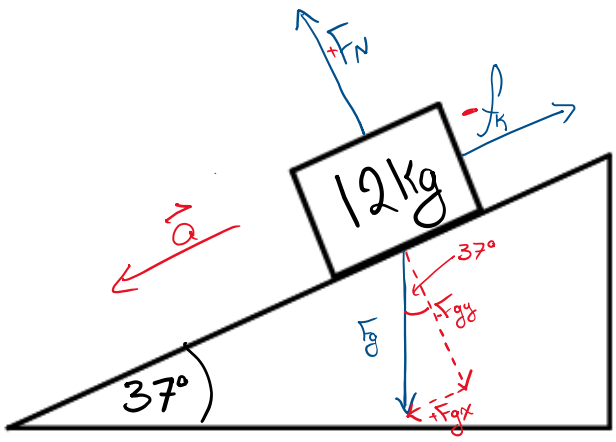
Lesson 2.3B – Inclined Planes & Pulleys

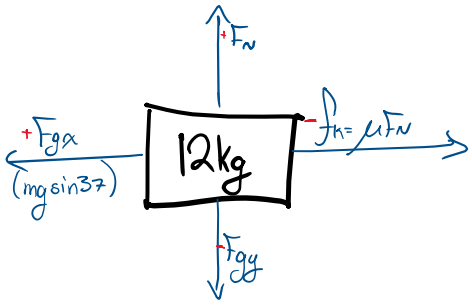
Unit 2: Dynamics and Equilibrium

With Friction

- Solve similarly to problems without friction.
- Frictional forces are parallel to the surface and perpendicular to F_N
- Make linear FBD's to help visualizing opposing components
- If you know the direction of motion, define the frictional direction as opposite
- If you do not know the direction of motion, determine the motion by comparing x-forces, then fill in the frictional direction afterward

Example 1: Find the acceleration of a 12 Kg block on a 37° incline with $\mu_k = 0.20$.





y-direction

$F_{net_y} = 0$

$F_N - F_{gy} = 0$

$F_N = mg\cos\theta$

x-direction

$F_{net\,x} = m\vec{a}_x$

$F_{gx} - f_k = m\vec{a}$

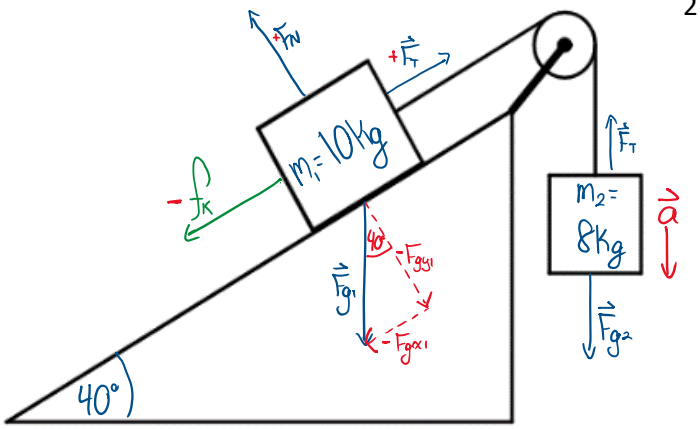
$mg\sin\theta - \mu_k mg\cos\theta = m\vec{a}$

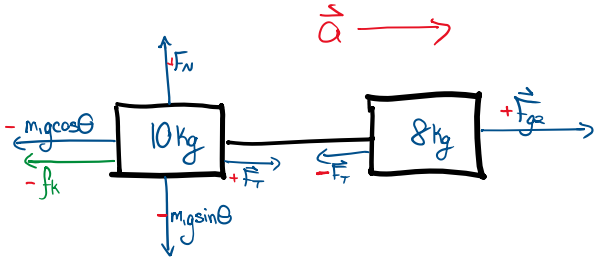
$\vec{a} = g(\sin\theta - \mu_k\cos\theta)$

$\vec{a} = 9.8(\sin 37 - 0.20\cos 37)$

$\vec{a} = 4.33\ m/s^2$

Example 2: Find the acceleration of the system and the tension of the rope if $\mu_k = 0.15$, the incline is 40°, the mass on the incline plane is 1.0×10^1 Kg, and the hanging mass is 8.0 Kg.





Find direction of motion (fill in $\vec{f}$ after)

F_{gx1}	F_{g2}
$m_1 g \sin\theta$	$m_2 g$
$10(9.8)\sin 40$	$8(9.8)$
$62.99N$	$78.4N$

$<$

(+) direction

Find $\vec{a}$ of the system:

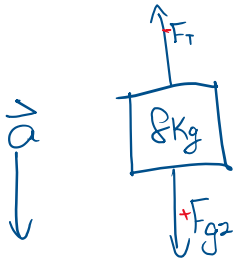
$$\vec{F}_{net} = m_T\vec{a}$$

$$F_{g2} - F_{g1x} - f_k = m_T\vec{a}$$

$$\vec{a} = \frac{m_2 g - m_1 g\sin\theta - \mu_k m_1 g\cos\theta}{m_1 + m_2}$$

$$= \frac{9.8(8 - 10\sin 40 - 0.15(10)\cos 40)}{8+10}$$

$$\vec{a} = 0.23\ m/s^2$$



Find F_T:

$$\vec{F}_{net} = m_2\vec{a}$$

$$m_2 g - F_T = m_2\vec{a}$$

$$F_T = m_2 g - m_2\vec{a}$$

$$\vec{F}_T = m_2(g - \vec{a})$$

$$\vec{F}_T = 8(9.8 - 0.23)$$

$$\vec{F}_T = 76.6N$$

Assignment: WS 2.3B – Incline Planes and Pulleys (w/friction)