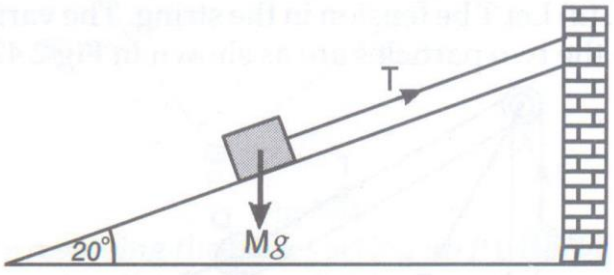
Laws of Motion

1. A rope passes overs pulley, which is sufficiently high. Two monkeys of equal weights climb the rope from opposite ends, one of them climbing quickly than the other, relative to the rope. Which of the monkeys will reach the top first? Assume that pulley is weightless, while rope is weightless as well as in inextensible.

2. A massless rope is passed over a frictionless pulley. A monkey holds on to one end of the rope and a mirror having the same weight as the monkey, is attached to the other end of the rope at the monkey's level. Can the monkey get away from his image seen in the mirror:

   (a) by climbing up the rope (b) by climbing down the rope (c) by releasing the rope

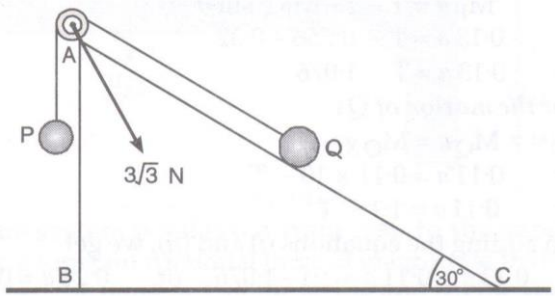
3. A block of mass 8kg is at rest on plane inclined at 20^o to the horizontal. The block is connected to a vertical wall at the top of the plane by a string. The string is taut and parallel to a line of greatest slope of the plane.



   (a) Given that the tension in the string is 13N, find the frictional and normal components of the force exerted on the block by the plane.

   (b) The string is cut; the block remains at rest, but is on the point of slipping down the plane. Find the coefficient of friction between the block and the plane. **[(a)f =14.36N, R=75.18N,(b) 0.364]**

4. A small smooth pulley is fixed at the highest point A of a cross-section ABC of a triangular prism with $\angle ABC = 90^0$ and $\angle BCA = 30^0$. The prism is fixed with the face containing BC in contact with a horizontal surface. Particles P and Q are attached to opposite ends of a light inextensible string, which passes over the pulley. The particles are in equilibrium with P hanging vertically below the pulley and Q in contact with AC.



   The resultant force exerted on the pulley by the string is $3\sqrt{3}$ N.

   (a) Show that the tension in the string is 3N.

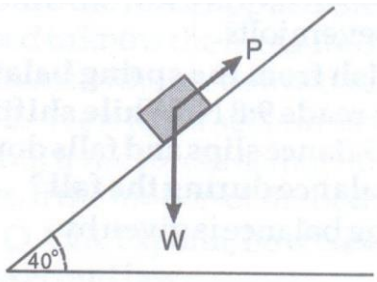
   (b) The coefficient of friction between Q and the prism is 0.75. Given that Q is in limiting equilibrium and on the point of moving upwards, find its mass. **[0.261kg]**

5. (a) Describe how a man weighing 980 N might be able to slide down a rope that can support a weight of only 755 N.

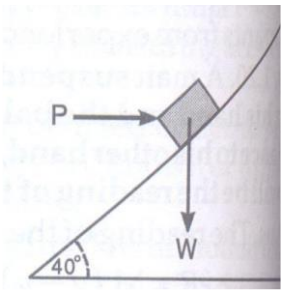
   (b) What is the least acceleration, he can have without breaking the rope?

   (c) What will be his minimum velocity after sliding 8m? **[(b) $2.25 ms^{-2}$, (c) $6 ms^{-1}$]**

6. A small block of weight 12N is at rest on a smooth plane inclined at 40o to the horizontal. The block is held in equilibrium by a force of magnitude P. Find the value of P when



(i) The force is parallel to the plane

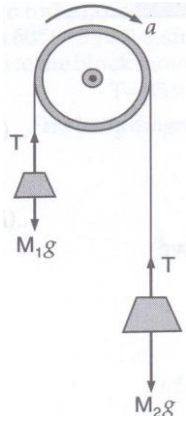


(ii) Force is horizontal

[(i) 7.71N (ii) 10.07N]

7. Two masses 7kg and 12kg are connected at the two ends of a light inextensible string that passes over a frictionless pulley. Find the acceleration of the masses and the tension in the string, when the masses are released.

[2.58ms^{-2}, 86.6N]



8. A horizontal force of 500 N pulls two masses 10kg and 20 kg (connected by a frictionless table) connected by a light string. What is the tension in the string? Does the answer depend on which mass end the pull is applied?

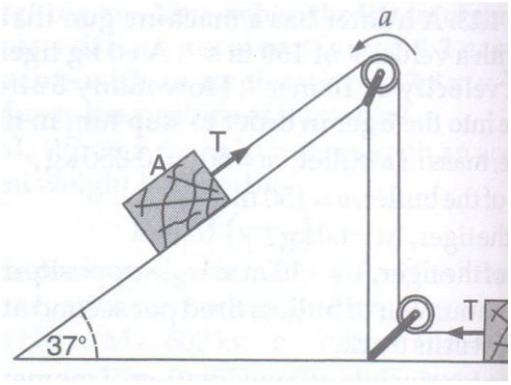
9. Two blocks each having mass 20kg, rest on a frictionless surface as shown. Assuming the pulleys to be light and frictionless, calculate

(i) acceleration of the system

(ii) tension in the string

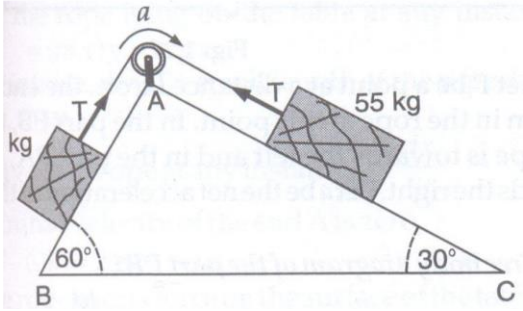
(iii) time required for block A to move 1m down the plane.

[(i) 2.95ms^{-2} (ii) 59N (iii) 0.82s]

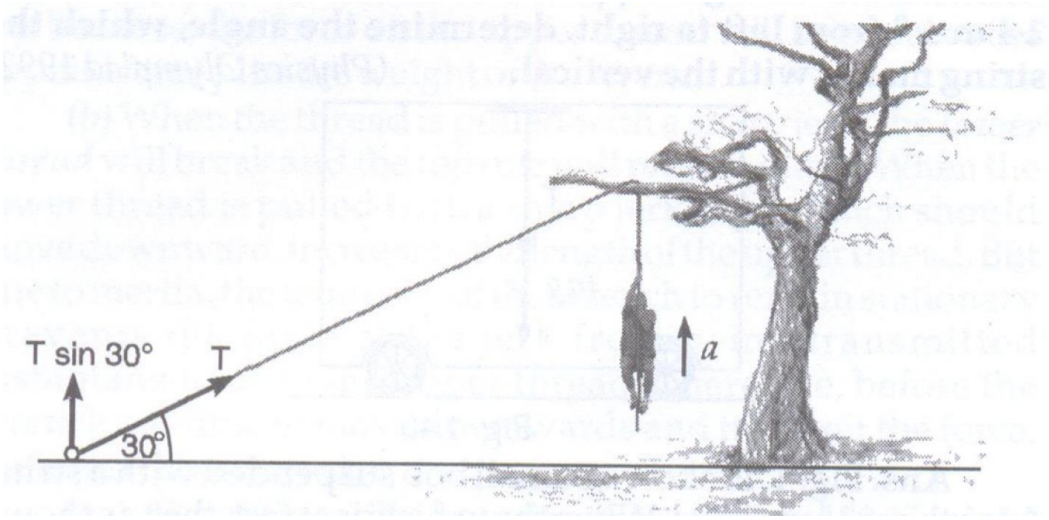


10. Two blocks connected by an inextensible string passing over a light frictionless pulley are resting on two smooth inclined planes as shown. Determine the acceleration of the blocks and the tension in the string. Assume string massless.

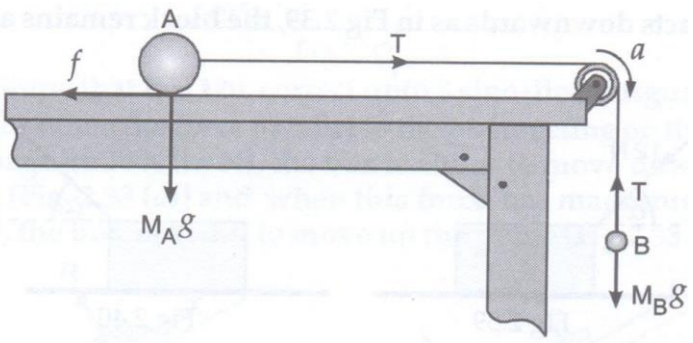
[-0.306ms^{-2},286.3N]



11. Figure shows a light rope fixed at one end to a clamp on the ground and its other end passing over the branch of a tree and hanging on the other side of it. The rope makes an angle of 30° with the ground. A weighing 45kg starts climbing up the rope. Find the maximum acceleration with which the boy can climb safely, if the clamp comes out of the ground, when a force of 270 N acts on it vertically upwards. Assume that there is no friction between the rope and the tree branch. Take g = 10ms^{-2} **[2ms^{-2}]**



12. Two particles A and B of masses 0.4kg and 0.1kg respectively are attached to the ends of a light inextensible strin. Particle A is held at rest on horizontal table with the string passing over a smooth pulley at the edge of the table. Particle B hangs vertically below the pulley as shown.



The system is released from rest. In the subsequent motion, a constant frictional force of magnitude 0.6N acts on A. Find (i) tension T in string (ii) speed of B 1.5s after it starts to move. **[0.9N, 1.12ms^{-1}]**