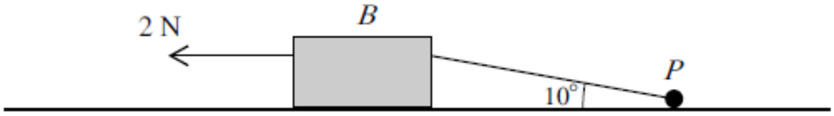
Topic X8 Mechanics (Pre-TT B) [52]

Covering chapters 21 and 22..

1.



A block B of mass 0.8 kg and a particle P of mass 0.3 kg are connected by a light inextensible string inclined at 10° to the horizontal. They are pulled across a horizontal surface with acceleration 0.2 m s^{-2}, by a horizontal force of 2 N applied to B (see diagram).

(i) Given that contact between B and the surface is smooth, calculate the tension in the string. **[3]**

(ii) Calculate the coefficient of friction between P and the surface. **[7]**

2.

A particle P of mass 0.5 kg moves upwards along a line of greatest slope of a rough plane inclined at an angle of 40° to the horizontal. P reaches its highest point and then moves back down the plane. The coefficient of friction between P and the plane is 0.6.

(i) Show that the magnitude of the frictional force acting on P is 2.25 N, correct to 3 significant figures. [3]

(ii) Find the acceleration of P when it is moving

(a) up the plane,

(b) down the plane.

[4]

(iii) When P is moving up the plane, it passes through a point A with speed 4 m s^{-1}.

(a) Find the length of time before P reaches its highest point.

(b) Find the total length of time for P to travel from the point A to its highest point and back to A.

[8]

3.

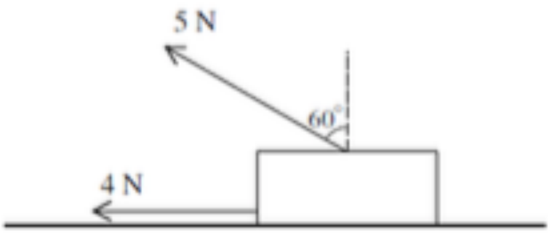


Fig. 1

A rectangular block B of weight 12 N lies in limiting equilibrium on a horizontal surface. A horizontal force of 4 N and a coplanar force of 5 N inclined at 60° to the vertical act on B (see Fig. 1).

(i) Find the coefficient of friction between B and the surface. **[6]**

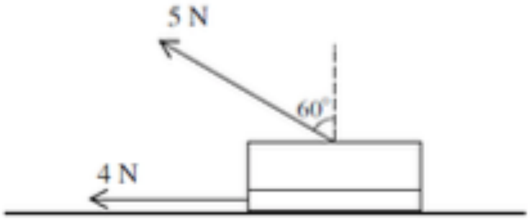


Fig. 2

B is now cut horizontally into two smaller blocks. The upper block has weight 9 N and the lower block has weight 3 N. The 5 N force now acts on the upper block and the 4 N force now acts on the lower block (see Fig. 2). The coefficient of friction between the two blocks is μ.

(ii) Given that the upper block is in limiting equilibrium, find μ. **[2]**

(iii) Given instead that $\mu = 0.1$, find the accelerations of the two blocks. **[6]**

4.

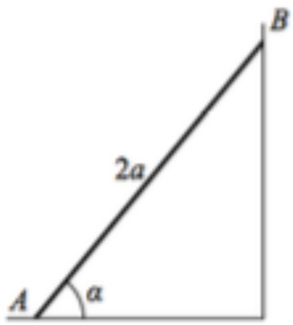


Figure 1

A uniform ladder AB, of length $2a$ and weight W, has its end A on rough horizontal ground.

The coefficient of friction between the ladder and the ground is $\frac{1}{4}$.

The end B of the ladder is resting against a smooth vertical wall, as shown in Figure 1.

A builder of weight $7W$ stands at the top of the ladder.
To stop the ladder from slipping, the builder's assistant applies a horizontal force of magnitude P to the ladder at A, towards the wall.
The force acts in a direction which is perpendicular to the wall.

The ladder rests in equilibrium in a vertical plane perpendicular to the wall and makes an angle α with the horizontal ground, where $\tan \alpha = \frac{5}{2}$.

The builder is modelled as a particle and the ladder is modelled as a uniform rod.

(a) Show that the reaction of the wall on the ladder at B has magnitude $3W$.

(5)

(b) Find, in terms of W, the range of possible values of P for which the ladder remains in equilibrium.

(5)

Often in practice, the builder's assistant will simply stand on the bottom of the ladder.

(c) Explain briefly how this helps to stop the ladder from slipping.

(3)