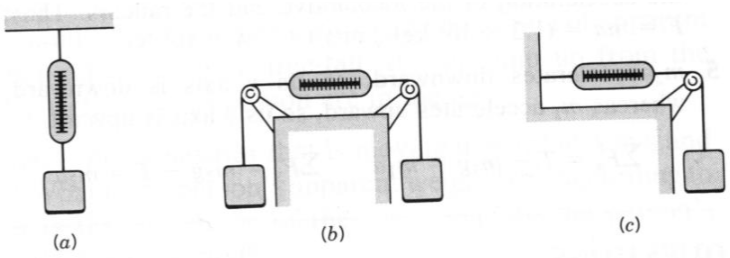
Homework #6

Donald Aingworth IV

October 2, 2024

Problem 3

What is the reading on the spring scale for each of the situations depicted in the figure below? Each of the blocks has a mass of 5.00 kg.



Solution

Situation (a)

There is only one force acting on the block, a downward force of gravity. As such, we can use the formula for the gravitational force here.

$$F_g = m * g = 5.00\text{kg} * 9.81\text{m/s}^2 = \boxed{49.05\text{N}}$$

Situation (b)

We can use the formula for gravtational force again.

$$F_g = m * g = 5.00\text{kg} * 9.81\text{m/s}^2 = \boxed{49.05\text{N}}$$

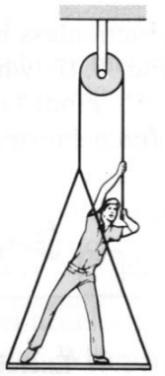
Situation (c)

There is only one force acting on the block, a downward force of gravity, which pulls the spring scale from one side. As such, we can use the formula for the gravitational force here.

$$F_g = m * g = 5.00\text{kg} * 9.81\text{m/s}^2 = \boxed{49.05\text{N}}$$

Problem 5

A painter of mass M = 75.0 kg stands on a platform of mass m = 15.0 kg. He pulls on a rope that passes around a pulley, as shown in the figure. Find the tension in the rope given that (a) he is at rest, or (b) he accelerates upward at 0.400 m/s^2. (c) If the maximum tension the rope can withstand is 700 N, what happens when he ties the rope to a hook on the wall?



Solution

Section (a)

If the platform is at rest, the acceleration is zero so the net force is zero. As such, the only forces acting on it are the gravity and the tension, which is applied twice because there are two forces pulling it up.

$$0 = F_{net} = 2T - mg - Mg$$
$$T = \frac{mg + Mg}{2} = \frac{90 * 9.81}{2}\text{N} = \boxed{441.45\text{N}}$$

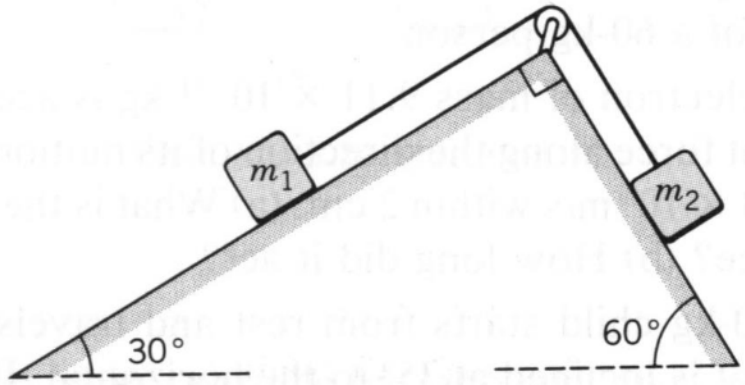
Section (b)

We can repeat the same, but substituting in the total mass and acceleration.

$$F_{net} = \Sigma m * a = 90 * 0.400\text{N} = 36\text{N}$$
$$36\text{N} = 2T - mg - Mg$$
$$T = 18 + \frac{90 * 9.81}{2}\text{N} = 18 + 441.45\text{N} = 459.45\text{N}$$

Problem 8

Two blocks of masses $m_1 = 4.85$ kg and $m_2 = 5.75$ kg are on either side of the wedge as shown in the figure below. Find their acceleration and the tension in the rope. Ignore friction and the pulley.



Solution

We first find the downhill force for both objects. We use trigonometry and the formula for the force of gravity.

$$F_{gd1} = m_1 g * \sin(30^\circ)$$
$$F_{gd2} = m_2 g * \sin(60^\circ)$$

We then use Newton's second law for the net force on it, including the tension force. We then add the two together, and tension will cancel out.

$$\begin{aligned} F_{d1} = m_1 a &= T - m_1 g * \sin(30^\circ) \\ F_{d2} = m_2 a &= m_2 g * \sin(60^\circ) - T \\ (m_1 + m_2)a &= m_2 g * \sin(60^\circ) - m_1 g * \sin(30^\circ) \\ a &= \frac{m_2 g * \sin(60^\circ) - m_1 g * \sin(30^\circ)}{m_1 + m_2} \end{aligned}$$

We can then substitute this in to find the tension. I will substitute it in for F_{d1}

$$\begin{aligned} m_1 a &= T - m_1 g * \sin(30^\circ) \\ T &= m_1 a + m_1 g * \sin(30^\circ) \\ &= m_1 \frac{m_2 g * \sin(60^\circ) - m_1 g * \sin(30^\circ)}{m_1 + m_2} + m_1 g * \sin(30^\circ) \end{aligned}$$

Now that we have the formulas, we can substitute in to find the answers.

$$a = \frac{m_2 g * \sin(60°) - m_1 g * \sin(30°)}{m_1 + m_2} = 9.81 * \frac{5.75 * \sin(60°) - 4.85 * \sin(30°)}{5.75 + 4.85}$$
$$= \boxed{2.36\text{m/s}^2}$$
$$T = m_1 \frac{m_2 g * \sin(60°) - m_1 g * \sin(30°)}{m_1 + m_2} + m_1 g * \sin(30°)$$
$$= 9.81 * 4.85 \frac{5.75 * \sin(60°) - 4.85 * \sin(30°)}{5.75 + 4.85} + 9.81 * 4.85 * \sin(30°)$$
$$= \boxed{35.3\text{N}}$$