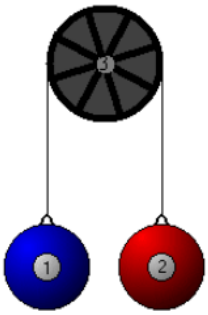
Multiple Masses and Finding Net Force

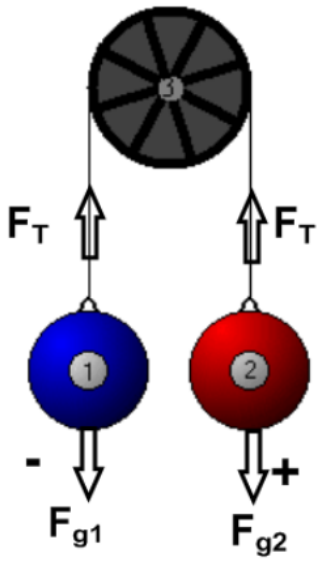
Chapter 10.2 of MHR:
Read Pg 478 - 489
Problems Pg 485 #s 19 - 22, Pg 488 #s 24 - 28



This is an example of a system where there are multiple masses, the Atwood machine.

We will apply the concept of forces to determine the resulting acceleration.

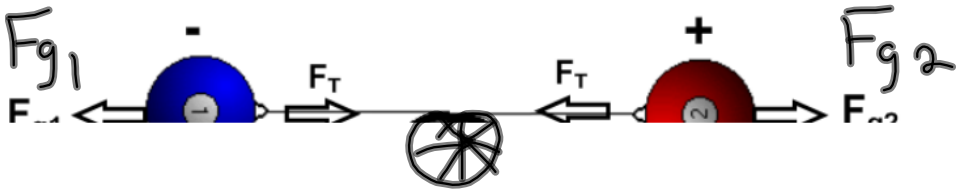
Define the Direction of Forces



Our problems will not include friction and the pulley will be massless.

You may find it easier to picture, or draw, the system horizontally.

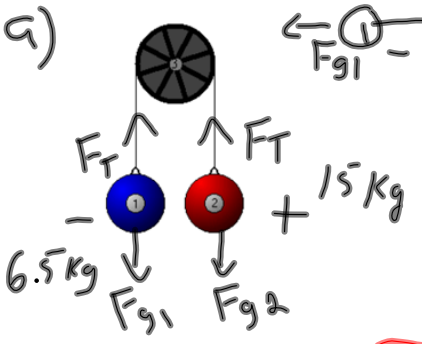
$$\sum Forces = \sum masses \times \vec{a}$$

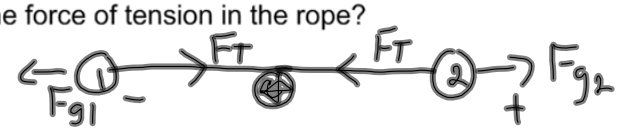


Atwood Machine Examples

What is the acceleration of an Atwood machine with masses of 6.5 kg and 15 kg on opposite sides of the pulley? What is the magnitude of the force of tension in the rope?

a)





$\sum F_{forces} = \sum masses \times \vec{a}$

Equal and opposite

$$F_{g1} + F_{g2} + \cancel{F_T} + \cancel{F_T} = (m_1 + m_2)a$$

$$F_{g1} + F_{g2} = (m_1 + m_2)a$$

$$-m_1 g + m_2 g = (m_1 + m_2)a$$

$$-(6.5)(9.81) + (15)(9.81) = (6.5 + 15)a$$

$$-63.75 + 147.15 = 21.5a$$

$$83.4 = 21.5a$$

$$\boxed{3.9\ m/s^2 = a}$$

b) Choose one mass to analyze

Say m_2 ← Newton's 2nd Law with m_2

$$\sum \text{Forces on } m_2 = m_2 \times \vec{a}$$

$$F_{g2} + F_T = m_2 a$$

$$147.15 + F_T = (15)(3.9)$$

$$F_T = 58.5 - 147.15$$

$$\boxed{= -89\ N}$$

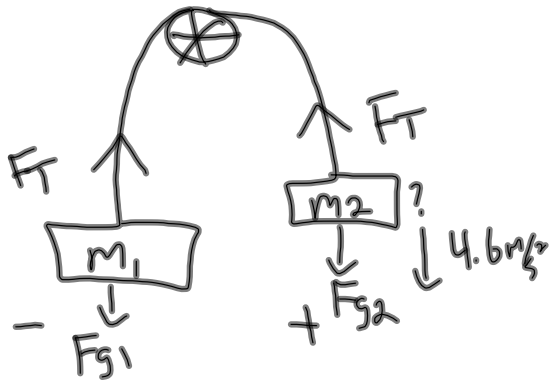
#20)

$m_1 = 5.2\,kg$

$a = 4.6\,m/s^2$

$m_2 = ?$

$F_T = ?$



$$\sum \text{Forces} = \sum \text{masses} \times \vec{a}$$

$$F_{g1} + F_{g2} = (m_1 + m_2)a$$

$$-m_1 g + m_2 g = (m_1 + m_2)a$$

$$-(5.2)(9.81) + m_2(9.81) = (5.2 + m_2)(4.6)$$

$$-51 + 9.81m_2 = 24 + 4.6m_2$$

$$9.81m_2 - 4.6m_2 = 24 + 51$$

$$5.2m_2 = 75$$

$$\boxed{m_2 = 14\ kg}$$

b) F_T

$$\sum \text{Forces on } m_1 = m_1 a$$

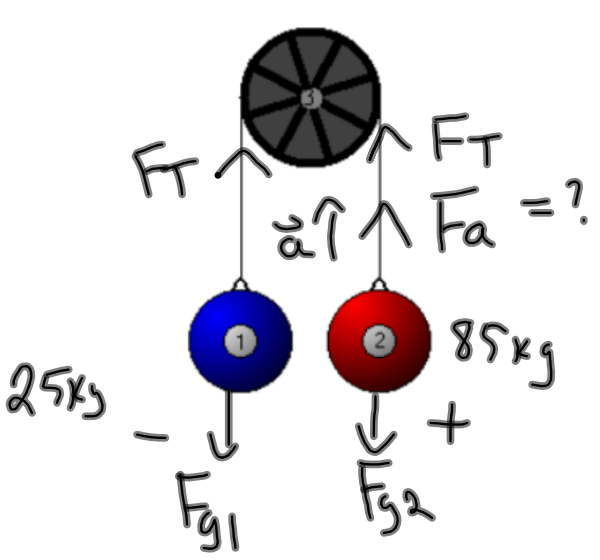
$$F_{g1} + F_T = m_1 a$$

$$-51 + F_T = (5.2)(4.6)$$

$$F_T = 24 + 51$$

$$\boxed{= 75\ N}$$

A counter weight of 25 kg is used to help a person of mass 85 kg to do chin ups. What is the force applied by the person if he accelerates at 1.2 m/s²?



$$\sum \text{Forces} = \sum \text{masses} \times a$$

$$F_{g1} + F_{g2} + F_a = (m_1 + m_2)a$$

$$m_1 g + m_2 g + F_a = (m_1 + m_2)a$$

$$-(25)(9.81) + (85)(9.81) + F_a = (25+85)(-1.2)$$

$$-245 + 834 + F_a = (110)(-1.2)$$

$$589 + F_a = -132$$

$$\boxed{F_a = -721\ \text{N}}$$