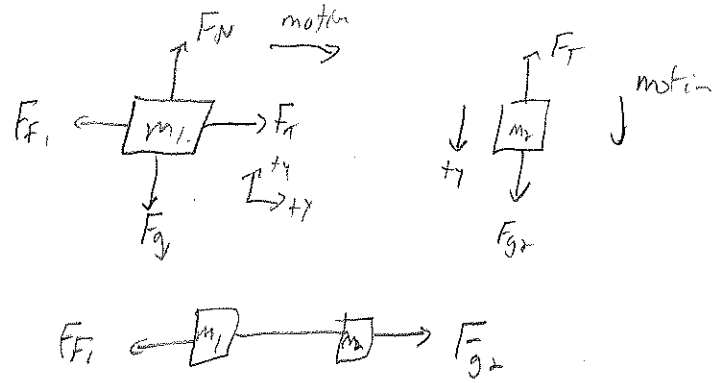
Even More Connected Systems Practice

#1) $m_1 = 2.25\ kg$
$m_2 = 0.600\ kg$
$\vec{F}_{f1} = 2.25\ N\ [W]$
$a_{sys} = ?$
$\vec{g} = 9.81\ m/s^2\ [down]$
$\vec{a}_{1y} = 0\ m/s^2$
$m_{sys} = m_1 + m_2 = 2.85\ kg$



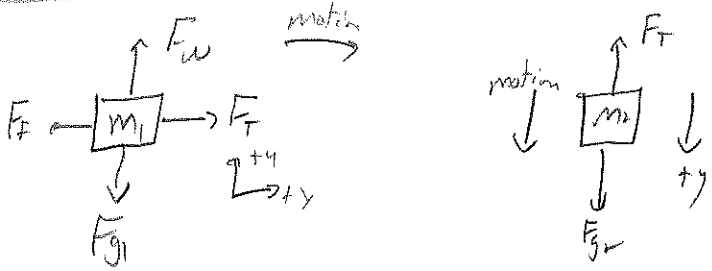
$F_{Net,sys} = F_{g2} - F_{f1} = m_{sys} a_{sys}$

$$a_{sys} = \frac{m_2 g - F_{f1}}{m_{sys}} = \frac{(0.600\ kg)(9.81\ m/s^2) - 2.25\ N}{2.85\ kg}$$

$$= 1.2758\ m/s^2 = 1.28\ m/s^2$$

$\boxed{\vec{a} = 1.28\ m/s^2\ [E]}$

#2) $\mu_K = 0.211$
$m_2 = 346\ g$
$a_{sys} = 0.109\ m/s^2$
$\vec{g} = 9.81\ m/s^2$
$\vec{a}_{1y} = 0\ m/s^2$
$m_1 = ?$



$F_{Net,sys} = F_{g2} - F_F = m_{sys} a_{sys}$

$F_{Net,1y} = F_N - F_{g1} = ma_{y1} = 0N \rightarrow F_N = F_{g1} = m_1 g$
$F_F = \mu_K F_N = \mu_K m_1 g$

$m_{sys} a_{sys} = m_2 g - \mu_K m_1 g$

$m_1 a_{sys} + m_2 a_{sys} = m_2 g - \mu_K m_1 g$

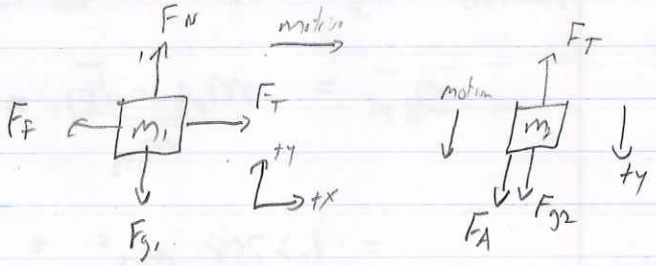
$$m_2 g - m_2 a_{sys} = m_1 a_{sys} + \mu_K m_1 g$$

$$m_2 (g - a_{sys}) = m_1 (a_{sys} + \mu_K g)$$

$$m_1 = \frac{m_2 (g - a_{sys})}{(a_{sys} + \mu_K g)} = \frac{(0.346\ kg)(9.81\ m/s^2 - 0.109\ m/s^2)}{(0.109\ m/s^2 + (0.211)(9.81\ m/s^2)}$$

$$m_1 = 1.54047\ kg = \boxed{1.54\ kg}$$

#3) $m_1 = 750.\ g$
$\vec{F}_A = 0.7616\ N\ [down]$
$a_{sys} = 0.296\ m/s^2$
$\mu_K = 0.138$
$\vec{g} = 9.81\ m/s^2\ [down]$
$\vec{a}_{1y} = 0\ m/s^2$
$m_2 = ?$
$F_T = ?$



a) $F_{Net,sys} = F_A + F_{g2} - F_f = m_{sys} a_{sys}$

$F_{Net,y,1} = F_N - F_{g1} = m a_{1y} = 0N \rightarrow F_N = F_{g1} \rightarrow F_f = \mu_K F_N$
$= \mu_K m_1 g$

$$m_1 a_{sys} + m_2 a_{sys} = F_A + m_2 g - \mu_K m_1 g$$

$$m_2 g - m_2 a_{sys} = m_1 a_{sys} + \mu_K m_1 g - F_A$$

$$m_2 (g - a_{sys}) = m_1 (a_{sys} + \mu_K g) - F_A$$

$$m_2 = \frac{m_1 (a_{sys} + \mu_K g) - F_A}{g - a_{sys}}$$

$$= \frac{(0.750\ kg)(0.296\ m/s^2 + (0.138)(9.81\ m/s^2) - 0.7616\ N}{(9.81\ m/s^2 - 0.296\ m/s^2)}$$

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#3) cont

$m_1 = 0.0500004\ kg = \boxed{0.050\ kg}$

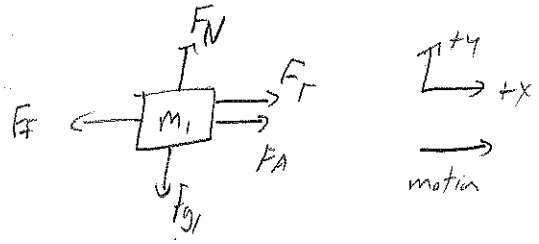
b) $F_{Net,2} = F_A + F_{g2} - F_T = m_2 a_2$

$F_T = F_A + F_{g2} - m_2 a_2 = F_A + m_2(g - a_{sys})$

$= 0.7616N + (0.0500004\ kg)(9.81 m/s^2 - 0.296 m/s^2)$

$= 1.237335\ N = \boxed{1.24\ N}$

c) If same F_A on pencil case instead, a_{sys} still the same



$F_{Net,1,x} = F_T + F_A - F_f = m_1 a_1$

$F_T = m_1 a_1 + F_f - F_A$

$= m_1 a_1 + \mu_K m_1 g - F_A$

$= m_1(a_{sys} + \mu_K g) - F_A$

$= (0.750\ kg)(0.296 m/s^2 + (0.138)(9.81 m/s^2)) - 0.7616\ N$

$= 0.475735\ N = \boxed{0.48\ N}$

#3d) $F_{net,sys} = F_{g2} - F_f = m_{sys}\, a_{sys}$

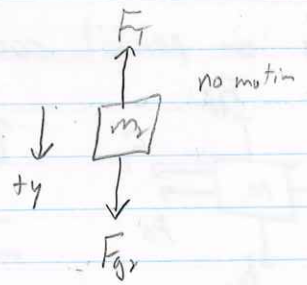
$$a_{sys} = \frac{m_2 g - \mu_K m_1 g}{m_1 + m_2}$$

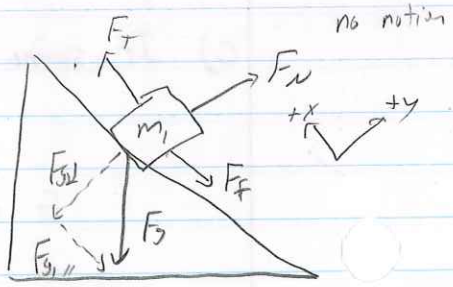
$$= \frac{(0.050004\,kg)(9.81\,m/s^2) - (0.138)(0.750\,kg)(9.81\,m/s^2)}{(0.750\,kg + 0.050004\,kg)}$$

$$= -0.655996\,m/s^2 = \boxed{-0.66\,m/s^2}$$

"−" means slowing down

#4) $m_2 = 120\,g$
$m_1 = 150\,g$
$\theta = 25°$
$\vec{a}_{1y} = 0\,m/s^2$
$a_{sys} = 0\,m/s^2$
$\vec{g} = 9.81\,m/s^2$ [down]
$\mu_s = ?$





Assume if could move, hanging mass would descend. (*)

$$F_{net,sys} = F_{g2} - F_{g1//} - F_f = m_{sys}\, a_{sys} = 0N$$

$$\therefore F_T = F_{g2} - F_{g1//} = m_2 g - m_1 g \sin\theta$$

$$F_{net,1y} = F_N - F_{g\perp} = m a_{1y} = 0N \rightarrow F_N = F_{g\perp} \rightarrow F_f = \mu_s F_N = \mu_s F_{g\perp}$$

$$\therefore \mu_s m_1 g \cos\theta = m_2 g - m_1 g \sin\theta$$

$$\mu_s = \frac{m_2 - m_1 \sin\theta}{m_1 \cos\theta} = \frac{(120_g) - (150_g)\sin(25°)}{(150_g)\cos(25°)}$$

$$= 0.41639 = 0.4$$

(*) If you assumed other direction for F_f, would get -0.4 which means choice of direction was wrong.

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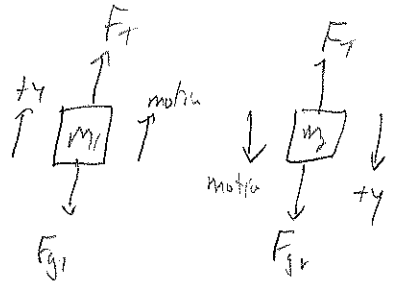
#5) $m_1 = 0.25\, m_2$ ← m_2 is heavier mass

$\vec{g} = 9.81\ m/s^2$ [down]

$m_{sys} = m_1 + m_2 = 1.25\, m_2$

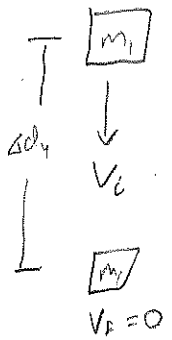


a) $F_{net,sys} = F_{g2} - F_{g1} = m_{sys}\, a_{sys}$

$$a_{sys} = \frac{m_2 g - m_1 g}{m_{sys}} = \frac{m_2 g - 0.25 m_2 g}{1.25 m_2} = \frac{0.75}{1.25} g$$

$$a_{sys} = \frac{3}{5} g = 5.886\ m/s^2 = \boxed{5.89\ m/s^2}$$

b)



$\vec{V}_i = 4.6\ m/s$ [down] $\quad \vec{a}_1 = 5.89\ m/s^2$ [up]

$\Delta d_y = ?$ [down]

$\vec{V}_f = 0\ m/s$ [down]

$$V_f^{2\to 0} = V_i^2 + 2 a_1 \Delta d_y$$

$$V_i^2 = -2 a \Delta d_y$$

$$\Delta d_y = \frac{V_i^2}{-2a} = \frac{(4.6\ m/s)^2}{-2(-5.886\ m/s^2)} = 1.79749\ m = \boxed{1.8\ m}$$

c) $\Delta \vec{V} = \vec{a}\, \Delta t \rightarrow \vec{V}_f - \vec{V}_i = \vec{a}_1 \Delta t \rightarrow \Delta t = \frac{V_f - V_i}{a_1} = \frac{0\ m/s - 4.6\ m/s}{-5.886\ m/s^2}$

$$\Delta t = 0.7815\ s = \boxed{0.78\ s}$$

d) $\vec{F}_A = -1.00\,N$ [sys dir] $\quad a_{sys} = 0\ m/s^2$

$m_2 = ?$

$$F_{Net,sys} = F_{g2} - F_{g1} - F_A = m_{sys}\, a_{sys} = 0\,N$$

$$m_2 g - m_1 g = F_A$$

$$m_2 g - 0.25\, m_2 g = F_A$$

$$0.75\, m_2 g = F_A$$

$$\therefore m_2 = \frac{F_A}{0.75\, g} = \frac{1.00\,N}{0.75\,(9.8\,m/s^2)} = 0.13592\ kg$$

$$= \boxed{136\ g}$$