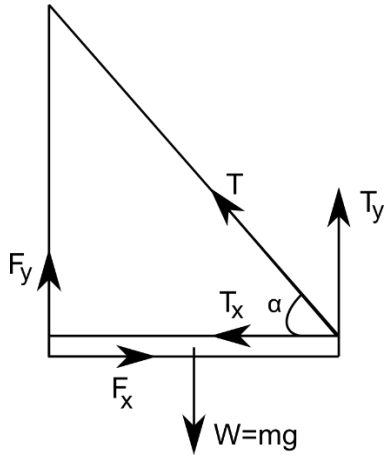
Answer on Question 73158, Physics, Mechanics, Relativity

Question:

A horizontal rod with a mass of $10\,kg$ and length $12\,m$ is hinged to a wall at one end and supported by a cable which makes an angle of 30° with the rod at its other end. Calculate the tension in the cable and the force exerted by the hinge.

Solution:



a) The sum of torques about the hinge must be equal to zero:

$$\sum \tau = 0,$$

$$-W\frac{L}{2} + TLsin\alpha = 0,$$

$$-mg\frac{L}{2} + TLsin\alpha = 0,$$

$$mg\frac{L}{2} = TLsin\alpha,$$

here, $W = mg$ is the weight of the rod, $m = 10\,kg$ is the mass of the rod, $g = 9.8\ m/s^2$ is the acceleration due to gravity, $L = 12\,m$ is the length of the rod, T is the tension in the cable and $\alpha = 30^{\circ}$ is the angle which the cable makes with the rod.

Then, from this formula we can find the tension in the cable:

$$T = \frac{mg}{2sin\alpha} = \frac{10\ kg \cdot 9.8\ \frac{m}{s^2}}{2 \cdot sin30^\circ} = 98\ N.$$

b) The sum of the forces must be equal to zero:

$$\sum F = 0.$$

Let's write the sum of the components of the forces in projections on axis x and y:

$$F_x - T_x = 0,$$

$$F_x = T_x = Tcos\alpha = 98\ N \cdot cos30^\circ = 85\ N,$$

$$F_y + T_y - W = 0,$$

$$F_y = mg - Tsin\alpha = 10\ kg \cdot 9.8\ \frac{m}{s^2} - 98\ N \cdot sin30^\circ = 49\ N.$$

Finally, we can find the force exerted on the hinge from the Pythagorean theorem:

$$F = \sqrt{F_x^2 + F_y^2} = \sqrt{(85\ N)^2 + (49\ N)^2} = 98\ N.$$

Answer:

a) $T = 98\ N.$

b) $F = 98\ N.$