(a) The displacement of a particle is given by the following wave equation :

$y = 7.5 \cos [5 \times 10^{-3}x + 10t + \pi/2]$

Find the (i) amplitude (ii) wave length (iii) wave velocity (iv) maximum particle velocity.

(b) A policeman on duty detects 15% drop in the frequency of the horn of a speeding car as it recedes away from him. If the speed of sound in air is 300 m/s, then find the speed of car.

Q26. (a) Write the theorem of parallel axis.

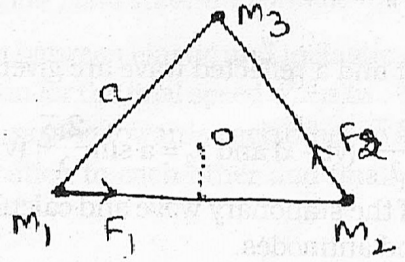
(b) Obtain the moment of inertia of a uniform disc of mass M and radius R about an axis passing from a distance of R/2 from the centre of disc and in the plane of the disc.

(c) A ring and disc start rolling from rest from the top of an incline simultaneously. Which of them will reach the foot of incline in a shorter time.

OR

(a) Two particles of masses 1kg and 3kg are located at $(2\hat{i} + 5\hat{j} + 13\hat{k})$ and $(-6\hat{i} + 4\hat{j} - 12\hat{k})$ respectively. Find the position of their centre of mass.

(b) Three point masses M_1, M_2 and M_3 are located at the vertices of an equilateral triangle of side 'a'. Forces F_1 and F_2 are applied on M_1 and M_2 as shown. Find the force F_3 needs to be applied on M_3 such that the net torque at the centroid of the triangle is zero.



SUBJECT : PHYSICS (SET-I)

Time : 3 Hrs. **M.M.: 70**

General Instructions :

(i) All questions are compulsory.

(ii) Question numbers 1 to 5 are very short answer type questions carrying 1 marks each.

(iii) Question numbers 6 to 10 are very short answer type questions carrying 2 marks each.

(iv) Question numbers 11 to 22 are short answer type questions carrying 3 marks each.

(v) Question numbers 23 is also a short answer type question carrying 4 marks.

(vi) Question numbers 24 to 26 are long answer type questions carrying 5 marks each.

(vii) You may use the following constants :

$G = 6.6 \times 10^{-11}\ Nm^2kg^{-2}$ $R_e = 6.4 \times 10^6\ m$

$M_e = 6 \times 10^{24}\ kg$ $R = 8.3\ J\ mol^{-1}K^{-1}$

Q1. A particle is executing SHM. Identify the position of the particle where PE = 0.

Q2. Explain why does a cyclist bends inward while riding along a curved road?

Q3. A ballet dancer streches her hand out for slowing down. Name the conservation law obeyed.

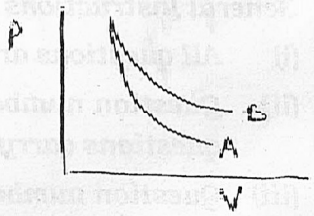
Q4. Two wires of length and radius (l, r) and (2l, 2r) of same material are stretched by equal forces. Which will have more Young's modulus?

Q5. A ball's momentum is doubled keeping its mass same. What happens to its KE?

Q6. If three non zero vectors $\bar{A}$, $\bar{B}$ and $\bar{C}$ are such that $\bar{A} \times \bar{B} = \bar{B} \times \bar{C} = 0$ then find the angle between $\bar{A}$ and $\bar{C}$.

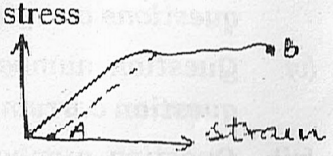
Q7. The change in the value of 'g' at a height h above the earth is same as at a depth d below the surface of earth. If h and d are small as compared to the radius of earth, then find the ratio h/d.

Q8. In the given diagram, curves A and B represent P-V diagrams for two processes. Justify that B represents isothermal processes and A represents adiabatic process.

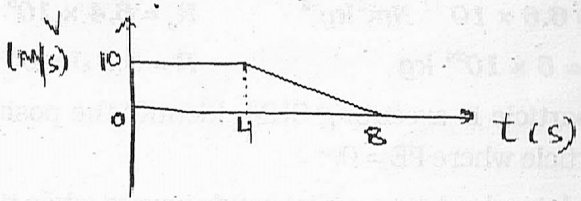


Q9. (a) Spring balance fails to give correct readings after long use. Why?

(b) Identify the properties denoted by points A and B in the following graph.

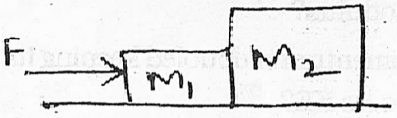


Q10. The adjoining figure shows v-t graph for an object of mass 2kg. What is the force on the object for (i) $0 < t < 4s$ (ii) $4s < t < 8s$.



OR

Consider the objects of mass m_1 and m_2 placed on a frictionless surface. A force F is applied on m_1. Calculate the (i) aceeleration and (ii) contact force between the two objects. (iii) what will happen to the acceleration when same force F is now aplied on M_2?



Q11. Using dimensions, check whether the given equations are correct or not. If incorrect, then correct the equations.

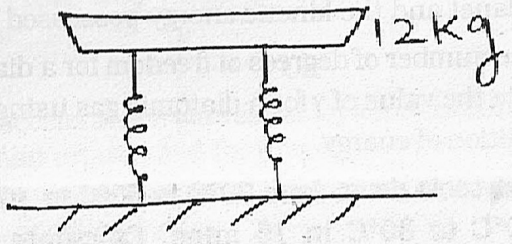
(a) $T^2 = \frac{4\pi^2 r^2}{G}$ where, T : time period of satellite, r : orbital radius G : Gravitational constant

(b) $m = \frac{m_0}{\left[1 - \frac{V^2}{C^2}\right]^{1/2}}$ where m : mass of an object; m_0 : rest mass of the object; V : speed of the obejct; C : speed of light

Q12. A particle undergoes SHM accordign to the equation : $x = A \sin 2\pi\nu t$. Find its velocity at a distance of $\frac{\sqrt{3}}{2}$ times the amplitude.

OR

A tray of mass 12kg is supported by two identical springs as shown. When the tray is gently pressed and released, it executes SHM with a time period of 1.5s. Find the spring constant of each spring. When a block of mass 'm' is placed on the tray, the time period of oscillations change to 3s. What is the mass of the block?



Q13. Two cars A and B are running at velocities of 60 km/hr and 45 km/hr respectively. Calculate the relative velocity of car A if : (i) they both are travelling eastwards (ii) Car A is travelling eastwards and Car B is travelling westwards (iii) Car A is travelling eastwards and Car B is travelling towards north.

Q14. Give reasons why -

(a) passengers are thrown forward from their seats when a moving bus suddenly stops.

(b) a cricketer moves his hands backwards while holding a catch.

(c) apparent weight of a person in a lift increases when lift accelerates upwards.

Q15. Derive a relation between the two specific heats of a gas on the basis of first law of thermodynamis.

Q16. State bernoullis theorem and hence prove that velocity of efflux is equal to that of a freely falling body

Q17. A planet of mass (m) orbits the sun of mass (M) in a circular orbit of radius (r). Obtain the expression for the time period of the planet and the kinetic energy possessed by it.

Q18. Write the number of degrees of freedom for a diatomic gas. Calculate the value of γ for a diatomic gas using the law of equipartition of energy.

Q19. Describe the essential parts of an ideal heat engine (carnot engine) and state the formula for its efficiency

Q20. Distinguish between elastic and inelastic collision. Derive an expression for the final speed when two bodies of masses m_1 and m_2, moving towards each other at speeds V_1 and V_2 collide and stick to each other and finally move together with speed V.

Q21. (a) Why do some liquids rise in a capillary tube?

(b) Derive the relation for the height upto which a liquid rises in a capillary tube.

(c) Give reason for the drop of level in mercury in a glass capillary tube.

Q22. (a) Draw a diagram to show various forces acting on a car moving on a rough circular track banked at an angle θ.

(b) A curve of radius 12cm is banked at an angle of 30°. What is its maximum speed of frictionless road.

Q23. While getting ready for school, Nikhil saw an inkspot on hiw washed uniform. He asked his mother about it. His mother said that I was unable to remove this inkspot even though I used extra detergent. Nikhil asked his mother to use hot water instead of cold water for washing.

(a) What values do you associate with Nikhil?

(b) Why does the hot water clean better than cold water?

(c) A light ring of radius 3.5 cm is lying on the surface of water of surface tension 0.07 N/m. Find the force required to lift the ring from the surface of water.

Q24. Derive an expression for the range of a projectile of mass 'm' projected upwards with speed 'u' at an angle θ wrt the horizontal. Also find the expression for the height attained by it. Prove that range is same for two complimentary angles.

OR

A car accelerates from rest at an acceleration α for time t_1, and than retards at β for time t_2 to come to rest. Draw the velocity-time graph for the car and hence find the maximum speed attained by the car and distance covered by it in terms of α, β and T where, T is the total time taken by the car.

Q25. An incident and a reflected wave are given as $y_1 = a \sin \frac{2\pi}{\lambda}(vt - x)$ and $y_2 = a \sin \frac{2\pi}{\lambda}(vt + x)$. Derive the equation of the stationary wave and calculate the position of nodes and antinodes.

OR