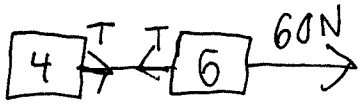
Tension

Tension occurs inside a material that is being pulled or stretched

It is an internal force at acts everywhere along a rope (or string or chain) in both directions

Example 1: Consider two carts, one 4.0 kg, the other 6.0 kg attached by a rope. The 6.0 kg mass is being pulled along a flat surface by a force of 60.0 N, friction is negligible.



a) What are the horizontal forces acting on the 6.0 kg cart?

Applied and Tension

b) What are the horizontal forces acting on the 4.0 kg cart?

Tension

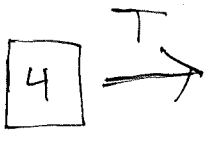
c) What is the net force acting on the carts as a system?

$60N_{right} + \cancel{T_{left}} + \cancel{T_{right}} = 60N \text{ right}$

d) What is the tension in the rope?

$F_{net} = ma$

$$a = \frac{F_{net}}{m_{total}} = \frac{60N}{(4+6)} = \frac{60N}{10kg} = 6\,\frac{m}{s^2}$$

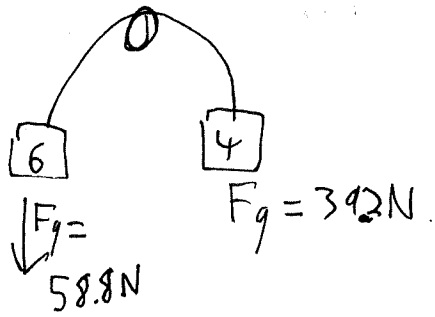


F_{net} of 4kg block

$= ma = 4kg \times 6\frac{m}{s^2} = 24N$

$\simeq 20N$

Example 2: A 6.0 kg and a 4.0 kg mass hang from a frictionless pully.



a) What will happen if the blocks are allowed to fall freely?

6 Falls, 4 lifts

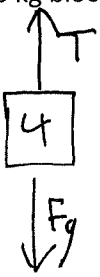
b) What is the net force acting on the system?

$F_{net} = 58.8 - 39.2 = 19.6\,N \approx 2.0 \times 10^1\,N$

c) What will the acceleration of the blocks be?

$F_{net} = ma \rightarrow a = \frac{19.6N}{10\,kg} = 1.96\,m/s^2 \approx$

d) Draw free body diagrams for the 6.0 kg block and the 4.0 kg block.



e) Determine the tension in the string connecting the blocks.

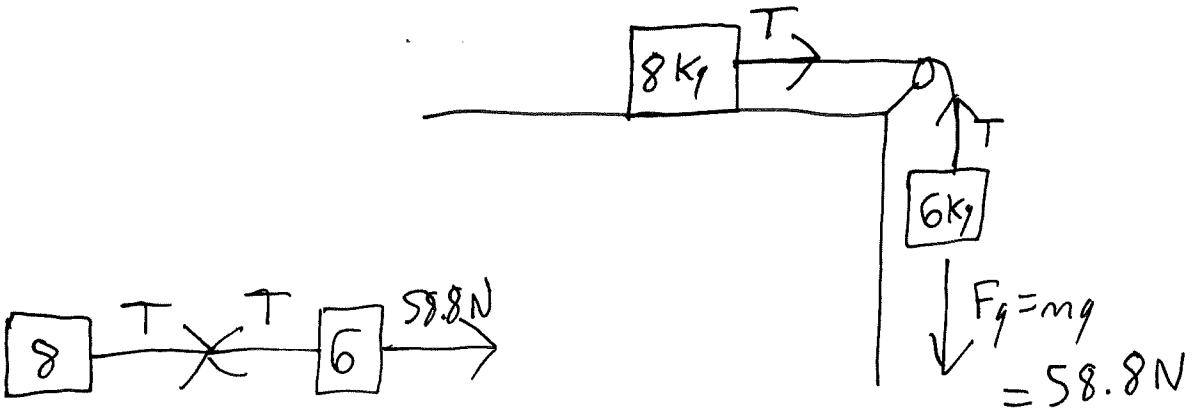
$F_{net} = ma = 6\,kg \times 1.96\,m/s^2 = 11.76\,N$

$T = 58.8 - 11.76 = 47\,N$

Note: When solving for acceleration we consider the whole system

When solving for tension we consider one part only

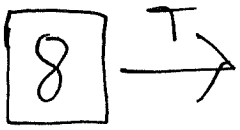
Example 4: An 8.0 kg mass is on a frictionless table and is connected with a rope to a 6.0 kg hanging mass. When the 6.0 kg mass is released determine the tension in the rope.



$F_{net} = ma \rightarrow a = \frac{F_{net}}{m}$

$= \frac{58.8N}{14kg}$

$= 4.2 m/s^2$



$F_{net} = ma = 8kg \times 4.2 m/s^2$

$= 33.6N$

Since T is only force

$F_{net} = T = 34N$

Forces in 2D

EXAMPLE 1: A block is pushed by two people, one towards the North, the other towards to East. The person pushing North pushes with a force of 65 N, the person pushing East pushes with a force of 45 N.

If we ignore friction what is the net force acting on the block?

What is the acceleration of the block if it has mass of 105 kg?