Time: 2 Hour   Total Marks: 60

MCQ MULTIPLE CORRECT

1. A bullet of mass m fired at 30° to the horizontal leaves the barrel of the gun with a velocity v. The bullet hits a soft target at a height h above the ground while it is moving downward and emerges out with half the kinetic energy it had before hitting the target. Which of the following statements are correct in respect of bullet after it emerges out of the target?

    (a) The velocity of the bullet will be reduced to half its initial value.

    (b) The velocity of the bullet will be more than half of its earlier velocity.

    (c) The bullet will continue to move along the same parabolic path.

    (d) The bullet will move in a different parabolic path.

    (e) The internal energy of the particles of the target will increase.

2. If the sun and the planets carried huge amounts of opposite charges,

    (a) all three of Kepler's laws would still be valid.

    (b) only the third law will be valid.

    (c) the second law will not change.

    (d) the first law will still be valid.

3. Speed of sound waves in a fluid depends upon

    (a) directly on density of the medium.

    (b) square of Bulk modulus of the medium.

    (c) inversly on the square root of density.

    (d) directly on the square root of bulk modulus of the medium.

4. The rotation of earth about its axis is

    (a) periodic motion.

    (b) simple harmonic motion.

    (c) periodic but not simple harmonic motion.

    (d) non-periodic motion.

5. The displacement time graph of a particle executing S.H.M. is shown in Fig. Which of the following statement is/are true?

    (a) The force is zero at $t = \dfrac{3T}{4}$

    (b) The acceleration is maximum at $t = \dfrac{4T}{4}$

    (c) The velocity is maximum at $t = \dfrac{T}{4}$

    (d) The P.E. is equal to K.E. of oscillation at $t = \dfrac{T}{2}$

TRUE/FALSE

6. In an elastic collision of two bodies, the momentum and energy of each body is conserved.

All The Best!!!

      (a) True   **(b)** False

7. A scalar quantity is one that, can never take negative values.

  (a) True   **(b)** False

8. A scalar quantity is one that, does not vary from one point to another in space

  (a) True   **(b)** False

FILL IN THE BLANKS

9.   For solids with elastic modulus of rigidity, the shearing force is proportional to _____ while for fluids it is proportional to _____

10.   Viscosity of gases _____ with temperature, whereas viscosity of liquids ____ with temperature.

VERY SHORT DESC

11. Is stress a vector quantity?

12. An organ pipe of length L open at both ends is found to vibrate in its first harmonic when sounded with a tuning fork of 480 Hz. What should be the length of a pipe closed at one end, so that it also vibrates in its first harmonic with the same tuning fork?

13. A monkey climbs up a slippery pole for 3 seconds and subsequently slips for 3 seconds. Its velocity at time t is given by v(t) = 2t (3-t); 0< t < 3 and v (t)=–(t–3)(6–t) for 3 < t < 6 s in m/s. It repeats this cycle till it reaches the height of 20 m.
    (a) At what time is its velocity maximum?
    (b) At what time is its average velocity maximum?
    (c) At what time is its acceleration maximum in magnitude?
    (d) How many cycles (counting fractions) are required to reach the top?

14. Why is electrical power required at all when the elevator is descending? Why should there be a limit on the number of passengers in this case?

15. Two molecules of a gas have speeds of $9 \times 10^6 \text{ ms}^{-1}$ and $1 \times 10^6 \text{ m s}^{-1}$, respectively. What is the root mean square speed of these molecules.

SHORT DESC - 25 WORDS

16. When two bodies having temperatures T_1 and T_2 are brought in contact, then the temperature of this system may not be $\dfrac{(T_1 + T_2)}{2}$. Explain Why?

17. Show that the total linear momentum of an isolated system of interacting particles is conserved.

18. A child sits stationary at one end of a long trolley moving uniformly with a speed V on a horizontal floor. If the child gets up and runs about on the trolley in any manner, what is the speed of the CM of the (trolley + child) system?

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19. Establish the relation $\theta = \omega_0 t + \frac{1}{2} \alpha t^2$, where the letters have their usual meanings.

20. Show that the projection angle θ_0 for a projectile launched from the origin is given by

$$\theta_0 = \tan^{-1}\left(\frac{4H}{R}\right)$$

Where, H is the maximum height attained by the projectile and R is the range of the projectile.

MED DESC - 50 WORDS

21. In Millikan's oil drop experiment, what is the terminal speed of an uncharged drop of radius 2.0×10^{-5} m and density $1.2 \times 10^3 \, \text{kg m}^{-3}$. Take the viscosity of air at the temperature of the experiment to be 1.8×10^{-5} a-s. How much is the viscous force on the drop at that speed? Neglect buoyancy of the drop due to air.

22. The motion of a particle executing simple harmonic motion is described by the displacement function.
$$x(t) = A\cos(\omega t + \phi)$$
If the initial (t = 0) position of the particle is 1 cm and its initial velocity is a $\omega \, cm/s$, what are its amplitude and initial phase angle? The angular frequency of the particle is πs^{-1}. If instead of the cosine function, we choose the sine function to describe the SHM: $x = B\sin(\omega t + \alpha)$, what are the amplitude and initial phase of the particle with the above initial conditions?
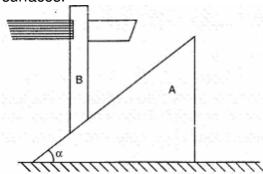
23. Find the components along the x, y, z-axes of the angular momentum $\vec{1}$ of a particle, whose position vector is with components x, y, z and momentum is $\vec{p}$ with components p_x, p_y and p_z. Show that if the particle moves only in the x-y plane the angular momentum has only a z-component.

24. What should be the maximum average velocity of water in a tube of diameter 0.5 cm. So that the flow is laminar? The viscosity of water is 0.00125 Nm^{-2} s

25. A steel tape 1m long is correctly calibrated for a temperature of 27.0°C. The length of a steel rod measured by this tape is found to be 63.0 cm on a hot day when the temperature is 45.0°C. What is the actual length of the steel rod on that day? What is the length of the same steel rod on a day when the temperature is 27.0°C?
Coefficient of linear expansion of steel = $1.20 \times 10^{-5} \, K^{-1}$.

LONG DESC - 100 WORDS

26. Air is streaming past a horizontal air plane wing such that its speed is $120 \, ms^{-1}$ over the upper surface and $90 \, ms^{-1}$ at the lower surface. If the density of air is $1.3 \, kg \, m^{-3}$, find the difference in pressure between the top and bottom of the wing. If using is 10 m long and has an average width of 2 m, calculate the gross lift of the wing.

27. Write the expression for the magnitude and direction of the resultant of two vectors inclined at an angle θ. Discuss special cases when values of θ is (i) 0°, (ii) 180° and (iii) 90°

28. Find the acceleration of rod B and wedge A in the arrangement shown in figure, if the ratio of the mass of wedge to that of rod equals n and there is no friction between any contact surfaces.

29. A star 2.5 times the mass of the sun and collapsed to a size of 12 km rotates with a speed of 1.2
rev. per second. (Extremely compact stars of this kind are known as neutron stars. Certain stellar objects called pulsars belong to this category). Will an object placed on its equator remain stuck to its surface due to gravity? (mass of the sun = 2×10^{30} kg).

30. A box of wood is placed on a 30° slope. If the coefficient of friction be 0.1, what is the downward acceleration of the wooden box?