





7.

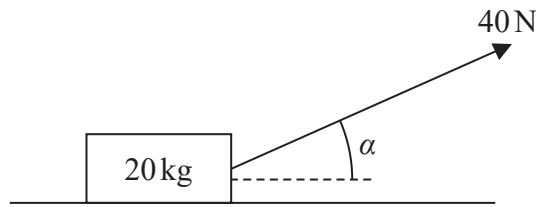


Figure 1

A wooden crate of mass 20 kg is pulled in a straight line along a rough horizontal floor using a handle attached to the crate.

The handle is inclined at an angle  $\alpha$  to the floor, as shown in Figure 1, where  $\tan \alpha = \frac{3}{4}$

The tension in the handle is 40 N.

The coefficient of friction between the crate and the floor is 0.14

The crate is modelled as a particle and the handle is modelled as a light rod.

Using the model,

(a) find the acceleration of the crate.

(6)

The crate is now pushed along the same floor using the handle. The handle is again inclined at the same angle  $\alpha$  to the floor, and the thrust in the handle is 40 N as shown in Figure 2 below.



Figure 2

(b) Explain briefly why the acceleration of the crate would now be less than the acceleration of the crate found in part (a).

(2)

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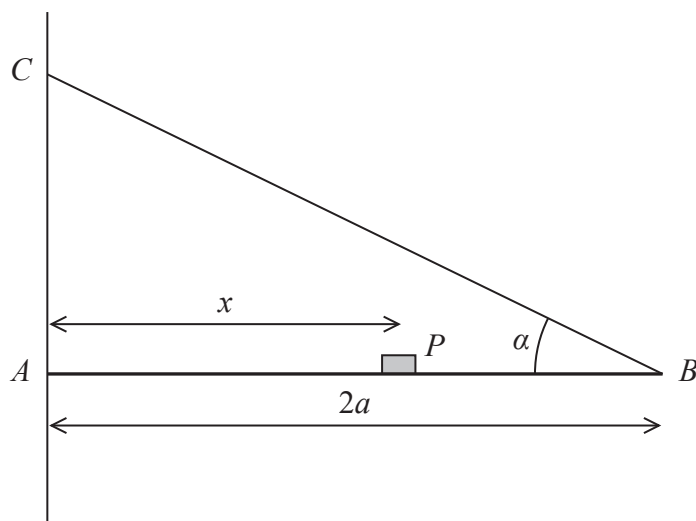


Figure 3

A plank,  $AB$ , of mass  $M$  and length  $2a$ , rests with its end  $A$  against a rough vertical wall. The plank is held in a horizontal position by a rope. One end of the rope is attached to the plank at  $B$  and the other end is attached to the wall at the point  $C$ , which is vertically above  $A$ .

A small block of mass  $3M$  is placed on the plank at the point  $P$ , where  $AP = x$ . The plank is in equilibrium in a vertical plane which is perpendicular to the wall.

The angle between the rope and the plank is  $\alpha$ , where  $\tan \alpha = \frac{3}{4}$ , as shown in Figure 3.

The plank is modelled as a uniform rod, the block is modelled as a particle and the rope is modelled as a light inextensible string.

(a) Using the model, show that the tension in the rope is  $\frac{5Mg(3x + a)}{6a}$  (3)

The magnitude of the horizontal component of the force exerted on the plank at  $A$  by the wall is  $2Mg$ .

(b) Find  $x$  in terms of  $a$ . (2)

The force exerted on the plank at  $A$  by the wall acts in a direction which makes an angle  $\beta$  with the horizontal.

(c) Find the value of  $\tan \beta$  (5)

The rope will break if the tension in it exceeds  $5Mg$ .

(d) Explain how this will restrict the possible positions of  $P$ . You must justify your answer carefully. (3)

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