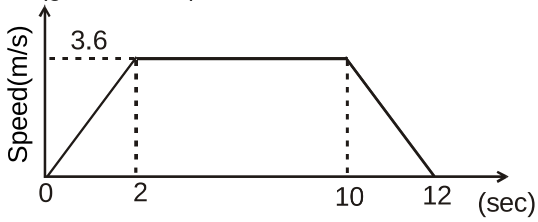
High Level Problems (HLP)

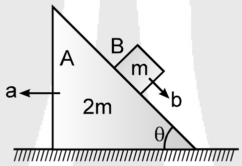
1. A lift is going up. The total mass of the lift and the passengers is 150 kg. The variation in the speed of the lift is given in the graph. (g = 9.8 m/s^2)



(a) What will be the tension in the rope pulling the lift at t equal to
(i) 1 sec (ii) 6 sec and (iii) 11 sec ?
(b) What is the height through which the lift takes the passengers ?
(c) What will be the average velocity and average acceleration during the course of entire motion?

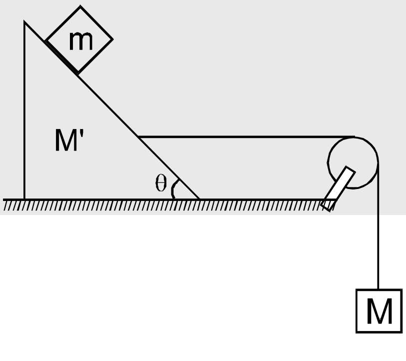
[IIT 1976]

2. The system shown in figure is released from rest calculate the value of acclerations 'a' and 'b'. (Where b is w.r.t. to A)



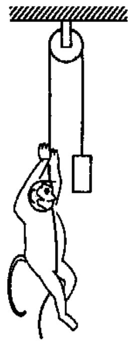
3. A person is standing on a weighing machine placed on the floor of an elevator. The elevator stars going up with some acceleration, moves with uniform velocity for a while and finally decelerates to stop. The maximum and the minimum weights recorded are 80.5 kg and 59.5 kg. Assuming that the magnitudes of the acceleration and the deceleration are the same, find (a) the true weight of the person and (b) the magnitude of the acceleration. Take g = 10 m/s^2.

4. What will be the value M of the hanging block as shown in the figure which will prevent the smaller block from slipping over the triangular block. All the surface are frictionless and the string and the pulley are light.

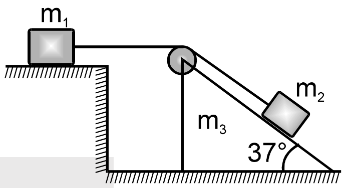


5. A monkey of mass 15 kg is climbing on a rope with one end fixed to the ceiling .If it wishes to go up with an acceleration of 1 m/s^2, how much force should it apply to the rope? If the rope is 5m long and the monkey starts from rest, how much time will it take to reach the ceiling ?

6. Figure shown a monkey is climbing on a rope that goes over a smooth light pulley and a block of equal mass hanging on the other end. Show that the monkey and the block move in the same direction with equal acceleration, whatever force the monkey exerts on the rope. If intially both were at rest, their separation will not change as time passes.



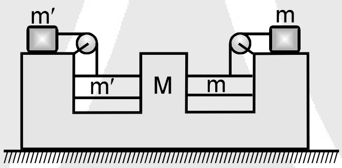
7. In the arrangement shown in Fig, a wedge of mass m_3 = 3.45 kg is placed on a smooth horizontal surface. A small and light pulley is connected on its top edge, as shown. A light, flexible thread passes over the pulley. Two blocks having mass m_1= 1. 3 kg and m_2= 1.5 kg are connected at the ends of the thread. m_1 is on smooth horizontal surface and m_2 rests on inclined surface of the wedge. Base length of wedge is 2 m and inclination is 37^0. m_2 is initially near the top edge of the wedge. If the whole system is released from rest. Calculate:



(i) velocity of wedge when m_2 reaches its bottom

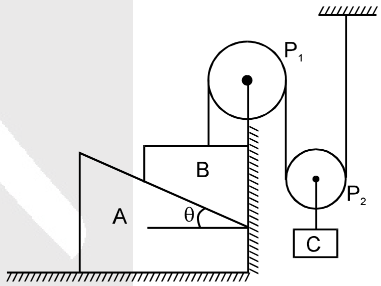
(ii) velocity of m_2 at that instant and tension in the thread during motion of m_2. All the surfaces are smooth. [g = 10 ms^{-2}]

8. Neglecting friction every where, find the acceleration of M. Assume m > m′.

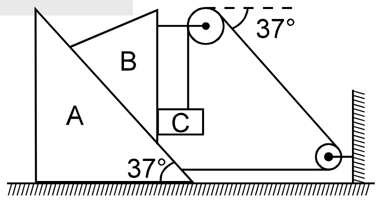


9. In the figure shown P_1 and P_2 are massless pulleys. P_1 is fixed and P_2 can move. Masses of A, B and C are $\frac{9m}{64}$, 2m and m respectively. All contacts are smooth and the string is massless. $\theta = \tan^{-1}\left(\frac{3}{4}\right)$.

Find the acceleration of block C in m/s^2.



10. A system is shown in figure. All contact surfaces are smooth and string is tight & inextensible. Wedge 'A' moves towards right with speed 10 m/s & velocity of 'B' relative to 'A' is in downward direction along the incline having magnitude 5m/s. Find the horizontal and vertical component of velocity of Block 'C'.



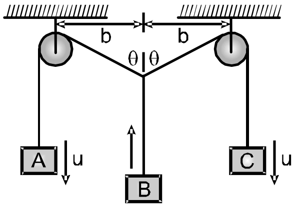
11. An object of mass 2 kg is placed at rest in a frame (S_1) moving with velocity $10\hat{i}+5\hat{j}$ m/s and having acceleration $5\hat{i}+10\hat{j}$ m/s^2. This object is also seen by an observer standing in a frame (S_2) moving with velocity $5\hat{i}+10\hat{j}$ m/s.

(i) Calculate 'Pseudo force' acting on object. Which frame is responsible for this force.

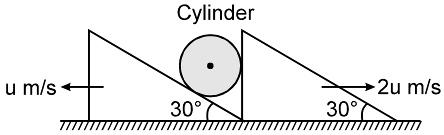
(ii) Calculate net force acting on object with respect to S_2 frame.

(iii) Calculate net force acting on object with respect to S_1 frame.

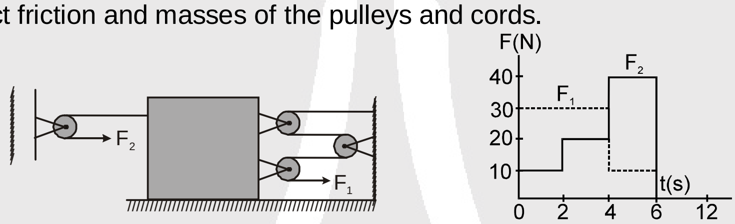
12. In the figure shown the blocks A & C are pulled down with constant velocities u . Find the acceleration of block B.



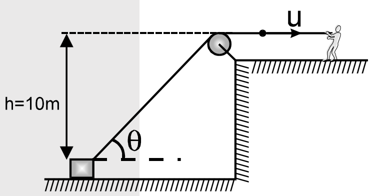
13. System is shown in the figure. Assume that cylinder remains in contact with the two wedges. Find the velocity of cylinder.



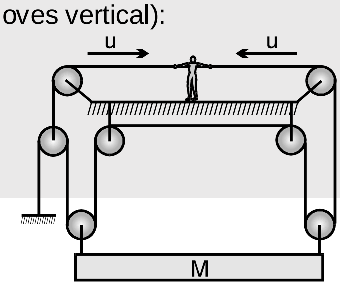
14. The 40 kg block is moving to the right with a speed of 1.5 m/s when it is acted upon by the forces F_1 and F_2. These forces vary in the manner shown in the graph. Find the velocity (in m/s) of the block at t = 12 s. Neglect friction and masses of the pulleys and cords.



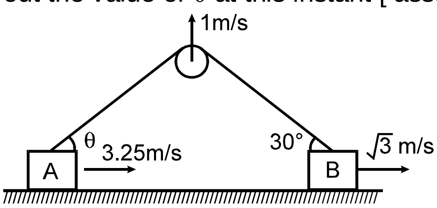
15. In the figure shown, a person pulls a light string with a constant speed u = 10 m/s. The other end of the string is tied to a very small block which moves on a smooth horizontal surface. The block is initially situated at a distance from the pulley which is very large in comparison to h. Find the angle 'θ' when the block leaves the surface. Take g = 10 m/s^2.



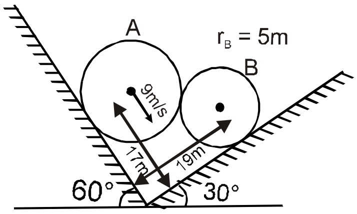
16. System is shown in the figure and man is pulling the rope from both sides with constant speed ' u'. Then find the speed of the block. (M moves vertical):



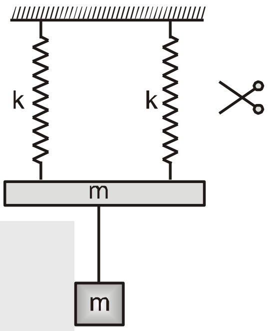
17. In the figure shown, find out the value of θ at this instant [assume string to be tight]



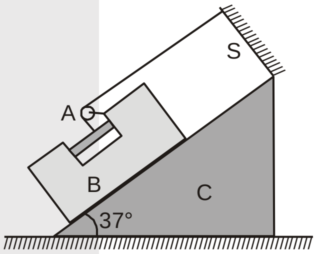
18. System is shown in the figure. Velocity of sphere A is 9 m/s. Find the speed of sphere B.



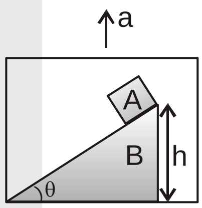
19. System shown in figure is in equilibrium. Find the magnitude of change in tension in the string just before and just after, when one of the spring is cut. Mass of both the blocks is same and equal to m and spring constant of both springs is k. (Neglect any effect of rotation)



20. In the figure shown C is a fixed wedge. A block B is kept on the inclined surface of the wedge C. Another block A is inserted in a slot in the block B as shown in figure. A light inextensible string passes over a light pulley which is fixed to the block B through a light rod. One end of the string is fixed and other end of the string is fixed to A.S is a fixed support on the wedge. All the surfaces are smooth. Masses of A and B are same. Then find the magnitude of acceleration of A. (sin 37º = 3/5)



21. A lift is moving upwards with a constant acceleration a = g. A small block A of mass ' m ' is kept on a wedge B of the same mass ' m '. The height of the vertical face of the wedge is ' h'. A is released from the top most point of the wedge. Find the time (in second) taken by A to reach the bottom of B. All surfaces are smooth and B is also free to move. If h = 4m, θ = 30° and g = 10m/s^2



HLP Answers

1. (a) (i) 1740 N (ii) 1470 N (iii) 1200 N (b) 36 m (c) Average velocity = 3 m/s; Average acceleration = 0

2. $a = \frac{b\cos\theta}{3}$; $b = \frac{3g\sin\theta}{3-\cos^2\theta}$ **3.** 70 kg and 1.5 m/s^2 **4.** $\frac{M'+m}{\cot\theta-1}$ **5.** 165 N, $\sqrt{10}$ s

7. **(i)** 2 ms^{-1} **(ii)** $\sqrt{13}$ ms^{-1}, 3.9 Newton **8.** $a = \frac{(m-m')g}{2M+3m+3m'}$ **9.** 3m/s^2 upwards

10. Horizontal component of velocity is 14 m/sec and vertical component of velocity is 26 m/sec.

11. (i) F = $-10\hat{i}-20\hat{j}$ N, Due to acceleration of frame s_1 (ii) $10\hat{i}+20\hat{j}$ N (iii) zero.

12. $\frac{u^2}{b}\tan^3\theta$ **13.** $\sqrt{7}u$ m/s **14.** 12 m/s. **15.** $\theta = \frac{\pi}{4}$ **16.** $\frac{3u}{4}$

17. $\tan^{-1}\frac{3}{4}$ **18.** 12 m/s **19.** $\frac{mg}{2}$ **20.** $\frac{4\sqrt{2}}{3}$ m/s **21.** 1