1. A 2.0 kg object is subjected to three forces that give it an acceleration of $\vec{a} = \left(-8.0 m/s^2\right)\hat{i} + \left(6.0 m/s^2\right)\hat{j}$. If two of the three forces are $\vec{F}_1 = (30.0N)\hat{i} + (16.0N)\hat{j}$ and $\vec{F}_2 = (-12.0N)\hat{i} + (8.0N)\hat{j}$, find the third force.

$$\Sigma \vec{F} = m\vec{a}$$

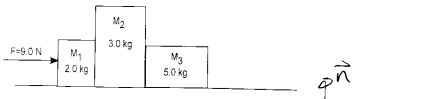
$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = m\vec{a}$$

$$(30\hat{i} + 16\hat{j}) + (-12\hat{i} + 8\hat{j}) + \vec{F}_3 = 2(-8\hat{i} + 6\hat{j})$$

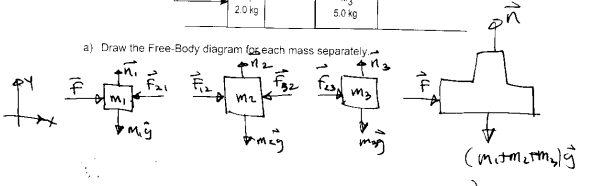
$$18\hat{i} + 24\hat{j} + \vec{F}_3 = -16\hat{i} + 12\hat{j}$$

$$\boxed{\vec{F}_3 = -34\hat{i} - 12\hat{j}}$$

2. A force of magnitude 9.0 N pushes three boxes as shown below. The blocks move on a frictionless surface.



a) Draw the Free-Body diagram for each mass separately.



b) Calculate the force that M_3 exerts on M_2.

m_3

$\Sigma F_x = F_{23} = m_3 a$

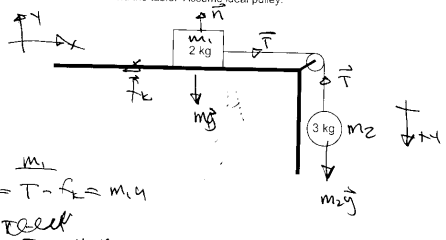
$F_{23} = 5(0.9)$

$\boxed{F_{23} = 4.5\,N}$

$\Sigma F_x = F = (m_1+m_2+m_3)a$

$\boxed{a = 0.9\,m/s^2}$

3. Find the acceleration of the masses and the tension in the string if $\mu_k = 0.30$ between the block and the table. Assume ideal pulley.



m_1

$\Sigma F_x = T - f_k = m_1 a$

$T - \mu_k n = m_1 a$

$\Sigma F_y = n - m_1 g = 0$

$n = m_1 g$

$T - \mu_k m_1 g = m_1 a$

m_2

$\Sigma F_y = m_2 g - T = m_2 a$

$T - \mu_k m_1 g = m_1 a$

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

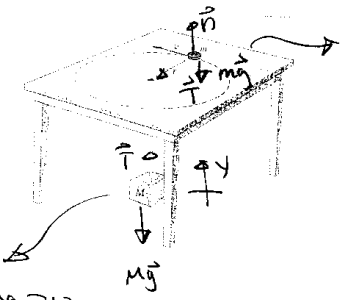
$a = \dfrac{(m_2 - \mu_k m_1) g}{m_1 + m_2}$

$\boxed{a = 4.7\,m/s^2}$

$T = m_2 g - m_2 a$

$\boxed{T = 15.3\,m/s^2}$

4. A hockey puck of mass m = 200 g is attached to a string that passes through a frictionless hole in the center of a table, as shown below. The puck moves in a circle of radius r = 50.0 cm. Tied to the other end of the string, and hanging vertically beneath the table, is a mass M = 600 g. Assuming the tabletop is frictionless, calculate the speed the hockey puck must have if the mass M is to remain at rest.



$\Sigma F_r = T = \frac{mv^2}{r}$

$Mg = \frac{mv^2}{r}$

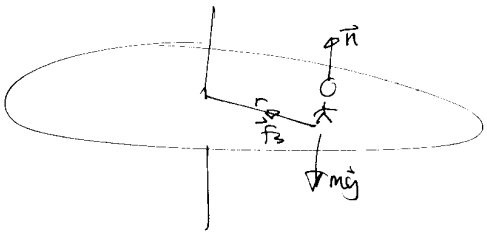
$v = \sqrt{\frac{Mgr}{m}}$

$\Sigma F_y = T - Mg = 0$

$T = Mg$

$v = 3.83 \text{ m/s}$

5. A child sits on a rotating merry-go-round, 2.3 m from its center. If the speed of the child is 2.2 m/s, what is the minimum coefficient of static friction between the child and the merry-go-round that will prevent the child from slipping?



$\Sigma F_r = f_s = \frac{mv^2}{r}$

$\Sigma F_y = n - mg = 0$

$n = mg$

$\mu_s n = \frac{mv^2}{r}$

$\mu_s mg = \frac{mv^2}{r}$

$\mu_s = \frac{v^2}{rg}$

$\mu_s = 0.21$