Physics 12
Static and Kinetic Friction
Two boxes and a Pulley
Incline plane

1. Frictional forces always oppose motion. The are many types of frictional forces but we will only study two, static(μ_s) and kinetic(μ_k).

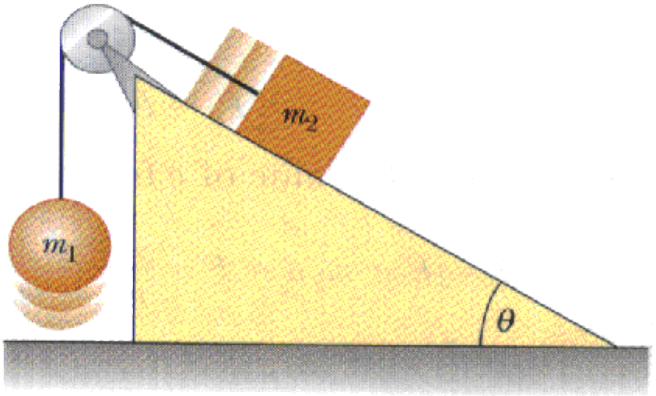
2. Kinetic friction (μ_k) is always less than static friction(μ_s).

3. The relationship between frictional forces, μ, and normal force is:

$$\mu = \frac{F_f}{F_n}$$

or $F_f = \mu F_n$

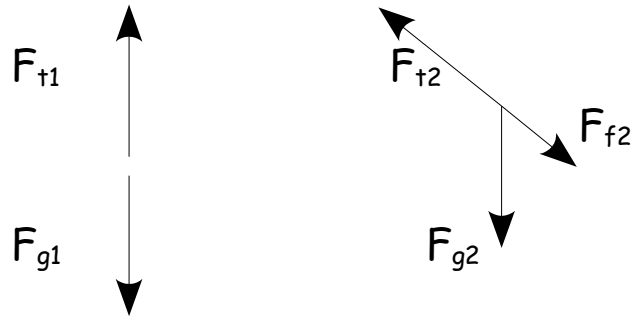
4. Now we can revisit the Atwood's machine on an incline:



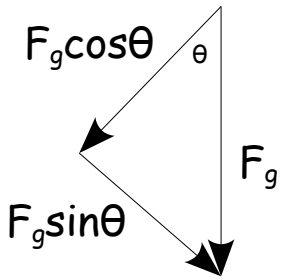
5. The steps are the same as before.
6. First decide on a direction of motion, it doesn't matter if you end up being incorrect, the conclusions can still be determined correctly.

Mass 1 goes down and mass 2 slides up the slope.

7. Next free body diagrams for the two objects and determine all the forces acting on the objects.



8. Decompose the weight into its normal component and the component parallel to the incline.



Produce a net force statement for the direction you think the system will move.

$$\sum F = ma$$

$$F_{g1} + - F_{t1} + F_{t2} + -F_{f2} + -F_{g2}\sin\theta = m_{1+2}a$$

Since $F_{t1} = F_{t2}$ they add to zero in the above equation

$$m_1g - \mu F_{n2} - F_{g2}\sin\theta = m_{1+2}a$$

$$m_1g - \mu m_2g\cos\theta - m_2g\sin\theta = m_{1+2}a$$

The above statement can be used to solve for the acceleration of the system.

9. A sum of the forces statement can be done for the individual masses.

For object 1

$$\sum F_1 = m_1a$$

$$F_{g1} + -F_{t1} = m_1a$$

For object 2

$$\sum F_2 = m_2a$$

$$F_{t2} + -F_{f2} + - F_{g2} = m_2a$$

$$F_{t2} + - \mu F_{n2} + - F_{g2}\sin\theta = m_2a$$

$$F_{t2} + -\mu m_2g\cos\theta - m_2g\sin\theta = m_2a$$