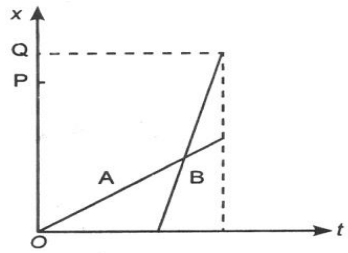
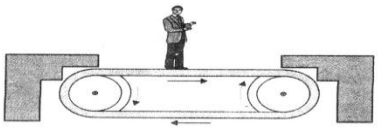
1. State Newton's Second Law of motion. Prove that second law is the real law of motion.
2. If linear momentum of a body increases by 50% ,what will be % increases in the kinetic energy of body?
3. Show that total mechanical energy of a free falling body remains constant throughout the fall.
4. The position-time ($x - t$) graphs for two children A and B returning from their school O to their homes P and Q respectively are shown in figure. Choose the correct entries in the brackets.
   a) (A/B) lives closed to the school than (B/A).
   b) (A/B) starts from the school earlier than (B/A).
   c) (A/B) walks faster than (B/A). (Any Two)



5. Establish the relation $x = xo + v_0 t + \frac{1}{2}at^2$ Using calculus method.
6. (i) Determine a unit vector which is perpendicular to both $\vec{A} = 2\hat{\imath} + \hat{\jmath} + \hat{k}$ and $\vec{B} = \hat{\imath} - \hat{\jmath} + 2\hat{k}$.

   (ii) Derive an equation for the distance covered by a uniformly accelerated body in n^{th} second of its motion.



7. (i) Figure shows a man standing stationary with respect to the horizontal conveyor belt that is accelerating with 1 m s^{-2}. What is the net force on the man? If the coefficient of static friction between the man's shoes and the belt is 0.2, up to what acceleration of the belt can the man continue to be stationary relative to the belt? (Mass of the man = 65 kg).
   (ii) Prove that the coefficient of static friction is "tangent" of the angle of repose.

8. (i) Find an expression for the work done against friction ,when a body is made to slide up an inclined plane.
   (ii) Discuss the conservation of energy in an elastic spring, also find the potential energy of spring.

9. (i) Derive an expression for kinetic energy of a body by calculus method. Deduce its relation with linear momentum also show it graphically.
   (ii) State and prove work – energy theorem.

10. (I)The force experienced by a mass moving with a uniform speed v in a circular path of radius r experienced a force which depends on its mass, speed and radius. Prove that the relation is $f = \frac{mv^2}{r}$.

    (II) A physical quantity Q is given by $Q = \frac{A^2 B^{\frac{3}{2}}}{C^{+4} D^{\frac{1}{2}}}$

    The percentage error in A, B, C, D are 1%, 2%, 4%, 2% respectively. Find the percentage error in Q.

11. The displacement (in meter) of a particle moving along x –axis is given by x = 18 t + 5 t^2. Calculate :
    i. the instantaneous velocity at t = 2s,
    ii. average velocity between t = 2s and t = 3s, and
    iii. Instantaneous acceleration.

12. What is meant by banking of roads? Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle Θ.The coefficient of friction between the wheels and road is μ.
13. (i) State the principle of homogeneity of dimensions. Test the dimensional homogeneity of the following equation : $h = h_0 + v_0 t + \frac{1}{2} gt^2$.

    (ii) A cricket ball of mass 150 g is moving with a velocity of 12 ms^{-1}, and is hit by a bat, so that the ball is turned back with a velocity of 20 ms^{-1}. The force of the blow acts for 0.01 second on the ball. Find the average force exerted by the bat on the ball.

14. (i) Why metal ball rebounds better than rubber ball?

    (ii)What are central forces? Are they conservative in nature?

    (iii)When the exchange of energy is maximum during an elastic collision?

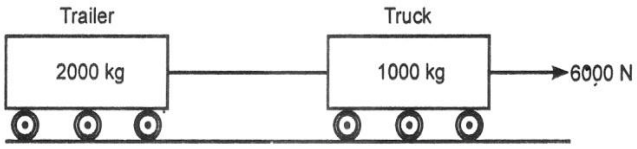
    Or

    Deduce the mathematical expression for centre for two elastic particles having masses m1 &m2

15. A body tied to one end of a string is made to resolve in a vertical circle. Derive the expression for the velocity of the body and tension in the string at any point. Hence find (a) tension at the bottom and the top of the circle (b) minimum velocity at the lowest point so that it just able to loop the loop and minimum velocity at the top.
16. Distinguish between static friction, limiting friction and kinetic friction. How do they vary with the applied force, explain by diagram.
17. (i) A tuck of mass 1000 kg is pulling a trailer of mass 2000 kg as shown. The retarding (frictional) force on the truck is 500 N and that on the trailer is 1000 N. The truck engine exerts a force of 6000 N. Calculate

    a) the acceleration of the truck and the trailer, and

    b) the tension in the connecting rope.

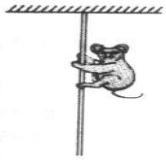


    (ii) A drunkard walking in a narrow lane takes 5 steps forward and 3 steps backward, followed again by 5 steps forward and 3 steps backward, and so on. Each step is 1 m long and requires 1 s. Determine how long the drunkard takes to fall in a pit 13 m away from the start.

18. (i) Deduce the expression of centripetal acceleration using position vectors.

    (ii) State parallelogram law of vector addition. Show that resultant of two vectors A and B inclined at an angle θ is $R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$.

19. A money of mass 40 kg climbs on a rope which can stand a maximum tension on 600 N. In which of the following cases will the rope break : the monkey
    (a) climbs up with an acceleration of 6 $\mathrm{m\ s}^{-2}$
    (b) climbs down with an acceleration of 4 $\mathrm{m\ s}^{-2}$



(c) climbs up with a an acceleration of 4 $\mathrm{m\ s^{-1}}$
(d) falls down the rope nearly freely under gravity?
(Ignore the mass of the rope.)

20. a) Show that there are two values of time for which projectile have same height . Also show sum of these two times is equal to total time of flight of projectile.
21. (i) Define friction.
(ii) Show that kinetic friction is less than the static friction.
(iii) Establish that static friction is a self-adjustable force.
(iv) Write the basic laws of limiting friction.
(v) Prove angle of friction equals to angle of repose.

22. Define projectile motion. Deduce mathematical expression for (a) Trajectory (b) Time of flight (c) Vertical height and (d) Horizontal range of angular projection.
23. Derive an expression for the velocity of the two masses $m_1$and m_2 moving with speeds u_1 and u_2 undergoing elastic in one dimension. Discuss all possible cases.
24. (i) Define friction.
(ii) Show that kinetic friction is less than the static friction.
(iii) Establish that static friction is a self-adjustable force.
(iv) Write the basic laws of limiting friction.
25. Consider a mass $'m'$ attatched t a string of length $'l'$ performing vertical circle. Find an expression for the
   i. velocity at any point,
   ii. tension at any point,
   iii. velocity minimum at the lower-mass point for a vertical circle.
26. What do you understand by friction? Discuss about static friction, limiting friction, kinetic friction and rolling friction.
27. Derive expression for velocity of a car on a banked circular road having coefficient of frictions. Hence write the expression for optimum velocity.
28. State Newton's Second Law of motion. Prove that second law is the real law of motion.
29. Explain :
   i. Why are ball bearings used in machinery?
   ii. Why does a horse have to apply more force to start a cart than to keep it moving?
   iii. What is the need for banking the tracks?
   iv. State two advantages and two disadvantages of friction.
30. A machine gun has a mass of 20 kg. It fires 35 g bullets at the rate of 400 bullets per second with a speed of 400 $\mathrm{ms^{-1}}$. What force must be applied to the gun to keep it in position?
31. Weights of 50 g and 40 g are connected by a string passing over a smooth pulley. If the system travels 2.18 m in the first 2 seconds, find the value of g.
32. A man capable of swimming with a velocity u in still water, wants to cross a river of which $'d'$ flowing with a velocity v. Find the angle in which he should be directed to reach at the exactly opposite point? To cross by the shortest time, in which direction, he should swim? What is the value of shortest time?
33. State parallelogram law of vector addition. Show that resultant of two vectors A and B inclined at an angle θ is $\mathrm{R} = \sqrt{\mathrm{A}^2 + \mathrm{B}^2 + 2\mathrm{AB}\cos\theta}$.

34. A passenger arriving in a new town whishes to go from the station to a hotel located 10 km away on a straight road from the station. A dishonest cabman takes him along a circular path 23 km long and reaches the hotel in 28 min. What is (a) the average speed of the taxi, (b) the magnitude of average velocity? Are the two equal ?
35. Show that range of projection of a projectile for two angles of a projection α and β is same where $\alpha + \beta = 90^{o}$.
36. Define the terms resultant or equivalent of two forces. Two forces F_1 and F_2 acting at an angle θ on a body simultaneously have a resultant F. Show that
$\theta = \cos -1\ [(F^2 - F_1^2 - F_2^2)/2F_1F_2]$
37. Define dot product of two vectors and give its geometrical interpretation.
38. There are two displacement vectors, one of magnitude 3 m and other of magnitude 4 m. How should the two vectors be added so that the magnitude of resultant vector.
39. Two particles are moving with common speed v such that they are always at a constant distance $'d'$ apart and their velocities are always equal and opposite. After what time, they turn to their initial positions?
40. Find a unit vector parallel to the vector $3\hat{\imath} + 7\hat{\jmath} + 4\hat{k}$.
41. A projectile is thrown at an angle of 60° with the horizontal. After how much time will its inclination with the horizontal be 45°? [Given $|\vec{v}|$ = 147 m/s]
42. Establish a relation between linear velocity and angular velocity ina uniform circular motion and explain the direction of linear velocity?
43. State polygon law of vectors and show that it can be deduced from triangle law of vectors.
44. Find the magnitude and direction of the resultant of two forces $\vec{P}$ and $\vec{Q}$ in terms of their magnitude and angle θ between them.
45. Find an expression for the maximum speed of circular motion of a car in a circular horizontal track of radius$'R'$. The coefficient of static friction between the car tyres and the road along the surface is μ_s.
46. In long jump, does it matters how high you jump? What factors determine the span of the jump?
47. Determine a unit vector which is perpendicular to both $\vec{A} = 2\hat{\imath} + \hat{\jmath} + \hat{k}$ and $\vec{B} = \hat{\imath} - \hat{\jmath} + 2\hat{k}$.
48. An object of mass m is moving in a circular path of radius R at a constant speed v. Obtain an expression for the magnitude of acceleration of the body.
49. An acceleration train is passing over a high bridge. A stone is dropped from the train at an instant when its speed is 10 m/s and acceleration is 1 m/s^2. Find the horizontal and vertical components of the velocity and acceleration of the stone one second after it is dropped. Take g = 10 m/s^2
50. A projectile is projected with velocity u making an angle θ with horizontal direction, find :
(a) time of flight (b) horizontal range
51. Derive the three motion equations of motion by calculus method. Express conditions under which they can be used.
52. (a) With the help of a simple case of an object moving with constant velocity show that the area under velocity show that the area under velocity-time cure represents the displacement over a given time interval.
(b) Establish the relation $x = v_0t + \frac{1}{2}at^2$ graphically.
(c) A car moving with a speed of 126 km/h is brought to a stop within a distance of 200 m. Calculate the retardation of the car and the time required to stop it.
53. Draw velocity-time graph of uniformly accelerated motion in one dimension. From the velocity time graph of uniform accelerated motion, deduce the equation of motion in distance and time.

54. A point object is thrown vertically upwards at such a speed that it returns to the thrower after 6 second. With what speed was it thrown up and how high did it rise? Plot speed time graph for the object and use it to find the distance travelled by it in the last second of its journey.
55. Derive an equation for the distance covered by a uniformly accelerated body in n^{th} second of its motion. A body travels half its total path in the last second of its fall from rest. Calculate the time of its fall.
56. A ball is dropped from a height of 90 m on a floor. At each collision with the floor, the ball loses one-tenth of its speed. Plot the speed-time graph of its motion between t = 0 to 12 s.
57. A physical quantity Q is given by

$$Q = \frac{A^2 B^{\frac{3}{2}}}{C^{+4} D^{\frac{1}{2}}}$$

The percentage error in A, B, C, D are 1%, 2%, 4%, 2% respectively. Find the percentage error in Q.

58. Answer the following :

a) You are given a thread and a metre scale. How will you estimate the diameter of the thread?

b) A screw gauge has a pitch of 1.0 mm and 200 divisions on the circular scale. Do you think it is possible to increase the accuracy of the screw gauge arbitrarily by increasing the number of divisions on the circular scale?

c) The mean diameter of a thin brass rod is to be measured by vernier calipers. Why is a set of 100 measurements of the diameter expected to yield a more reliable estimate than a setoff 5 measurements onl

59. Assuming that the mass (m) of the largest stone that can be moved by a flowing river depends only upon the velocity v, the density ρ of water and the acceleration due to gravity g. Show that m varies, with the sixth power of the velocity of the flow.
60. The time of oscillation (t) of a small drop of liquid under surface tension depends upon the density ρ, radius r and surface tension (σ).

    Prove dimensionally that $t \propto \sqrt{\frac{\rho r^3}{\sigma}}$.
61. Liquid is flowing steadily through a pipe. Assume that the volume of the liquid flowing out per second depends on (a) the coefficient of velocity of the liquid (η) (b) the radius of the pipe (r) and (c) the pressure gradient along the pipe (pressure gradient is drop in pressure per unit length of the pipe, and is equal to P/l, where P is the difference between the ends of the pipe and l is the length of the pipe). The dimensions of viscosity is $[ML^{-1}T^{-1}]$. Deduce by the method of dimensions, the formula for the volume of the liquid flowing out per second.
62. The factors affecting the tgime period of a simple pendulum are mass, length and the acceleration due to gravity. Deduce a relation for the time period of a simple pendulum.
63. The length, breadth and thickness of a rectangular sheet of metal are 4.234 m, 1.005 m and 2.01 cm respectively. Calculate the surface area and volume of the sheet to correct significant figures.