

2023
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 'Very Short Answer' type questions carrying 1 mark each.

1. State the principle of homogeneity of dimensions. 1
2. Under what conditions average velocity of the body is equal to instantaneous velocity. 1
3. Draw position-time graphs of two objects with unequal velocities, showing the time of meeting. 1
4. What is the impulsive force? 1
5. Lubricants are used between the two parts of a machine. Why? 1

P.T.O.

6. How is angular momentum related to linear momentum? 1
7. State Hooke's law. 1
8. Write an equation that expresses the first law of thermodynamics in terms of heat and work. 1
9. What is Mean free path? 1
10. What is the minimum condition for a system to execute S.H.M.? 1

Question Nos. 11 to 20 are 'Short Answer Type-II' questions carrying 2 marks each.

11. In a system of units if force (F) acceleration (A) and time (T) are taken as fundamental units. Find the dimensional formula of energy. 2
12. Displacement of a particle is given by the expression $x = 3t^2 + 7t - 9$, where x is in meters and t is in seconds. What is acceleration? 2
13. If $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 7\hat{i} + 24\hat{j}$, find a vector having the same magnitude as \vec{B} and parallel to \vec{A} . 2
14. If angular momentum moment of inertia is decreased, will its rotational be also conserved? Explain. 2
15. Write two characteristics of gravitational force. 2

16. A refrigerator is to maintain eatables kept inside at 9°C . Calculate the coefficient of performance, if the room temperature is 33°C . 2
17. Write any two differences between isothermal and adiabatic process. 2
18. A particle executing S.H.M. has a maximum displacement of 4 cm and its acceleration at a distance of 1 cm from its mean position is 3 cms^{-2} . What will be its velocity when it is at a distance of 2 cm from its mean position ? 2
19. "Bats can ascertain distances, directions, nature and size of the obstacles without any eyes". Explain how ? 2
20. Draw a graph showing the variation of kinetic energy and potential energy with displacement of a particle executing S.H.M. 2

*Question Nos. 21 to 27 are 'Short Answer Type-I' questions
carrying 3 marks each.*

21. Obtain the expression for rectangular components of a vector. 3
22. Calculate the force required to move a train of 2000 quintal up on an incline plane of 1 in 50 with an acceleration of 2ms^{-2} . The force of friction per quintal is 0.5 N. 3
23. A ballet dancer is rotating about his own vertical axis on smooth horizontal floor. The moment of inertia of the dancer decreases by 20% when he folds himself close to his axis of rotation. Find the percentage change in his rotational kinetic energy. 3

24. Assuming the earth to be a sphere of uniform mass density, how much would a body weigh half way down to the centre of the earth if it weighed 250 N on the surface? 3
25. Which is more elastic rubber or steel? Explain. 3
26. Derive the relation between kinetic energy of ideal gas and temperature. 3
27. Show that time period of oscillation of a body attached to a horizontal spring depends upon the mass of the body and the spring constant of the spring. 3

Question Nos. 28 to 30 are 'Long Answer Type' questions carrying 5 marks each.

28. Derive the law of conservation of linear momentum from Newton's third law of motion. A 50 g bullet is fired from a 10 kg gun with a speed of 500 ms^{-1} . What is the speed of the recoil of the gun? 5

OR

Derive an expression for maximum speed of a car on a banked road in circular motion.

Find the angle through which a cyclist bends from the vertical, when he covers a circular path of 34.3 m circumference in $\sqrt{22}$ seconds. 5

29. State and prove work energy theorem analytically.

1+4=5

OR

Define potential energy. Derive an expression for potential energy of a stretched spring.

1+4=5

30. State and prove Bernoulli's theorem of a liquid having streamline flow. 1+4=5

OR

Define terminal velocity. Derive an expression for the terminal velocity of small body falling through a viscous liquid.

1+4=5

Question Nos. 31 to 34 are 'Multiple Choice Type' questions carrying 1 mark each. Choose the correct answer out of the four alternatives and rewrite the correct answer.

31. In a uniform circular motion, the angle between velocity vector and acceleration vector is –

1

(A) π

(B) $\frac{\pi}{4}$

(C) 2π

(D) $\frac{\pi}{2}$

32. The kinetic energy of an object of mass m moving with velocity of 5 m/s is 25 J .
What will be its kinetic energy when its velocity is doubled? 1

(A) 1000 J

(B) 125 J

(C) 100 J

(D) 12.5 J

33. Coefficient of volume expansion of mercury is $0.18 \times 10^{-3} \text{ }^\circ\text{C}^{-1}$. If the density of mercury at 0°C is 13.6 g/cc then its density at 200°C is – 1

(A) 13.11 g/cc

(B) 52.11 g/cc

(C) 16.11 g/cc

(D) 26.11 g/cc

34. A gas occupies a volume of 300 cc at 27°C and 620 mm pressure. The volume of gas at 47°C and 640 mm pressure is – 1

(A) 260 cc

(B) 310 cc

(C) 390 cc

(D) 450 cc