Mock Test-2

Time: 3 Hours **Max. Marks: 70**

General Instructions

(a) All questions are compulsory.
(b) There are 30 questions in total. Questions 1–8 carry one mark each, questions 9–18 carry two marks each, questions 19–27 carry three marks each and questions 28–30 carry five marks each.
(c) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each. You have to attempt only one of the given choices in such questions.
(d) Use of calculators is not permitted.

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1. Which is more elastic: water or air? Why?

2. Give the magnitude and direction of the net force acting on a stone of mass 0.1 kg just after it is dropped from the window of a train moving at a constant velocity of 36 km/hr ($g = 10 m/s^2$).

3. The radius of a sphere is measured to be (2.1 ± 0.5) cm. Calculate its surface area with error limits.

4. The speed of an object can never be negative. Why?

5. State the conditions necessary for a satellite to appear stationary.

6. An impulsive force of 100 N acts on a body for 1 s. What is the change in its linear momentum?

7. If the unit of force were kilonewton, that of time were millisecond, and that of power were kilowatt, what would be the units of mass and length?

8. What is the moment of inertia of a solid sphere about its diameter?

9. Standing is not allowed in a double-decker bus. Why?

10. A light body and a heavy body have the same momentum. Which one will have greater kinetic energy?

11. Explain how the first and second laws of motion are contained in the second law?

12. Apply the first law of thermodynamics to give the equation of state for: (a) an isochoric process, (b) an isothermal process.

13. A man of mass 70 kg stands on a weighing scale in a lift which is moving:

(a) upwards with a uniform speed of 10 m/s

(b) downwards with a uniform acceleration of 5 m/s^2

(c) upwards with a uniform acceleration of 5 m/s^2.

What would be the readings on the scale in each case?

14. A molecule in a gas container hits the wall with a speed of 200 m/s at an angle 30° with the normal and rebounds with the same speed. Is momentum conserved in the collision? Is the collision elastic or inelastic?

15. What force is required to stretch a steel wire of 1 cm^2 cross-section to double its length? (Take $Y = 2 \times 10^{11} Nm^{-2}$).

16. With what acceleration a should a box descend so that a block of mass M placed in it exerts a force $Mg/4$ on the floor of the box?

17. What is the ratio of the distance travelled by a body falling freely from rest in the 1st, 2nd, and 3rd second of its fall?

18. Three particles each of mass m are placed at the vertices of an equilateral triangle of side a. What are the gravitational field and gravitational potential at the centroid of the triangle?

19. A person standing on a road has to hold his umbrella at 60° with the vertical to keep the rain away. He throws away the umbrella, starts running at 20 ms^{-1} and finds that rain drops are hitting his head vertically. Find the speed of the rain drops with respect to: (a) the road, (b) the moving person.

20. What you mean by gravitational potential? Derive an expression for the gravitational potential on the surface of the Earth and find a point where the gravitational potential is zero.

21. What is the need for banking a road? Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ.

OR

Four particles of masses 1 kg, 2 kg, 3 kg and 4 kg are placed at the four vertices A, B, C, and D of a square of side 1 m. Find the position of the centre of mass of the four particles.

22. Obtain an expression for orbital velocity and time period of a satellite revolving around a planet.

23. A block of mass 10 kg is sliding on a surface inclined at an angle of 30° with the horizontal. Find the acceleration of the block ($\mu = 0.5$).

24. State the parallelogram law of vector addition. Find analytically the magnitude and direction of the resultant vector.

25. Show that the projection angle θ for a projectile launched from the origin is given by

$$\theta = \tan^{-1}\left(\frac{4H}{R}\right)$$

where H is the maximum height and R is the horizontal range of the projectile.

26. State the two theorems used to find moments of inertia. The moment of inertia of a solid sphere about its tangent is $(5/3)MR^2$, where M is its mass and R is its radius. Find the moment of inertia of the sphere about its diameter.

27. Define relative velocity of a body. Draw position – time graphs of two objects moving along a straight line, when their relative velocity is (a) zero and (b) non-zero.

28. (a) What do you mean by moment of force? Derive an expression for torque in polar co-ordinates.

(b) Find the unit vector perpendicular to each of the vectors $3\hat{i}+\hat{j}+2\hat{k}$ and $2\hat{i}-2\hat{j}+4\hat{k}$.

OR

Derive an expression for the work done during an isothermal expansion.

29. (a) Justify energy conservation in the case of vibration of a simple pendulum.

(b) Two springs have force constants K_1 and K_2 with $K_1 > K_2$. On which spring is more work done when they are stretched by the same force?

OR

(a) What do you mean by inelastic collision in one dimension? Show that there is loss of kinetic energy in inelastic collisions.

(b) A gun-shot traveling at the rate of 100 ms^{-1} is just able to pierce a plank 4 cm thick. What velocity is required to just pierce a plank 9 cm thick?

30. (a) Show that the path followed by a projectile fired horizontally is parabolic.

(b) Show that for two complementary angles of projection of a projectile thrown with the same velocity, the horizontal ranges are equal.

(c) For what angle of projection of a projectile is the horizontal range maximum?

OR

Derive an expression for the pressure due to an ideal gas.