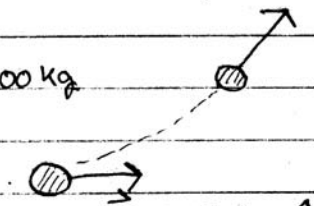
4-5)

$m = 4.00\,kg$



$V_f = 8\frac{m}{s}\hat{i} + 10\frac{m}{s}\hat{j}$, $t = 8s$

$\vec{V_i} = 3\,m/s\,\hat{i} + 0\hat{j}$, $t=0$

Find the components of the forces. We do not have a relationship between force and velocity, but acceleration connects these two quantities.

$$a_x = \frac{V_{fx} - V_{ix}}{t} = \frac{8\,m/s - 3\,m/s}{8s} = \frac{5\,m/s}{8s} = .625\,m/s^2$$

$$a_y = \frac{V_{fy} - V_{iy}}{t} = \frac{10\,m/s}{8s} = 1.25\,m/s^2$$

$$F_x = m\,a_x = 4\,kg\,(.625\,m/s^2) = 2.5\,N$$

$$F_y = m\,a_y = 4kg\,(1.25\,m/s^2) = 5\,N$$

$$F = \left(F_x^2 + F_y^2\right)^{1/2}$$

$$F = \left((2.5\,N)^2 + (5N)^2\right)^{1/2}$$

$$F = 5.6\,N$$

4-8)

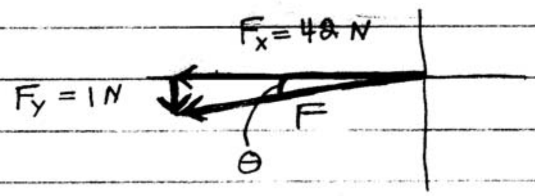
a) $\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$

$\vec{F} = (-2\hat{\imath} + 2\hat{\jmath}) + (5\hat{\imath} - 3\hat{\jmath}) + (-45\hat{\imath})$

Add "like" Components

$\vec{F} = -42\hat{\imath} - 1\hat{\jmath}$ this is the total fore

The direction of the ~~total force~~ and overall acceleration are the same. Draw a diagram of the components



$F = (F_x^2 + F_y^2)^{1/2}$

$F = ((42N)^2 + (1N)^2)^{1/2} = 42.01\ N$

$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = \tan^{-1}\left(\frac{1N}{42N}\right)$

$\theta = 1.36$

b) $m = \frac{F}{a} = \frac{42.01\ N}{3.75\ m/s^2} = 11.2\ kg$

c) $V_f = V_i + at = 3.75\ m/s^2 (10s) = 37.5\ m/s$

d) $a_x = F_x/m = \frac{-42N}{11.2\ kg} = -3.75\ m/s^2$

$V_{xf} = V_{xi} + a_x t = -3.75\ m/s^2\ 10s = -37.5\ m/s$ same metho for V_y

4-11

My mass is 80 kg. In Paris, I would weigh

$F_{gp} = m g_p = 80 \text{ kg} (9.8095 \text{ m/s}^2)$

$F_{gp} = 784.76 \text{ N}$

In Cayenne, I would weigh

$F_{gc} = m g_c = 80 \text{ kg} (9.7808 \text{ m/s}^2)$

$F_{gc} = 782.464 \text{ N}$

$\Delta F_g = 784.76 - 782.464 \text{N} = 2.296 \text{ N}$ roughly ½ lb

4-13)

we are given the change in velocity and want to find the force. Each of these quantities is related to acceleration.

$x_i = 0m$ $\qquad$ $x_f = .05\,m$

$v_i = 3\times10^5\,m/s$ $\qquad$ $v_f = 7\times10^5\,m/s$

$$v_{fx}^2 = v_{ix}^2 + 2a_x(x_f - \cancel{x_i}^{\,0})$$

$$a_x = \frac{v_{fx}^2 - v_{ix}^2}{2x_f} = \frac{40\times10^{10}\,m^2/s^2}{2\,(.05m)} = 4\times10^{12}\,\frac{m}{s^2}$$

$$F_x = ma_x = 9.1\times10^{-31}\,kg\,(4\times10^{12}\,m/s^2) = 3.64\times10^{-18}\,N$$

$$F_g = mg = 9.1\times10^{-31}\,kg\;9.8\,m/s^2 = 8.9\times10^{-30}\,N$$

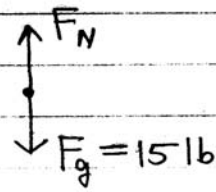
$$F_x/F_g = \frac{3.64\times10^{-18}\,N}{8.9\times10^{-30}\,N} = 4.08\times10^{11}$$

F_x 408 $\times10^{11}$ times larger Than F_g

4-17)

Note lbs are units of force not mass. lbs are analagous to Newtons not kilograms.

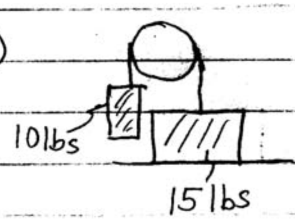
a)



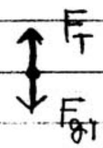
$$\Sigma F_y = ma_y = 0 \quad \text{static}$$

$$F_N - F_g = 0 \quad \therefore F_N = F_g = 15\,lb$$

b)



consider 10 lb object FBD below

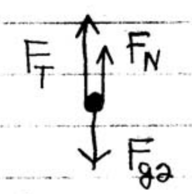


$$\Sigma F_y = F_T - F_{g1} = ma_y$$

$$F_T - F_{g1} = 0$$

$$F_T = F_{g1}$$

consider 15 lb object FBD below



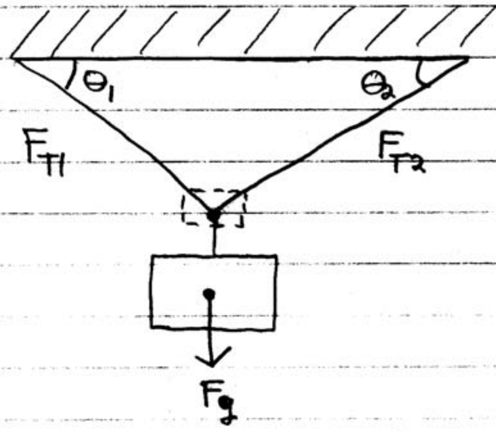
$$\Sigma F_y = ma_y = 0 \quad \text{static}$$

$$F_T + F_N - F_{g2} = 0$$

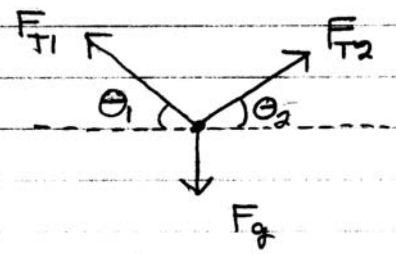
$$F_N = F_{g2} - F_T = 15\,lbs - 10\,lbs = 5\,lbs$$

c) 20 lb is greater than 15 lb so the 15 lb object accelerates upward so no longer in contact with surface $F_N = 0$

4-19



FBD for point where ropes are joined



Forces in x direction

$F_{T1x} = F_{T1} \cos\theta_1$

$F_{T2x} = F_{T2} \cos\theta_2$

Forces in y direction

$F_{T1y} = F_{T1} \sin\theta_1$

$F_{T2y} = F_{T2} \sin\theta_2$

F_g

solve Newton's 2nd Law in x then y. $a_x = a_y = 0$. static

$$\Sigma F_x = F_{T2x} - F_{T1x} = F_{T2} \cos\theta_2 - F_{T1} \cos\theta_1 = 0$$

Thus $F_{T2} = F_{T1} \dfrac{\cos\theta_1}{\cos\theta_2}$ Equation 1

$$\Sigma F_y = F_{T1y} + F_{T2y} - F_g = 0$$

$F_{T1} \sin\theta_1 + F_{T2} \sin\theta_2 - F_g = 0$ Equation 2

4-19)

the equation we are deriving does not contain F_{T2} so we can replace F_{T2} in equation 2 with F_{T2} from equation 1

$$F_{T1}\sin\theta_1 + \left(F_{T1}\frac{\cos\theta_1}{\cos\theta_2}\right)\sin\theta_2 = F_g$$

Now mult. both sides by $\cos\theta_2$ and The RHS will start to look like the desired expression.

$$F_{T1}\sin\theta_1\cos\theta_2 + F_{T1}\cos\theta_1\sin\theta_2 = F_g\cos\theta_2$$

$$F_{T1}\left(\sin\theta_1\cos\theta_2 + \cos\theta_1\sin\theta_2\right) = F_g\cos\theta_2$$

Trig ID $\sin(\theta_1+\theta_2) = \sin\theta_1\cos\theta_2 + \cos\theta_1\sin\theta_2$

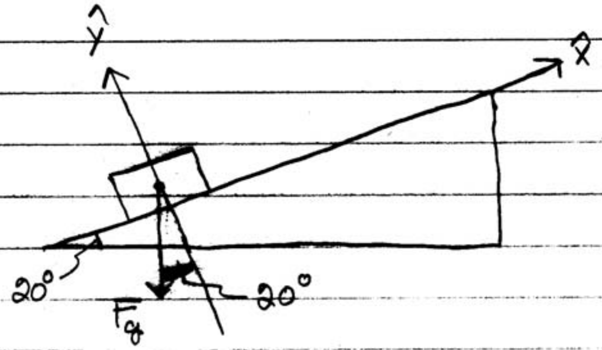
thus

$$F_{T1}\sin(\theta_1+\theta_2) = F_g\cos\theta_2$$

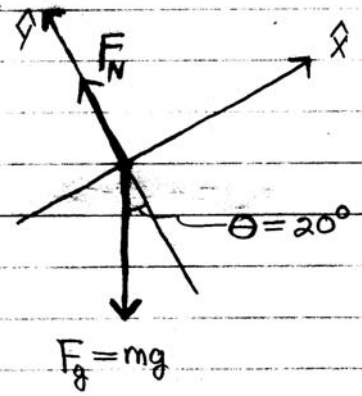
$$F_{T1} = \frac{F_g\cos\theta_2}{\sin(\theta_1+\theta_2)}$$

notice as θ_1 and θ_2 get small F_{T1} must get big. Does this make sense?

4-29)



Choose x coordinate up the incline and y coordinate perpendicular to the plane. Consider FBD for box on the plane



$$F_{gx} = F_g \sin\theta = mg\sin\theta$$

Note θ angle w/vertical

$$F_{gy} = F_g \cos\theta = mg\cos\theta$$

Sep into x & y components

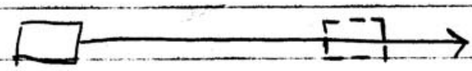
$$\Sigma F_x = m a_x$$

$$-mg\sin\theta = m a_x \qquad a_x = -g\sin\theta = -9.8\,m/s^2 \sin(20)$$

down ramp

$$a_x = -3.35\ m/s^2$$

4-29) Continued. Now that we have acceleration this becomes a chapter 2 problem.



$V_i = 5.00\ m/s$ $\qquad$ $V_f = 0\ m/s$

$x_i = 0$ $\qquad$ $x = ?$

$t = ?$

$a_x = -3.35\ m/s^2$

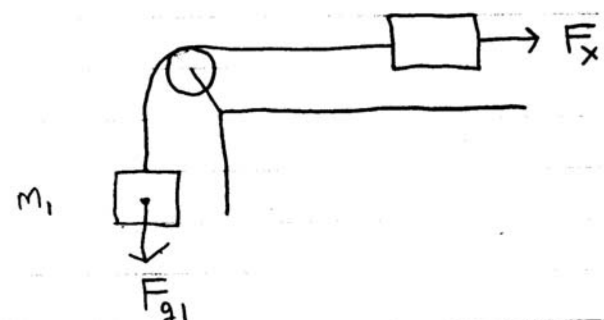
$$V_f^2 = V_i^2 + 2a(x_f - x_i)$$

$$x_f = \frac{-V_i^2}{2a} = \frac{-(5.00\ m/s)^2}{2(-3.35\ m/s^2)}$$

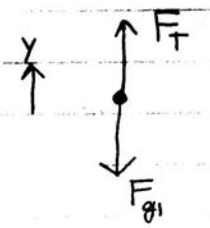
$$x_f = 3.73\ m$$

4-35-C) Do first

In order to answer the plotting question, lets find the acceleration of the system as a function of F_x



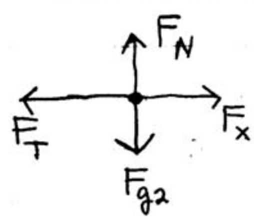
consider object 1



$$\Sigma F_y = m a_y$$

$$F_T - F_{g1} = m_1 a_1 \quad \text{Eq 1}$$

Consider object 2



$$\Sigma F_x = m a_x$$

$$-F_T + F_x = m_2 a_2 \quad \text{Eq 2}$$

note $a_1 = a_2$

we can add equations 1 & 2 to eliminate F_T

$$F_T - F_{g1} = m_1 a_1$$

$$-F_T + F_x = m_2 a_1 \qquad \text{Note } a_1 = a_2$$

$$F_x - F_{g1} = (m_1 + m_2) a_1$$

4-35-c) cont.

thus

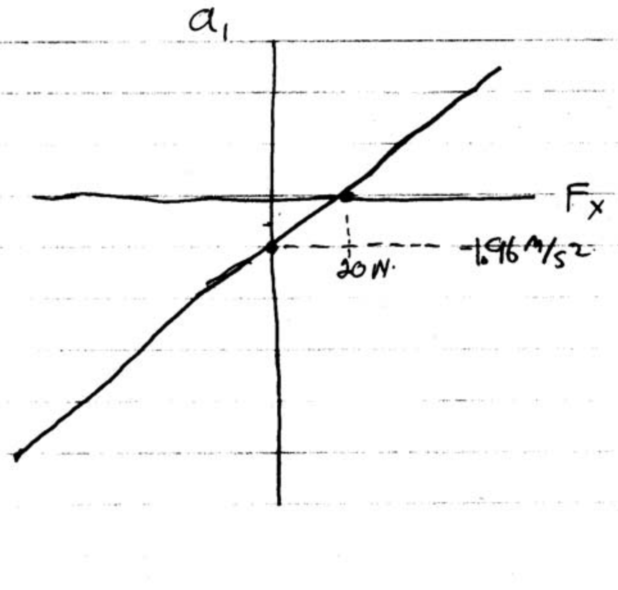
$$a_1 = \frac{1}{(m_1+m_2)} F_x - \frac{m_1 g}{(m_1+m_2)}$$

Note the linear relationship between a_1 and F_x of the form

$$y = \text{slope } x + \text{intercept}$$

$$\text{slope} = \frac{1}{m_1+m_2} = \frac{1}{(2\,kg + 8\,kg)} = .1\ kg^{-1}$$

$$\text{intercept} = -\frac{m_1 g}{(m_1+m_2)} = -\frac{2\,kg\ 9.8\,m/s^2}{10\,kg} = -1.96\,m/s^2$$



4-35-a&b

Now using the relationship between a_1 an F_x, we can address parts a & b (There are other ways)

a) For what values of F_x does the system accelerate upwards (to the right for m_2). This occurs when: $a_1 \geq 0$.

if $a_1 \geq 0$

$$0 \leq \frac{1}{(m_1+m_2)} F_x - \frac{m_1 g}{(m_1+m_2)}$$

$$F_x \geq m_1 g = 2\,kg\,(9.8\,m/s^2) = 19.6\,N$$

b) When $F_T = 0$, $a_1 = -9.8\,m/s^2$.

$$a_1 = \frac{1}{m_1+m_2} F_x - \frac{m_1 g}{m_1+m_2}$$

$$(m_1+m_2)\,a_1 = F_x - m_1 g$$

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

$$F_x = -8\,kg(9.8\,m/s^2) - 78.4\,N$$