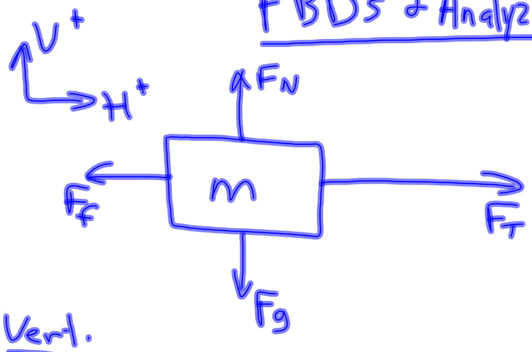
FBD's & Analyzing Forces



$F_{NET} = F_T - F_f$

$F_{NET} = ma$

$\therefore ma = F_T - F_f$

Hor.

Vert.

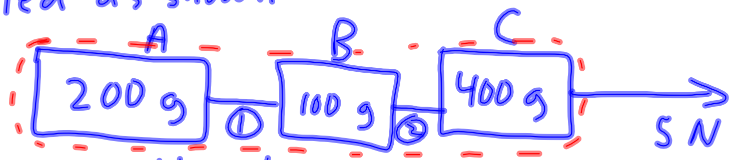
$F_{NET} = 0$

$F_{NET} = F_N - F_g$

$\therefore F_N = F_g$

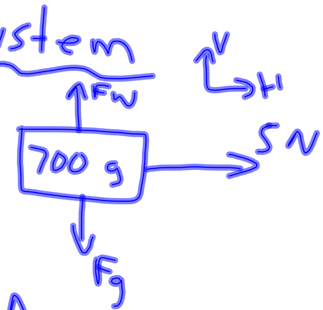
Train Problems...

A series of 3 toy trains is being pulled as shown:



Determine the tension in each of the ropes attaching the trains.

System



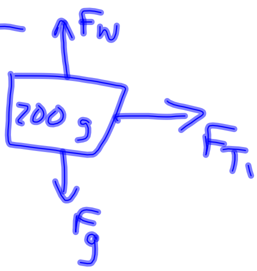
Hor.

$F_{NET} = ma$
$F_{NET} = 5$

$5 = 0.7a$

$a = 7.14\ \frac{m}{s^2}$

A



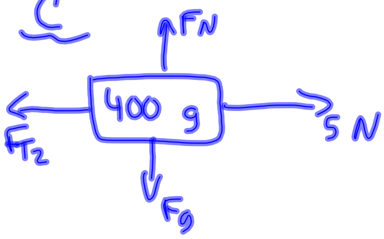
Hor.

$F_{NET} = ma$
$= (0.2)(7.14)$
$= 1.43\ N$

$F_{NET} = F_{T_1}$

$\therefore F_{T_1} = 1.43 N$

C



Hor.

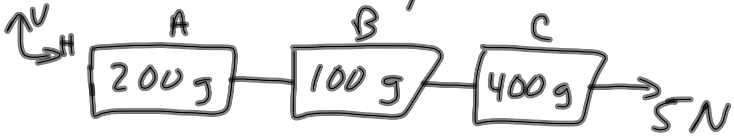
$F_{NET} = ma$
$= (0.4)(7.14)$
$= 2.86\ N$

$F_{NET} = 5 - F_{T_2}$

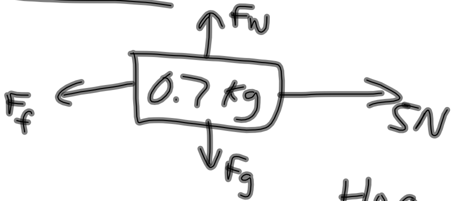
$\therefore 2.86 = 5 - F_{T_2}$

$F_T = 2.14\ N$

With Friction... $\mu = 0.4$



System



Vert.

$F_{NET} = 0$

$F_{NET} = F_g - F_N$

$\therefore F_N = F_g$

$= (0.7)(9.8)$

$= 6.86\ N$

Hor

$F_{NET} = 0.7a$

$F_{NET} = 5 - F_f$

$= 5 - \mu F_N$

$= 5 - (0.4)(6.86)$

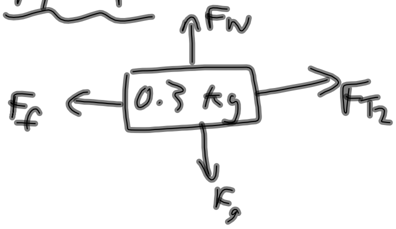
$= 5 - 2.74$

$= 2.26\ N$

$\therefore 0.7a = 2.26$

$a = 3.22\ \frac{m}{s^2}$

A & B



Vert.

$F_N = F_g$

$= (0.3)(9.8)$

$= 2.94\ N$

Hor.

$F_{NET} = ma$

$= (0.3)(3.22)$

$= 0.966\ N$

$F_{NET} = F_{T_2} - F_f$

$0.966 = F_{T_2} - \mu F_N$

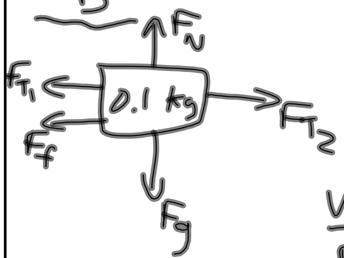
$= F_{T_2} - (0.4)(2.94)$

$0.966 = F_{T_2} - 1.176$

$\therefore F_{T_2} = 1.176 + 0.966$

$= 2.142\ N$

B



Vert.

$F_N = F_g$

$= 0.98\ N$

Hor.

$F_{NET} = ma$

$= (0.1)(3.22)$

$= 0.322\ N$

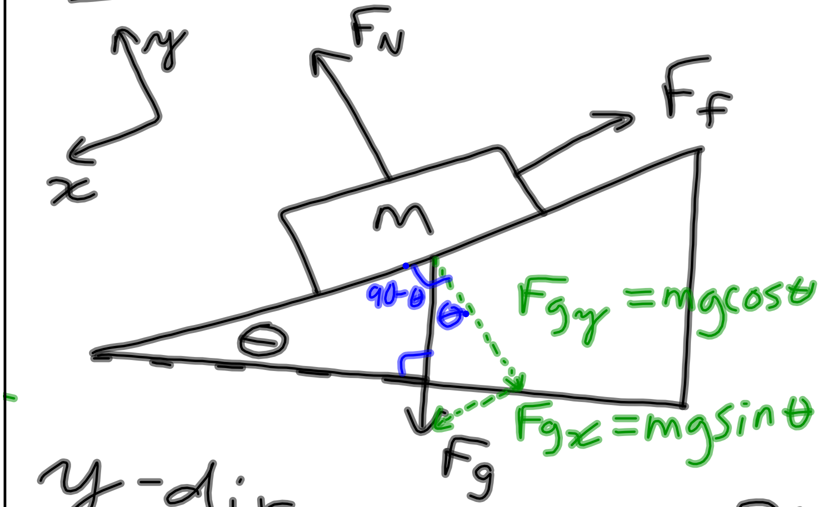
$F_{NET} = F_{T_2} - F_{T_1} - F_f$

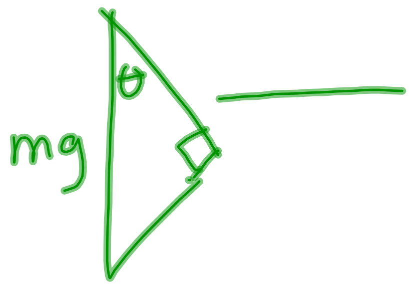
$0.322 = 2.142 - F_{T_1} - (0.4)(0.98)$

$F_{T_1} = 2.142 - 0.322 - 0.392$

$= 1.428\ N$

Ramps





y-dir

$F_{NET} = F_N - F_{gy}$

$= F_N - mg\cos\theta$

$F_{NET} = 0$

$\therefore F_N = mg\cos\theta$

x-dir

$F_{NET} = F_{gx} - F_f$

$= mg\sin\theta - \mu F_N$

$= mg\sin\theta - \mu mg\cos\theta$

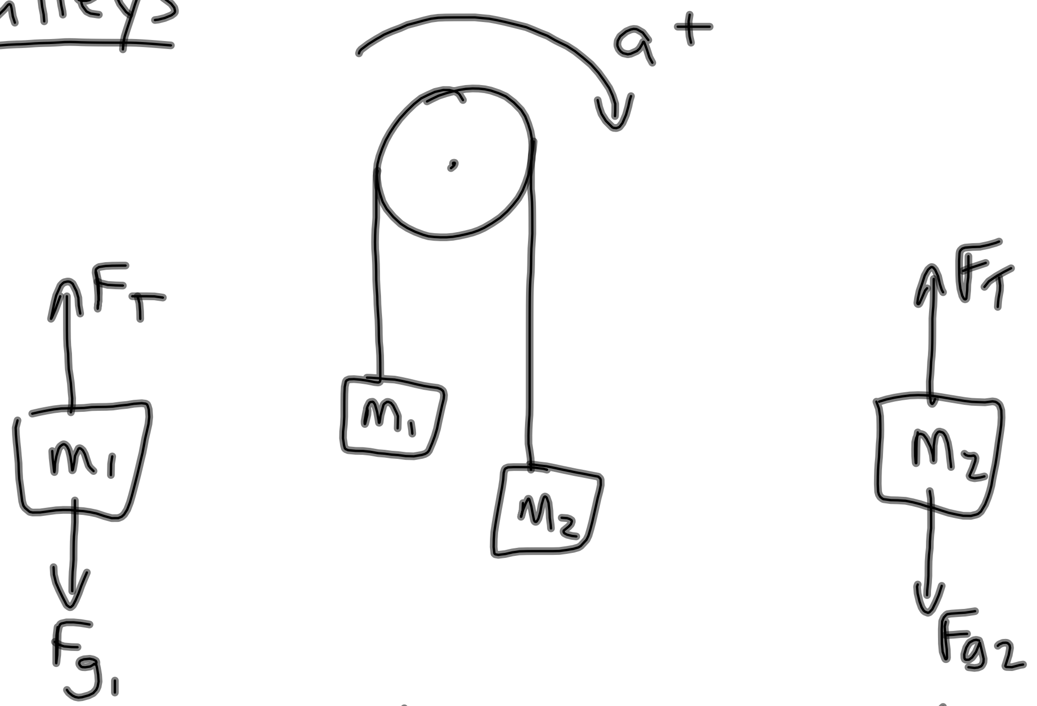
$F_{NET} = ma$

$\therefore ma = mg\sin\theta - \mu mg\cos\theta$

$a = g\sin\theta - \mu g\cos\theta$

- $g\sin\theta$: $\vec{a}$ due to gravity / as $\theta\uparrow$, this $\uparrow$
- $\mu g\cos\theta$: retarding due to friction / as $\theta\uparrow$, this $\downarrow$

Pulleys



$$F_{NET} = F_T - F_{g1}$$

$$F_{NET} = m_1 a$$

$$m_1 a = F_T - m_1 g$$

$$F_T = m_1 a + m_1 g$$

$$= m_1(a+g)$$

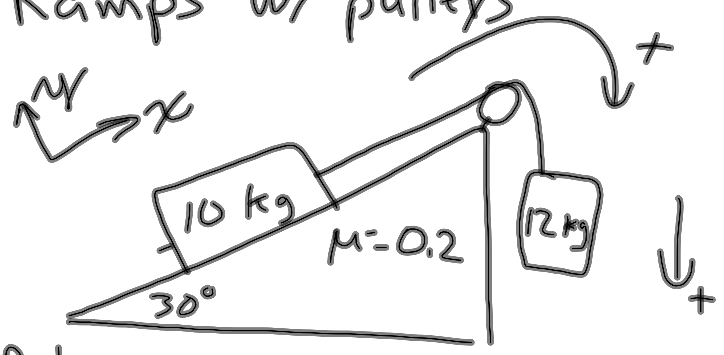
$$F_{NET} = F_{g2} - F_T$$

$$F_{NET} = m_2 a$$

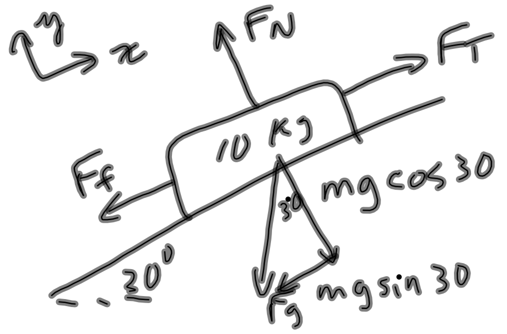
$$m_2 a = m_2 g - F_T$$

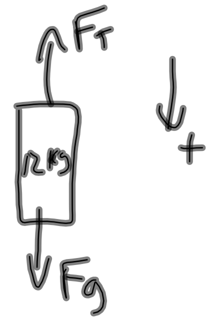
$$m_2 a = m_2 g - m_1(a+g)$$

Ramps w/ pulleys



Determine $\vec{a}$ & F_T





$F_{NET} = 12a$

$F_{NET} = F_g - F_T$

$\therefore$ $\boxed{12a = 117.6 - F_T}$

$F_T = 117.6 - 12a$

y-dir

$F_{NET} = 0$

$F_{NET} = F_N - mg\cos 30$

$\therefore F_N = mg\cos 30$

$= (10)(9.8)\cos 30$

$= 84.9\ N$

x-dir

$F_{NET} = F_T - mg\sin 30 - F_f$

$= F_T - (10)(9.8)\sin 30 - \mu F_N$

$= F_T - 49 - (0.2)(84.9)$

$= F_T - 66$

$F_{NET} = ma$

$\boxed{\therefore 10a = F_T - 66}$

$10a = 117.6 - 12a - 66$

$a = 2.35\ \frac{m}{s^2}$

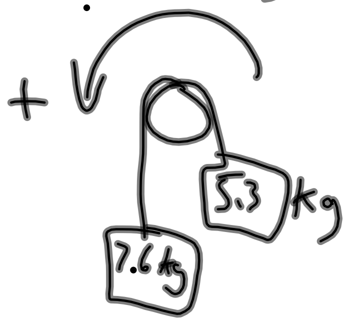
sub

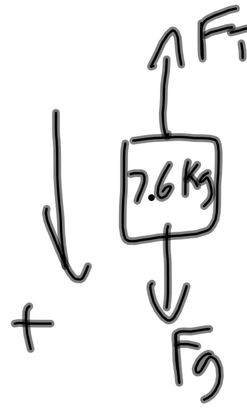
$23.5 = F_T - 66$

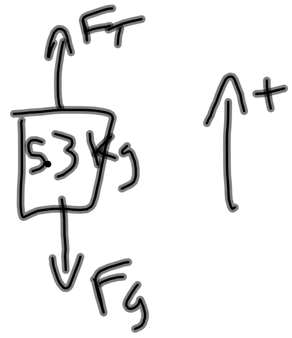
$89.5 = F_T$

- FBDs
- $\Sigma F = F_{NET}$ } each component
- $ma = F_{NET}$ }
- tie in objects somehow (common $\vec{a}$, F_T ...)

1)







$F_{NET} = F_g - F_T$

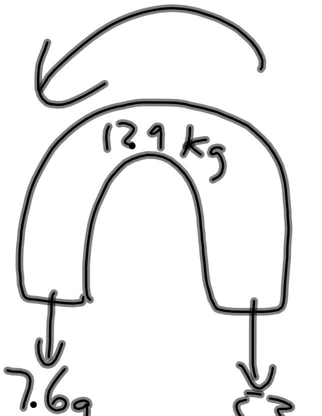
$ma = (7.6)(9.8) - F_T$

$7.6a = 74.5 - F_T$

$F_{NET} = F_T - F_g$

$5.3a = F_T - 51.9$

$F_T = 5.3a + 51.9$



$7.6a = 74.5 - (5.3a + 51.9)$

$7.6a = 74.5 - 5.3a - 51.9$

$12.9a = 74.5 - 51.9$

$a = \frac{22.6}{12.9}$

$= 1.75\ \frac{m}{s^2}$

$t = 1.2\ s$

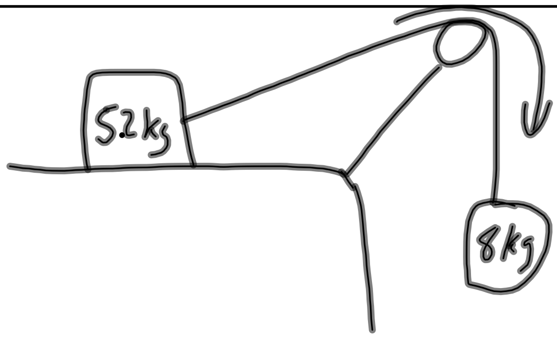
$v_1 = 0$

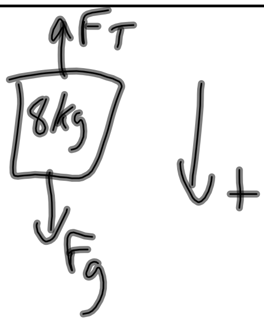
$d = v_1 t + \frac{1}{2}at^2$

$d = \frac{1}{2}(1.75)(1.2)^2$

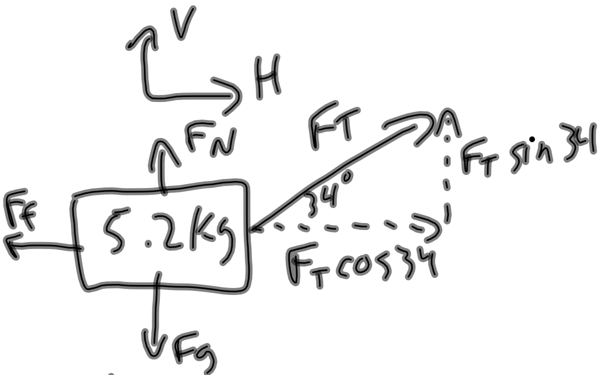
$= 1.26\ m$

$\vec{d} = 1.26\ m\ [\downarrow]$





$$F_{NET} = F_g - F_T$$
$$8a = 78.4 - F_T$$
$$\boxed{F_T = 78.4 - 8a}$$



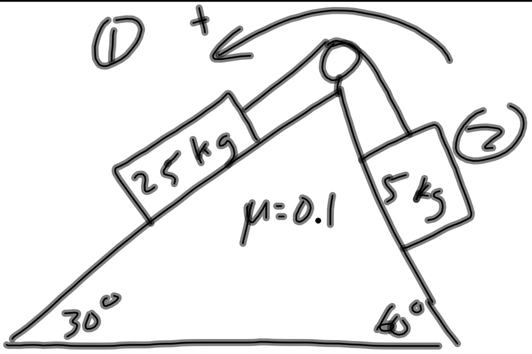
vert

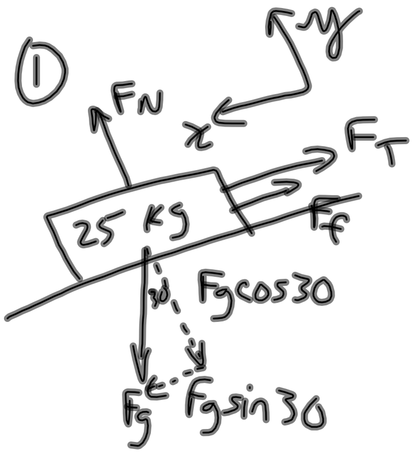
$$F_{NET} = F_N + F_T \sin 34 - 5.2g$$
$$\therefore 0 = F_N + F_T \sin 34 - 5.2g$$
$$F_N = 5.2g - F_T \sin 34$$

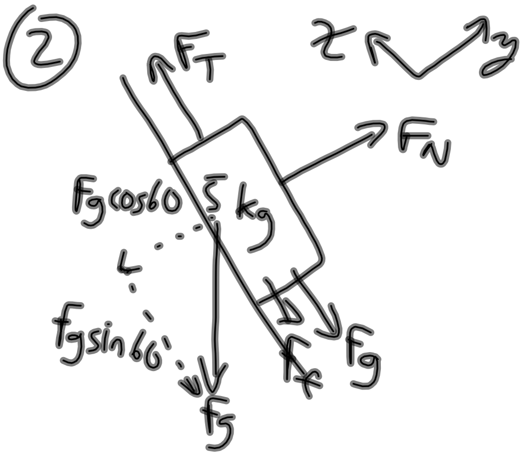
Hor.

$$F_{NET} = F_T \cos 34 - F_f$$
$$5.2a = F_T \cos 34 - (0.27)(5.2g - F_T \sin 34)$$
$$= F_T \cos 34 - 1.4g + 0.27 F_T \sin 34$$
$$5.2a = 0.829 F_T - 13.72 + 0.151 F_T$$
$$\boxed{5.2a = 0.98 F_T - 13.72}$$
$$5.2a = 0.98(78.4 - 8a) - 13.72$$
$$5.2a = 76.8 - 7.84a - 13.72$$
$$13.04a = 63.1$$
$$a = 4.84 \frac{m}{s^2}$$
$$d = 0.67 \text{ m}$$

$$v_i = 0 \quad d = \cancel{v_i t} + \frac{1}{2}at^2$$
$$0.67 = 2.42t^2$$
$$t = 0.53 \text{ s}$$







y-dir.

$F_{NET} = 0$

$F_{NET} = F_N - mg\cos 30$

$\therefore F_N = (25)(9.8)(0.866)$

$F_N = 212\ N$

x-dir

$F_{NET} = 25a$

$F_{NET} = F_g\sin 30 - F_T - F_f$

$25a = 122.5 - F_T - (0.1)(212)$

$25a = 122.5 - F_T - 21.2$

$\boxed{25a = 101.3 - F_T}$

$25(1.88) = 100.3 - F_T$

$\boxed{F_T = 53.3\ N}$

y-dir

$0 = F_N - F_g\cos 60$

$F_N = 24.5\ N$

x-dir.

$5a = F_T - F_g\sin 60 - F_f$

$5a = F_T - 42.4 - (0.1)(24.5)$

$\boxed{5a = F_T - 44.85}$

$25a = 101.3 - F_T$

$5a = -44.85 + F_T$

$30a = 56.45$

$\boxed{a = 1.88\ \frac{m}{s^2}}$