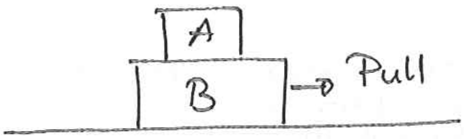
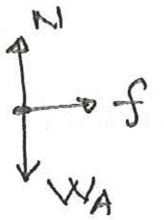
4.28)



a) If table is frictionless:

FBD of A:



N: normal force B exerts on A

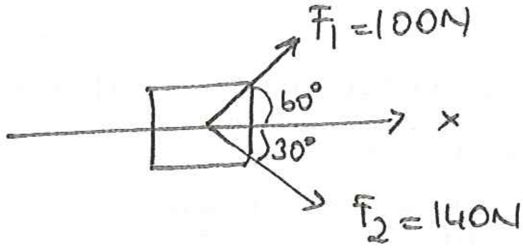
f: friction force

W_A: weight of A.

b) Pull = friction of table

FBD of A:

4.37)



a) Smallest F_3 to move in $+x$ direction.

$$\sum F_y = 0$$

$$F_{1y} + F_{2y} + F_{3y} = 0$$

$$F_{3y} = -(F_{1y} + F_{2y})$$

$$= -(F_1 \sin 60° - F_2 \sin 30°)$$

$$F_{3y} = -16.6N$$

For smallest $F_{3x} = 0$

$$\vec{F_3} = -16.6 N \hat{j}$$

b) $\sum F_x = F_{1x} + F_{2x} + F_{3x} = m a_x$

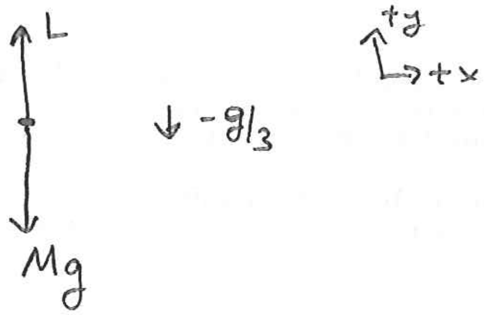
$$= F_1 \cos 60° + F_2 \cos 30° + 0 = m a_x$$

$$m = \frac{F_1 \cos 60° + F_2 \cos 30°}{(2.0 m/s^2)} = 85.6 kg$$

$$W = mg = 840N.$$

4.56)

a)

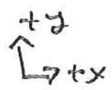


b) $\Sigma F_y = m a_y$

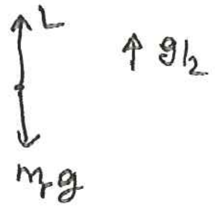
$$L - Mg = -M\frac{g}{3}$$

$$L = \frac{2Mg}{3}$$

c) m_r: remaining mass



final case FBD



$\Sigma F_y = m a_y$

$$L - m_r g = m_r\, g/2$$

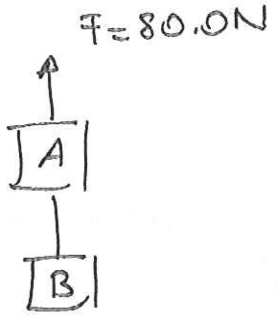
$$L = \frac{3 m_r g}{2} \quad \text{, Lift force remaining same}$$

$$L = \frac{2Mg}{3} \quad \text{(from part a)}$$

$$\frac{3 m_r \cancel{g}}{2} = \frac{2M\cancel{g}}{3} \Rightarrow m_r = \frac{4M}{9}$$

$\Rightarrow M - \frac{4M}{9} = \frac{5M}{9}$ of mass should be dropped.

4.57)



Tension = 36.0N

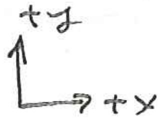
B descends 12m in 4s.

a) Mass of box B ?

Constant force → constant acceleration.

$$y-y_0 = \cancel{v_{0y}}\, t + \frac{1}{2} a_y t^2$$

0 (initialy at rest)



$$-a_y = \frac{-2(y-y_0)}{t^2} = \frac{2\,(12.0m)}{(4.0s)^2} = 1{,}5\,m/s^2$$

FBD of B:

$$\Sigma F_y = m a_y$$

$$T - m_B g = -m_B a_y$$

$$T = m_B (g - a_y)$$

$$m_B = \frac{T}{(g-a_y)} = \frac{36{,}0N}{(9{,}8m/s^2 - 1{,}5m/s^2)}$$

$$m_B = 4{,}34kg.$$

b) FBD of A:

$$\Sigma F_y = m a_y$$

$$F - T - m_a g = -m_a a_y$$

$$F - T = m_a (g - a_y)$$

$$m_a = \frac{F-T}{(g-a_y)} \Rightarrow m_a = 5{,}30kg.$$

4.60) $\vec{F} = k_1 \hat{\imath} + k_2 t^3 \hat{\jmath}$, $\vec{v}(t) = ?$

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

$\vec{a} = \frac{\vec{F}}{m} = \frac{k_1}{m} \hat{\imath} + \frac{k_2}{m} t^3 \hat{\jmath}$

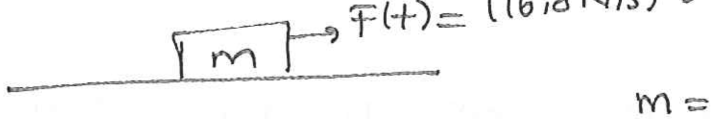
$\vec{v} = \vec{v}_0 + \int_0^t \vec{a}(t)\,dt$, $v_0 = 0$ (initlaly at rest)

$\vec{v} = \frac{1}{m} \int_0^t \vec{F}(t)\,dt$

$= \frac{1}{m} \int_0^t (k_1 \hat{\imath} + k_2 t^3 \hat{\jmath})\,dt$

$\vec{v}(t) = \frac{k_1}{m} t \hat{\imath} + \frac{k_2}{4m} t^4 \hat{\jmath}$

4.61)



$m = 45\ kg$

$F_x(t) = m\,a_x(t)$

$$a_x(t) = \frac{F_x(t)}{m} = \frac{16{,}8\ N/s}{45\ kg}\,t = (0{,}373\ m/s^3)\,t$$

$$v_x(t) = \cancel{v_0} + \int^{t} a_x(t')\,dt'$$

0 (initially at rest)

$$v_x(t) = (0{,}373\ m/s^3) \int t'\,dt'$$

$$v_x(t) = (0{,}186\ m/s^3)\,t^2$$

$$x - x_0 = \int_0^t v_x(t')\,dt' = (0.186\ m/s^3) \int_0^t t'^2\,dt'$$

$$x - x_0 = \frac{0.186\ m/s^3}{3}\,t^3$$

in 5s ; $$x - x_0 = \frac{(0.186\ m/s^3)}{3}\,(5s)^3$$

$$x - x_0 = 7.78\ m$$

4.62) $F_x(t) = k_1 + k_2 y$ $\quad F_y(t) = k_3 t$ $\quad \vec{v}(t) = ?$

$\vec{r}(t) = ?$

F_x depends on y, so we should start from F_y.

$$a_y = \frac{F_y}{m} = \left(\frac{k_3}{m}\right) t$$

$$v_y = \underbrace{\cancel{v_{0y}}}_{0} + \int_0^t \frac{k_3}{m} t' \, dt'$$

0 initially at rest

$$\boxed{v_y = \frac{k_3 t^2}{2m}}$$

$$y = \underbrace{\cancel{y_0}}_{0} + \int_0^t v_y(t') \, dt$$

0 (starts from origin)

$$y = \int_0^t \frac{k_3}{2m} t'^2 \, dt' = \frac{k_3}{6m} t^3 \qquad \boxed{y = \frac{k_3 t^3}{6m}}$$

$$F_x(t) = k_1 + \frac{k_2 k_3}{6m} t^3$$

$$a_x = \frac{k_1}{m} + \frac{k_2 k_3}{6m^2} t^3$$

$$v_x = \int_0^t a_x(t') \, dt' = \frac{k_1}{m} \int dt' + \frac{k_2 k_3}{6m^2} \int^t t'^3 \, dt'$$

$(v_{0x} = x_0 = 0$ again$)$ $\quad \boxed{v_x = \frac{k_1}{m} t + \frac{k_2 k_3}{24m^2} t^4}$

$$x = \int_0^t v_x(t') \, dt' = \frac{k_1}{m} \int_0^t t' \, dt' + \frac{k_2 k_3}{24m^2} \int_0^t t'^4 \, dt'$$

$$\boxed{x = \frac{k_1 t^2}{2m} + \frac{k_2 k_3 t^5}{120m^2}}$$

$$\vec{v}(t) = v_x \hat{\imath} + v_y \hat{\jmath}$$

$$\vec{v}(t) = \left(\frac{k_1}{m} t + \frac{k_2 k_3}{24m^2} t^4\right)\hat{\imath} + \frac{k_3}{2m} t^2 \hat{\jmath}$$

$$\vec{r}(t) = x \hat{\imath} + y \hat{\jmath}$$

$$\vec{r}(t) = \left(\frac{k_1 t^2}{2m} + \frac{k_2 k_3 t^5}{120m^2}\right)\hat{\imath} + \left(\frac{k_3 t^3}{6m}\right)\hat{\jmath}$$