

7.

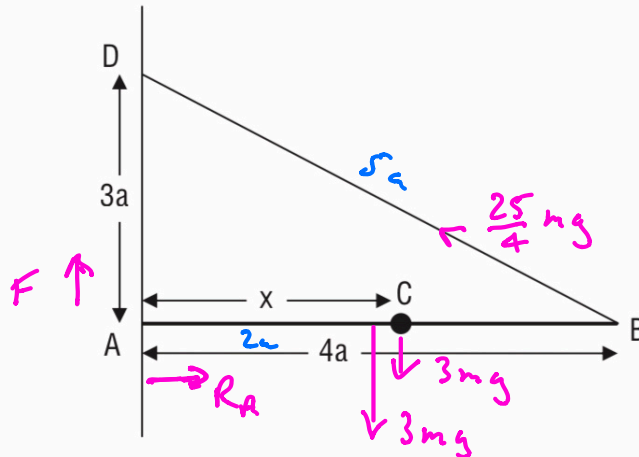


Figure 3

A uniform rod AB , of mass $3m$ and length $4a$, is held in a horizontal position with the end A against a rough vertical wall. One end of a light inextensible string BD is attached to the rod at B and the other end of the string is attached to the wall at the point D vertically above A , where $AD = 3a$. A particle of mass $3m$ is attached to the rod at C , where $AC = x$. The rod is in equilibrium in a vertical plane perpendicular to the wall as shown in Figure 3. The tension in the string is $\frac{25}{4}mg$.

Show that

(a) $x = 3a$, (5)

(b) the horizontal component of the force exerted by the wall on the rod has magnitude $5mg$. (3)

The coefficient of friction between the wall and the rod is μ . Given that the rod is about to slip,

(c) find the value of μ . (5)

a) Moments about A

$$3mg \times 2a + 3mgx = \frac{25}{4}mg \sin \angle ABD \times 4a$$

$$6mga + 3mgx = \frac{25}{4}mg \times \frac{3a}{5a} \times 4a$$

$$6a + 3x = \frac{25}{4} \times \frac{12a}{5}$$

$$3x = 15a - 6a$$

$$3x = 9a$$

$$x = \frac{9a}{3}$$

$$\underline{x = 3a}$$

b) Resolve \leftrightarrow

$$R_A = \frac{25}{4} mg \cos \angle ABC$$

$$R_A = \frac{25}{4} mg \times \frac{4a}{5a}$$

$$R_A = 5mg$$

c) Resolve \updownarrow

$$F + \frac{25}{4} mg \sin \angle ABC = 3mg + 3mg$$

At point of slipping $F = \mu R_A$

$$\mu R_A + \frac{25}{4} mg \times \frac{3a}{5a} = 6mg$$

$$5mg\mu + \frac{15}{4} mg = 6mg$$

$$5\mu = 6 - \frac{15}{4}$$

$$\mu = \frac{\frac{9}{4}}{5}$$

$$\mu = \frac{9}{20} = 0.45$$

5.

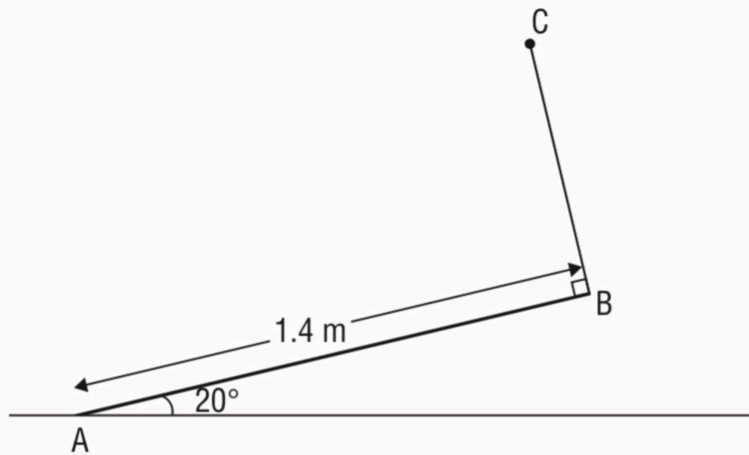


Figure 2

A uniform rod AB has mass 4 kg and length 1.4 m. The end A is resting on rough horizontal ground. A light string BC has one end attached to B and the other end attached to a fixed point C. The string is perpendicular to the rod and lies in the same vertical plane as the rod. The rod is in equilibrium, inclined at 20° to the ground, as shown in Figure 2.

(a) Find the tension in the string.

(4)

Given that the rod is about to slip,

(b) find the coefficient of friction between the rod and the ground.

(7)