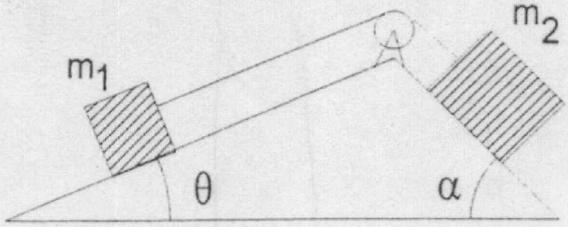
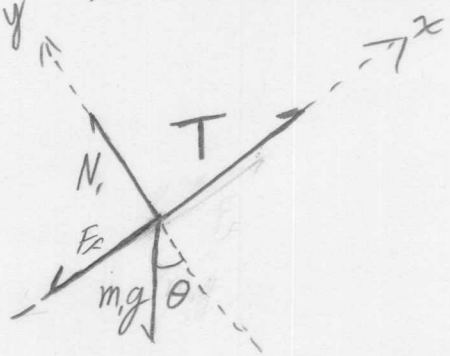
Force Problems

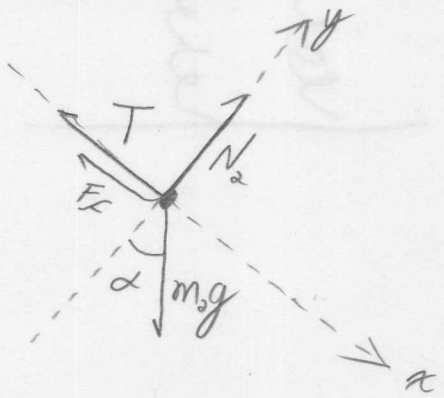
In the figure shown below, find the acceleration of the system. Assume the pulley is massless and frictionless. Use $\Sigma F = ma$ to solve the problem. Draw free body diagrams showing coordinate systems and all of the relevant forces, also, explicitly show basic formulas you are using.

$\theta = 30^\circ$
$\alpha = 45^\circ$
$\mu_k = 0.10$
$m_1 = 5.0$ kg
$m_2 = 15.0$ kg



a) Draw free body diagrams for EACH mass.
b) Write down Newton's Second Law for each mass on each axis.
c) Find an EXPRESSION (no numbers) for the acceleration of the system.





$x: T - m_1 g \sin\theta - \mu_k N_1 = m_1 a$

$y: N_1 - m_1 g \cos\theta = 0$

$x: m_2 g \sin\theta - T - \mu_k N_2 = m_2 a$

$y: N_2 - m_2 g \cos\theta = 0$

① $T - m_1 g \sin\theta - \mu_k m_1 g \cos\theta = m_1 a$ ② $m_2 g \sin\alpha - T - \mu_k m_2 g \cos\alpha = m_2 a$

add ① and ②

$$-m_1 g \sin\theta - \mu_k m_1 g \cos\theta + m_2 g \sin\alpha - \mu_k m_2 g \cos\alpha = (m_1 + m_2) a$$

$$a = g\left[\frac{m_2(\sin\alpha - \mu_k \cos\alpha) - m_1(\sin\theta + \mu_k \cos\theta)}{(m_1 + m_2)}\right]$$

$$a = (9.8)\frac{(15)(\sin(45) - 0.1\cos(45)) - (5)(\sin(30) + 0.1\cos(30))}{20}$$

$$a = 3.24 \ m/s^2$$