Answer on Question #50135, Physics, Mechanics | Kinematics | Dynamics

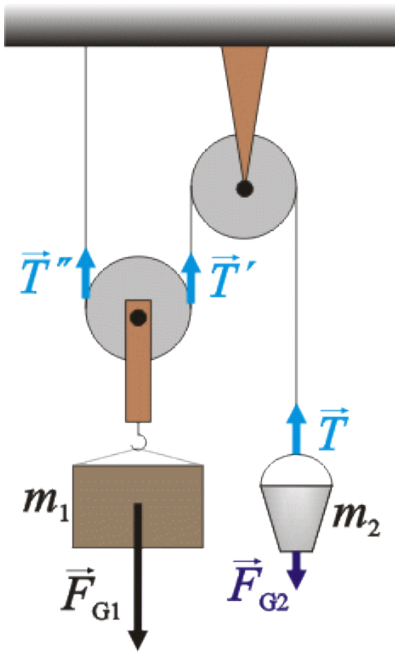
A string, with one end fixed, passes under a movable pulley of mass 8 kg, and over a fixed pulley; the string carries a 5 kg mass at its other end. Find the acceleration of the 5 kg mass.

Solution:

$m_1 = 8\ kg,$

$m_2 = 5\ kg,$

$a_2 = ?$



The force equation for movable pulley is

$$m_1 g - T'' - T' = m_1 a_1$$

The force equation for mass m_2 is

$$T - m_2 g = m_2 a_2$$

Because we leave the mass of the pulley system and the rope out of account they have no moment of inertia and don't affect the tension forces. The following holds for the magnitude of the tension forces:

$$T = T' = T''$$

We rewrite equations:

$$m_1 g - 2T = m_1 a_1$$

$$T - m_2 g = m_2 a_2$$

If the m_2 goes up a distance s, the block goes down a distance s/2

$$s = \frac{1}{2} a_2 t^2$$

$$\frac{s}{2} = \frac{1}{2} a_1 t^2$$

We divide the first equation by the second equation, yielding:

$$2 = \frac{a_2}{a_1}$$

Thus,

$$a_1 = \frac{a_2}{2}$$

We rewrite equations:

$$m_1 g - 2T = m_1 \frac{a_2}{2}$$
$$T - m_2 g = m_2 a_2$$

$$a_2 = \frac{(2m_1 - 4m_2)g}{m_1 + 4m_2}$$

$$a_2 = \frac{(2 * 8 - 4 * 5) * 9.8}{8 + 4 * 5} = -1.4\ m/s^2$$

Answer: $a_2 = 1.4\ m/s^2$ downward