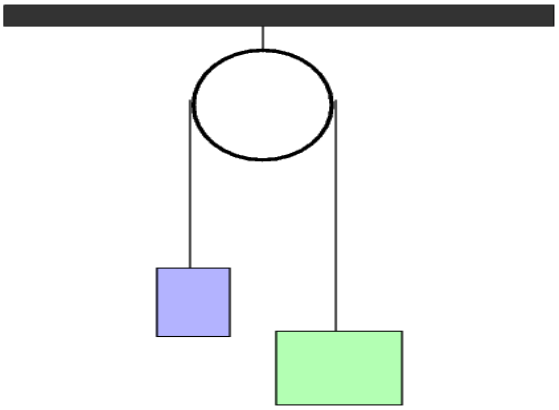
Physics 12
The Atwood's Machine

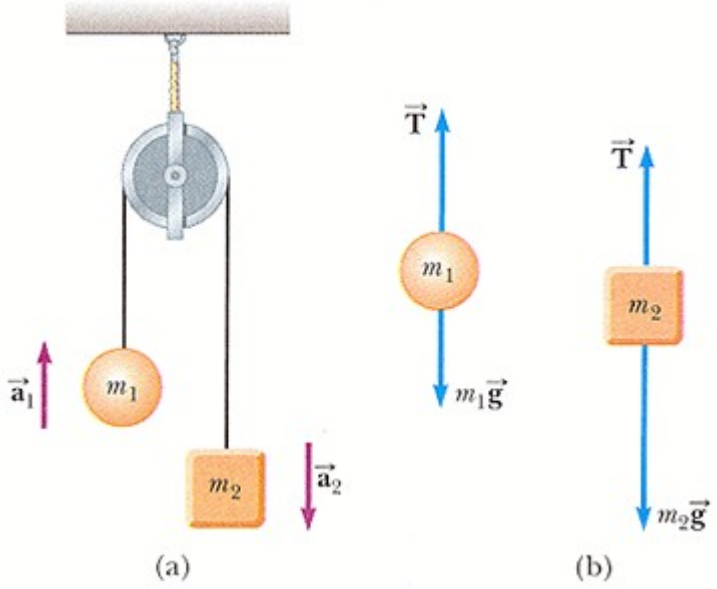
1. An Atwood's machine is simply two masses hanging over a pulley. This is how an elevator is constructed.



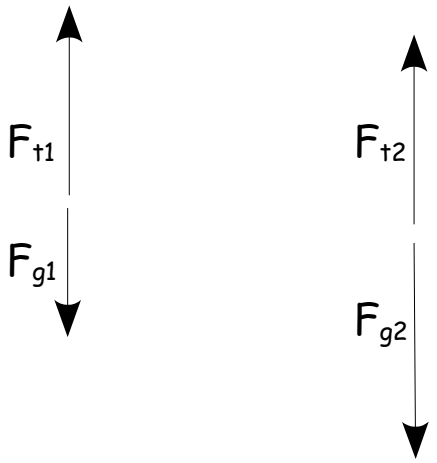
2. The pulley is considered to be frictionless. If the masses are not equal then the system of masses will accelerates.

3. A system of objects consists of all objects within a closed space and in this case consists only of two blocks.

4. To analyse the system you must first assign a positive direction of motion. In this case up on the left and down on the right.



5. Next determine the forces acting on the system.



6. Next use Newton's Second Law to make three net force statements, one for the masses separately and one for the complete system.

$$\sum F_1 = m_1 a$$

$$1) \quad F_{t1} + -F_{g1} = m_1 a$$

$$\sum F_2 = m_2 a$$

$$2) \quad -F_{t2} + F_{g2} = m_2 a$$

$$\sum F_{1+2} = m_{1+2} a$$

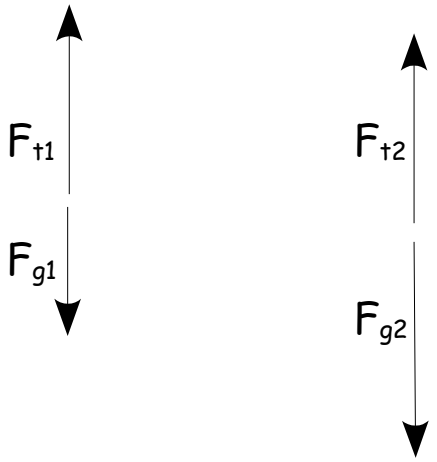
$$F_{t1} + -F_{g1} + -F_{t2} + F_{g2} = (m_1 + m_2)a$$

Since $F_{t1} = F_{t2}$

$$3) \quad F_{g2} - F_{g1} = (m_1 + m_2)a$$

Equations 1,2,and 3 are the potential equations used.

Example:
A fully loaded elevator has a mass of 1150kg. The elevator has a counterweight of 1000kg. Draw a free body diagram of the system. Calculate the acceleration of the elevator and tension in the cable.



use equation 3 to determine the acceleration of the cable

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

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

$$\frac{m_2g - m_1g}{(m_1 + m_2)} = a$$

$$\frac{1150kg \times 9.80m/s^2 - 1000kg \times 9.80m/s^2}{1000kg + 1150kg} = a$$

$$0.68m/s^2 = a$$

The tension in the cable can be solve by using either equation 1 or equation 2.

$$F_{t1} + -F_{g1} = m_1 a$$

$$F_{t1} = m_1 a + F_{g1}$$

$$F_{t1} = 1000kg \times 0.68m/s^2 + 1000kg \times 9.80m/s^2$$

$$F_{t1} = 10500N$$