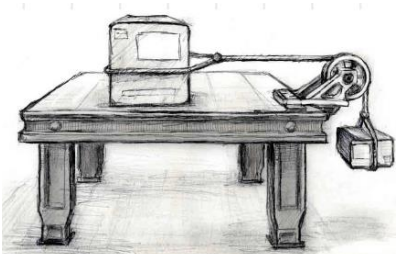
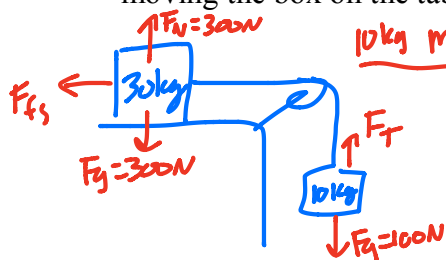


Worksheet 3.5



1. The large box on the table is 30 kg and is connected via a rope and pulley to a smaller 10 kg box, which is hanging. The 10 kg mass is the highest mass you can hang without moving the box on the table. Find the coefficient of static friction μ_s .



10 kg mass: $F_{\text{net}} = 100\text{N} - F_T = 10a = 0$ $F_T = 100\text{N}$

30 kg mass:

$$F_{\text{net}} = F_T - F_{fs} = 0$$

$$100\text{N} - F_{fs} = 0$$

$$F_{fs} = 100\text{N}$$

$$300\mu_s = 100$$

$$\mu_s = .33$$

2. A 90 kg woman stands in an elevator. Find the force which the floor of the elevator exerts on the woman a) when the elevator has an upward acceleration of 2 m/sec^2 ; b) when the elevator is rising at constant speed; c) when the elevator has a downward acceleration of 2 m/sec^2 .

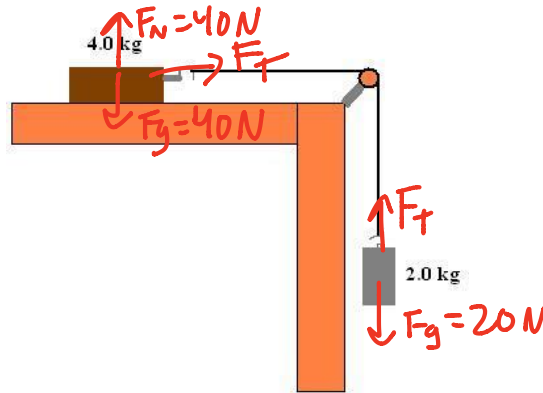
a) $F_{\text{net}} = F_N - 900\text{N} = 90(2\text{ m/s}^2)$

$F_N = 1080\text{N}$

b) $F_N = 900\text{N}$

c) $F_N - 900\text{N} = 90(-2\text{ m/s}^2)$

$F_N = 720\text{N}$



3. Use the diagram of the pulley system above to answer the following questions.

a. If there is no friction between the table and the 4 kg block, what will the acceleration of the blocks be?

$$\begin{aligned} 2\text{kg}: F_{\text{net}} &= 20 - F_T = 2\text{kg}(a) & 20 - 4a &= 2a \\ 4\text{kg}: F_{\text{net}} &= F_T = (4\text{kg})a & 20 &= 6a \\ & & a &= 3.3\text{m/s}^2 \end{aligned}$$

b. What coefficient of static friction between the 4 kg block and the table is required to prevent the blocks from moving?

$$\begin{aligned} F_T &= F_{fs} & 20\text{N} &= F_{fs} & 20\text{N} &= 40\text{N} \mu_s \\ F_T &= F_g = 20\text{N} & 20\text{N} &= F_N \mu_s & \mu_s &= .2 \end{aligned}$$

c. What is the tension in the line while the blocks are hanging stationary?

$$F_T = 20\text{N}$$

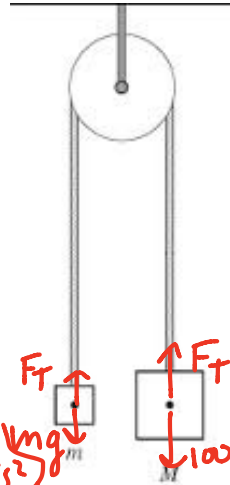
d. Consider the situation where the blocks are in motion with a coefficient of kinetic friction $\mu_k = 0.1$. What is the acceleration of the masses in this scenario?

$$\begin{aligned} 2\text{kg}: F_{\text{net}} &= 20 - F_T = 2a & 20 - 4a - 4 &= 2a & 16 &= 6a \\ 4\text{kg}: F_{\text{net}} &= F_T - f_{fk} = 4a \rightarrow F_T - (0.1)40 = 4a & & & a &= 2.7\text{m/s}^2 \\ & & F_T &= 4a + 4 & & \end{aligned}$$

e. How do the accelerations in (d) and in (a) compare?

'a' in (d) less than 'a' in (a) b/c of the friction.

4. An Atwood pulley system, like the one shown below with two masses m and $M = 10$ kg. When released, the masses have an acceleration of 5 m/s^2 . What is the mass of m ? What is the tension in the line?



$$F_{\text{net}} = 100\text{N} - F_T = 10(5 \text{ m/s}^2)$$

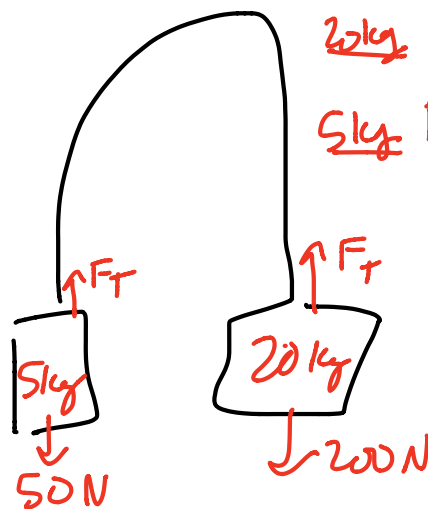
$$F_{\text{net}} = F_T - mg = m(5 \text{ m/s}^2)$$

$$-F_T = 50 - 100$$

$$F_T = 50 \text{ N}$$

$$50 - 10m = 5m \quad 15m = 50 \quad m = \frac{50}{15} = 3.3 \text{ kg}$$

5. A different Atwood pulley system has a large mass (M) of 20 kg and a small mass of 5 kg. What acceleration will the masses have when released?



$$20 \text{ kg} \quad F_{\text{net}} = 200 - F_T = 20(a)$$

$$5 \text{ kg} \quad F_{\text{net}} = F_T - 50 = 5(a)$$

$$F_T = 5a + 50$$

$$200 - 5a - 50 = 20a$$

$$250 = 25a$$

$$9 \text{ m/s}^2 = a$$