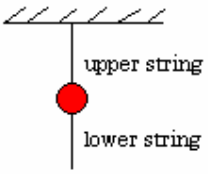
5. LAWS OF MOTION

1. In principle, a force is measured by measuring the _____.

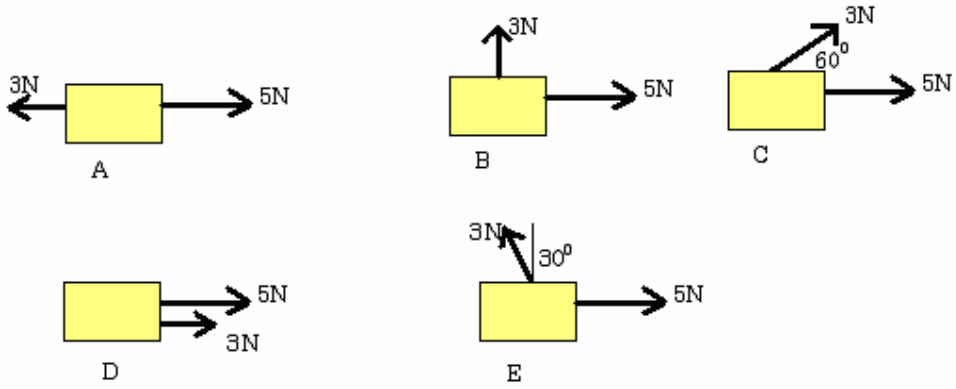
2. Which of the following quantities is not a vector?
mass, displacement, weight, acceleration, momentum, impulse, force, centripetal acceleration, angular velocity, tension, coefficient of friction.

3. Define one Newton.
4. Write the dimensional formula for impulse. State its SI unit.
5. A heavy ball is suspended as shown. A quick jerk to the lower string will break the string but a slow pull on the lower string will break the upper string. This occurs because: (choose correct option)

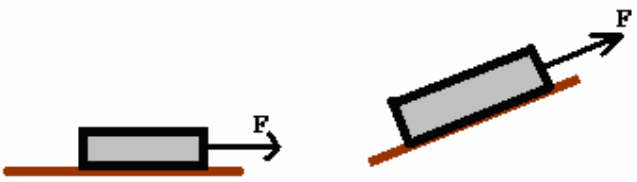


(i) the force is too small to move the ball
(ii) Action and reaction
(iii) the ball has inertia
(iv) air friction holds the ball back
(v) The ball has too much energy

6. Two forces, one with a magnitude of 3 N and the other of 5 N are applied to an object. Find the acceleration of a mass 1 kg for each of the following orientations of forces.



7. A heavy wooden block is dragged by an F along a rough plate. The applied force is same in each case. Mark the normal force and frictional force in each case. Coefficient of static frictions is μ_s



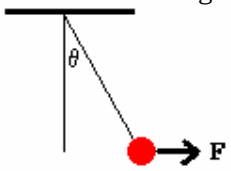
8. A car travels north at a constant velocity of 50 m/s. What is the net force on the car?

9. A 0.20 kg ball is thrown at an angle of 30° above the horizontal with an initial speed of 25 m/s. What is the net force on the ball at its highest point?

10. In a tug-of war, two men each pull on the rope with 15 kgf, in opposite directions. What is the tension in the rope?

11. A crane operator lowers a 4000 kg steel ball with a downward acceleration of 2 m/s^2. What is tension in the cable?

12. A 1 kg pendulum bob is held at an angle θ from the vertical by a 2 kgf horizontal force as shown. What is the tension in the string supporting the bob?

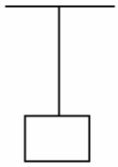


13. A man is standing on a weighing machine in an elevator. Of the following, when does the scale show the highest reading?
    (i) when elevator moves upward with increasing speed
    (ii) when elevator moves upward with decreasing speed
    (iii) when elevator remains stationary
    (iv) moves downward with increasing speed
    (v) moves downward at constant speed.

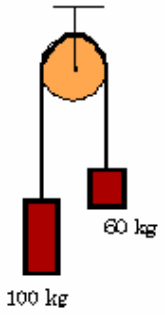
14. A block slides down a frictional plane which makes an angle of 30° with the horizontal. What is the acceleration of the block?

15. A lead block is suspended from your hand by a string. The reaction of the force of gravity on the block is the force exerted by the:

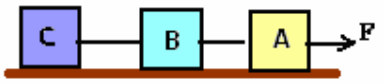
    (i) string on the block
    (ii) block on the string
    (iii) string on the hand
    (iv) hand on the string
    (v) block on the earth.



16. Two blocks are connected by a string that passes over a massless pulley as shown. Find tension in the string and acceleration of each block.



17. Three blocks each having mass M, are connected by strings as shown. Find net force acting on the block B.



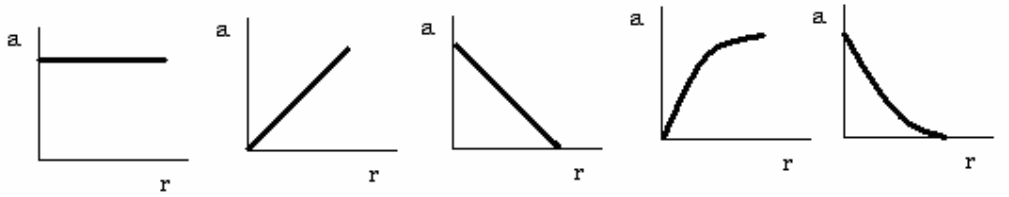
18. Two blocks (m and M) are pushed along a horizontal surface by a horizontal force $\vec{F}$. The magnitude of the force that either of these blocks exerts on the other is:
(Hint: find the acceleration,a; then look at the forces acting on M and put the net force equal to mass, M times its acceleration)

(i) mF/(m+M)
(ii) mF/M
(iii) mF(M-m)
(iv) MF/ (M+m)

19. Three books (X,Y and Z) rest on a table. The weight of each book is given. Find the net force acting on book Y.*(Hint: think of the acceleration of Y and then put net force = ma)*

20. A car rounds a 75 m – radius at a constant speed of 18 m/s. A ball is suspended by a string from the ceiling of the car and moves with the car. Find the angle between the string and the vertical.

21. Which of the following graphs is correct for a particle moving in a circle of radius *r* at a constant speed of 10 m/s?



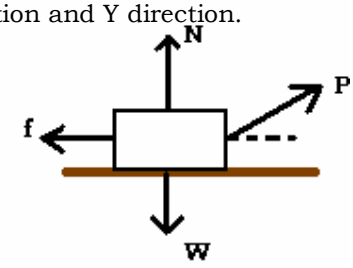
22. An object moves in a circle. If the radius is doubled, keeping the speed the same, how does the centripetal force vary?

23. An object of mass m and another of mass 2m are forced to move along a circle of radius 1.0 m at a constant speed of 1.0 m/s. Find the ratio of the magnitudes of their acceleration.

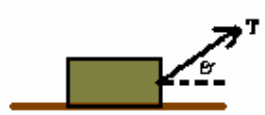
24. Define coefficient of static friction and coefficient of kinetic friction.

    On what factors does the frictional force depend?

25. A boy pulls a wooden box along a rough horizontal floor at a constant speed by means of a force $\vec{P}$. List all the forces acting along X direction and Y direction.
W = weight, f = friction, N : normal



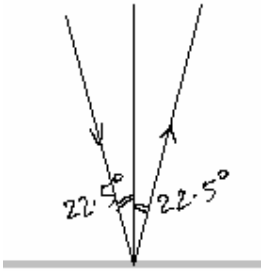
26. A block of mass m is pulled at constant velocity along a rough horizontal floor by an applied force $\vec{T}$ as shown. Draw the frictional force on the diagram, find its magnitude



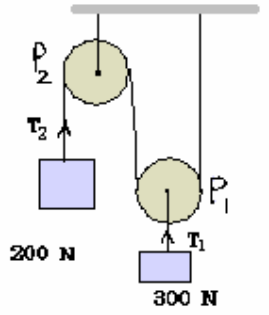
(i) T cos θ
(ii) T sin θ
(iii) zero
(iv) mg
(v) mg cos θ

27. A 50 N force is applied to a crate on a horizontal rough floor, causing it to move horizontally. If the coefficient of kinetic friction is 0.50, in what direction should the force be applied to obtain greatest acceleration?

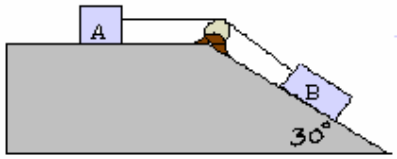
28. A batsman deflects a ball by an angle as shown in the figure, without changing its initial speed, which is equal to 54km/h. what is the impulse imparted to the ball? Mass of the ball is 0.15kg.



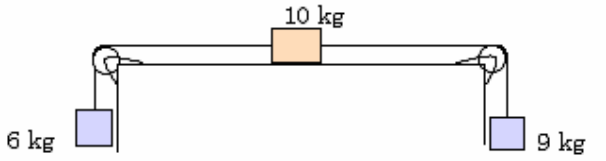
29. The weights are 200 and 300 N. The pulleys are essentially frictionless. Pulley P_1 has a stationary axle and pulley P_2 is free to move up and down. Find tensions T_1 and T_2 and acceleration of each body.



30. Two boxes have identical masses of 40 kg each. Both experience sliding friction with μ = 0.15. Find acceleration of the boxes and tension in the chord.

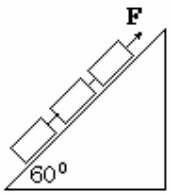


31. Three blocks with masses 6 kg, 9 kg and 10 kg are connected as shown in fig. The coefficient of friction between the table and 10kg block is 0.2. Find

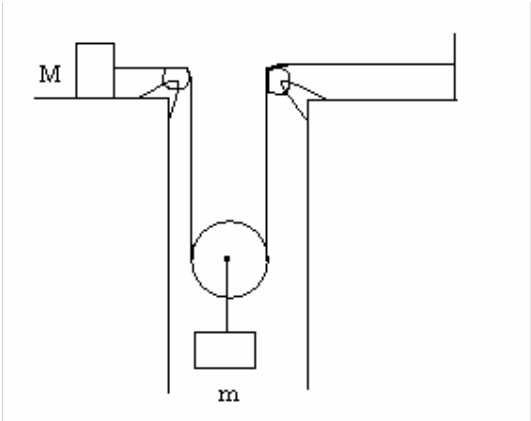


(a) acceleration of the system
(b) tensions in the chord on the left and in the chord on the right.

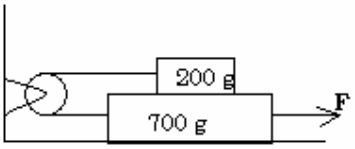
32. Three blocks of masses 2.0, 4.0 and 6.0 kg are arranged in the order lower, middle and upper respectively and are connected by strings on a frictionless inclined plane of 60°. A force of 120 N is applied upward along the incline to the uppermost block, causing an upward movement of the blocks. The connecting chord is light, what is acceleration of the blocks?



33. When m is 3.0 kg, the acceleration of the block is 0.6 m/s^2, while a = 1.6m/s^2 if m = 4.0 kg. Find frictional force on block M as well the mass. Neglect the mass and friction of the pulleys.



34. How large must F be to give the 700 g block acceleration of 30cm/s^2? The coefficient of friction between the two blocks and also between block and table is 0.150.



35. A certain car of mass m has a maximum frictional force of 0.7 mg between it and pavement as it rounds a curve on a flat road (μ = 0.7). How fast can the car be moving if it is to successfully negotiate a curve of 15 m radius?

36. A boy on a bicycle pedals around a circle of 22 m radius at a speed of 10 m/s. The combined mass of the boy and the bicycle is 80kg

    (a) What is the centripetal force exerted by the pavement on the bicycle?
    (b) What is the upward force exerted by the pavement on the bicycle?
    (c) What is the angle that the bicycle makes with the vertical?