Leave blank

7.

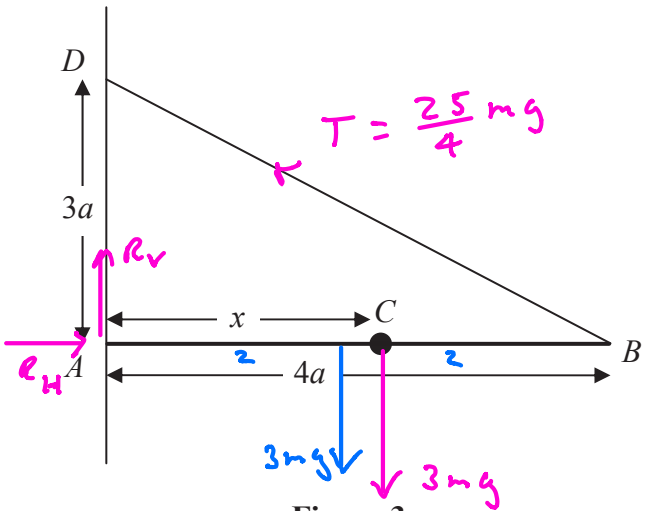

Figure 3

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)

$\tan\theta = \frac{3}{4}$

$\sin\theta = \frac{3}{5}$

$\cos\theta = \frac{4}{5}$

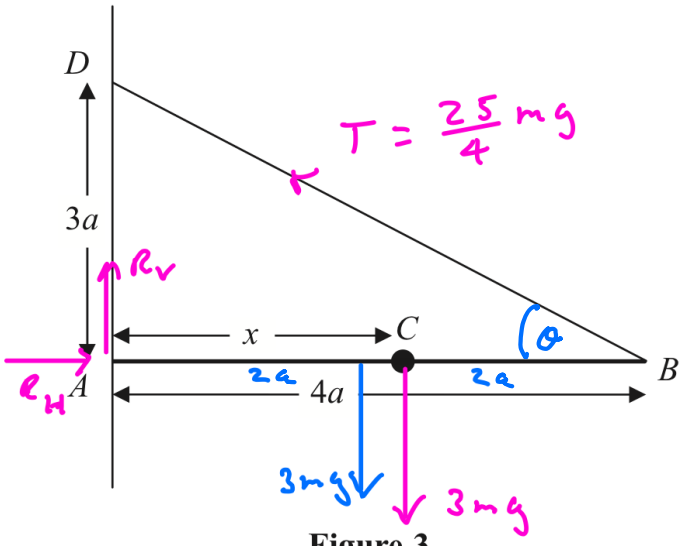

Figure 3

Mom about A

$$3mg \times 2a + 3mg \times x = T \times 4a\sin\theta$$

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

$$6a + 3x = 15a$$

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

$$3x = 9a$$

$$x = 3a$$

---

b) $\leftrightarrow$ equilibrium

$$R_H = T\cos\theta$$

$$R_H = \frac{25mg}{4} \times \frac{4}{5}$$

$$R_H = 5mg$$

---

c) $\updownarrow$ $R_V + T\sin\theta = 3mg + 3mg$

$$R_V = 6mg - \frac{25mg}{4} \times \frac{3}{5}$$

$$R_V = 6mg - \frac{15mg}{4} = \frac{9mg}{4}$$

But $R_V = \mu R_H$

$$\Rightarrow \quad \mu = \frac{R_V}{R_H} = \frac{\frac{9mg}{4}}{5mg} = \frac{9}{20}$$
