(C) unity  
(D) zero

7. When the temperature of a gas is doubled (in Kelvin scale) while keeping its volume constant, the average speed of gas will – 1
- (A) Remain unchanged (B) Increase by a factor of 2  
(C) Increase by a factor of  $\sqrt{2}$  (D) Decrease by a factor of  $\sqrt{2}$
8. Which of the following function of time represent periodic motion? 1
- (A)  $\sin \omega t + \cos \omega t$  (B)  $e^{-i\omega t}$   
(C)  $e^{i\omega t}$  (D)  $\log \omega t$

**Question numbers 9 and 10 are Assertion (A) and Reason (R) type questions.**

Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.

- (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).  
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).  
(C) Assertion (A) is true, but Reason (R) is false.  
(D) Assertion (A) is false and Reason (R) is also false.
9. Assertion(A) : When a person is standing on a rotating disc about an axis perpendicular to its plane and he stretches out his arms horizontally, it is observed that his angular speed decreases. 1
- Reason (R) : When the hands are stretched outward, the moment of inertia increases, and to conserve angular momentum, the angular velocity decreases .

10. Assertion(A) : In a cyclic process, internal energy of a gas always increases. 1  
Reason (R) : In a cyclic process, final state does not coincide with the initial state.

*Question Nos. 11 to 17 are "Very Short Answer Type" questions carrying 1 mark each.*

11. What does the slope of a velocity- time graph represent ? 1
12. Draw the Force–Displacement graph for a body obeying the relation ( $F = kx$ ), where ( $k$ ) is a constant and ( $x$ ) is the displacement. 1
13. A solid disc of mass ( $M$ ) and radius ( $R$ ) is recast into a thin-walled hollow cylinder of the same mass and radius. Identify object will have the larger moment of inertia about its central axis by giving reason. 1
14. State Kepler's third law of planetary motion . 1
15. Explain why we cannot boil water easily inside a satellite around the earth in space. 1
16. When air is quickly pumped into a bicycle tire, it becomes warm. Why does the temperature of air increase? 1
17. Transverse waves cannot be produced in liquids and gases. Give reason. 1

*Question Nos. 18 to 27 are "Short Answer Type-II" questions carrying 2 marks each.*

18. Check correctness of the expression for the speed of sound in air medium by dimensional analysis .  $V = \sqrt{\frac{\gamma P}{\rho}}$  where  $p$  is atmospheric pressure and  $\rho$  is the density of air medium.  $\gamma =$  dimensionless constant . 2

19. A ball is dropped from a height of 100 m. Just before hitting the floor, its velocity becomes 40m/s. After bouncing, the ball loses  $\frac{1}{10}$  of its speed during the collision. Draw the speed–time graph of the ball for the time interval  $t = 0\text{s}$  to  $t = 7.6\text{s}$ . 2
20. What are the static and kinetic frictions? 2
21. Determine the maximum acceleration of the train in which a box lying on its floor will remain stationary, given that coefficient of static friction between the box and train floor is 0.15. (take  $g=10\text{m/s}^2$ ) 2
22. State any two characteristics of an elastic collision , showing how energy and momentum behave during such a collision. 2
23. A body of mass 6kg initially at rest, is acted upon by a constant force of 10 N. Calculate the kinetic energy gained by the body after 10 seconds of applying the force. 2
24. Establish the mathematical relationship between torque and angular momentum of a rotating body. 2
25. A uniform circular plate of radius ( R ) has a smaller circular portion of radius  $\left(\frac{R}{2}\right)$  cut out from its edge. Determine the position of the center of mass of the remaining portion of the plate with respect to the center of the original plate. 2
26. Find the root mean square (rms) velocity of nitrogen molecules at a temperature of  $15^\circ\text{C}$  and a pressure of 76 cm of Hg.(Given: Molar mass of nitrogen  $M = 28\text{g}$ , Gas constant  $R=8.3 \text{ J mol}^{-1}\text{K}^{-1}$  ) 2
27. Calculate the number of degrees of freedom of molecules of hydrogen in 1cc of hydrogen gas at NTP . 2

*Question Nos. 28 to 33 are "Short Answer Type-I" questions carrying 3 marks each.*

28. Obtain the expressions for the rectangular (Cartesian) components of a vector in terms of (x), (y) and (z) axes. 3
29. A bullet fired into a fixed target loses half of its velocity after penetrating 3cm. How much further will it penetrates before coming to rest assuming that its faces constant resistance to motion? 3
30. Derive the expression for the work done during the adiabatic expansion of an ideal gas in a closed system. 3
31. What is the density of ocean water at a depth where the pressure is 100 atm . Given that its density at the surface is  $1.03 \times 10^3 \text{ kg m}^{-3}$  ? Compressibility  $45.8 \times 10^{-11} \text{ pa}^{-1}$ ,  $1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$ . 3

*Or*

A 10kW drilling machine is used to drill a bore in a small aluminium block of mass 10 kg. How much is rise in the temperature of the block in 3 minutes assuming 50% of power is used up in heating the machine itself or lost to the surrounding. Specific heat of aluminium =  $0.91 \text{ Jg}^{-1} \text{ }^\circ\text{C}^{-1}$ . 3

32. A simple pendulum of length  $l$  and having a bob of mass  $m$  is suspended in a car . The car is moving on a circular track of radius  $R$  with a uniform speed  $v$  . If the pendulum makes small oscillation in a radial direction about its mean position . What will be its time period? 3

*Or*

An open pipe is suddenly closed at one ends with the result that frequency of third harmonic of closed pipe is found to be higher by 100Hz than the fundamental frequency of open pipe . What is the fundamental frequency of open pipe. 3

**Question number 33 is case-study based question . Read the case carefully and answer the questions that follow :**

33. Recently, on 7<sup>th</sup> September 2025, a lunar eclipse was observed on the day of full moon. Some people in a village avoided eating or cooking during the eclipse, believing it could bring ill effects. A young boy, who had studied about eclipses in science, knew that solar and lunar eclipses are natural celestial phenomena caused by the motion of the Earth, Moon, and Sun and have no harmful effects on living beings.

When he explained this to his mother, she ignored his reasoning and followed the traditional belief. On his way to a friend's house, he noticed people performing prayers and rituals to ward off the so-called "ill effects" of the eclipse. The boy felt disheartened at the superstitions and decided to study more about the scientific reason behind such phenomena. 1+1+1=3

- (i) Why do we not observe a lunar eclipse on every full moon day?
- (ii) Name the natural phenomenon caused by the gravitational force between the Earth and the Moon.
- (iii) The time period of Jupiter around the Sun is 10 years. Calculate its distance from the Sun, given that the Earth's distance from the Sun is R and its time period is 1 year.

**Or**

Ajay was always fascinated by the flights of airplanes and rockets. He often wondered how rockets could travel into space and not return, while everything he threw upward would always fall back due to Earth's gravitational pull. Curious about this, he discussed the matter with his elder brother, who explained that rockets are launched based on a scientific principle. When the rocket is projected with increasing speed, a point comes when its speed becomes high enough to overcome Earth's gravitational pull — this speed is called the escape velocity. At this speed, the rocket can move out of Earth's gravitational field and never return on its own. Understanding this concept inspired Ajay to dream of becoming an astronaut in the future.

1+1+1=3

- (i) What is escape velocity?
- (ii) State the principle of launching of satellite.
- (iii) Find the ratio of escape velocity to orbital velocity for a satellite revolving close to the earth's surface.

*Question Nos. 34 to 36 are "Long Answer Type" questions carrying 5 marks each.*

34. Using Newton's third law of motion prove the law of conservation of linear momentum for a system of two interacting particles. A 30 g bullet leaves a rifle with a velocity of 300m/s and rifle recoils with a velocity of 0.60m/s. Find the mass of the rifle.

4+1=5

*Or*

Derive the expression for the centripetal force acting on a particle of mass (m) moving with a velocity (v) in a circular path of radius (r). A stone 0.50 kg tied to the end of a string is whirled round in a circle of radius 2m with a speed of 50 rev/min in a horizontal plane, what is the tension in the string?

4+1=5

35. For steady, incompressible, non-viscous fluid flow along a streamline through variable cross section between different levels. Show how pressure, kinetic energy, and potential energy are related . 5

*Or*

Derive the expression for pressure at a depth (h) inside a liquid of density ( $\rho$ ) under gravity . Explain why an air bubble in water rises from the bottom to top and grow in size. 4+1=5

36. Draw a graph showing the variation of total energy of a spring, kinetic energy and potential energy with the displacement (position) from equilibrium. Derive the expression for the total energy of a particle executing simple harmonic motion (SHM). 1+4=5

*Or*

Draw a diagram for a transverse wave travelling on a string. Show that by using the diagram, the speed of a travelling wave on a stretched string is  $V = v\lambda$ , where symbol have their usual meaning. 1+4=5