Solutions to HWK 3
PHY 131

(1)

The mass of the astronaut is $m = \frac{w}{g} = \frac{700}{9.8}$

$m = 71.4$ Kg

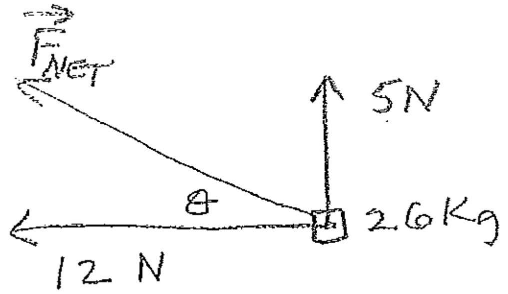
a) mass on moon = **71.4 Kg**

Weight on moon = $\frac{700\text{ N}}{6}$ = **116.7 N** since $g_{moon} \approx \frac{g_{earth}}{6}$

b) mass during trip = **71.4 Kg**

weight during trip = **0 Newtons**

(2)



$$\vec{F}_{net} = -12\hat{i} + 5\hat{j} \quad N$$

$$|\vec{F}_{net}| = \sqrt{12^2 + 5^2} = 13 N$$

a) $|\vec{F}_{net}| = 13N$

$$\tan\theta = \frac{5}{12}$$

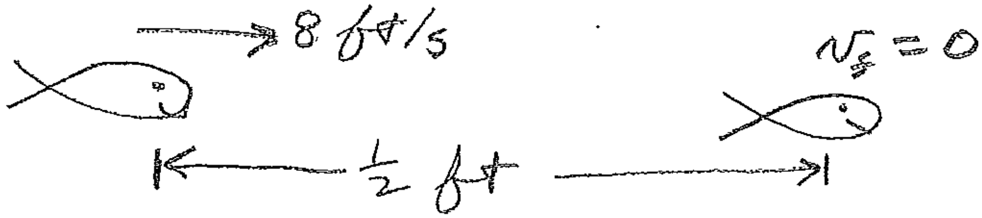
$\theta = 22.6°$ N of W

b) $a = \frac{F}{m} = \frac{13}{2.6} = .5 \ M/s^2$

$d = \frac{a}{2}t^2 = \frac{1/2}{2}(6)^2 = \frac{36}{4} =$ 9 M from the origin

at an angle of 22.6 N of W

(3)



The accelaration of the fish is determined from: $v^2 = v_0^2 + 2a(x - x_0)$

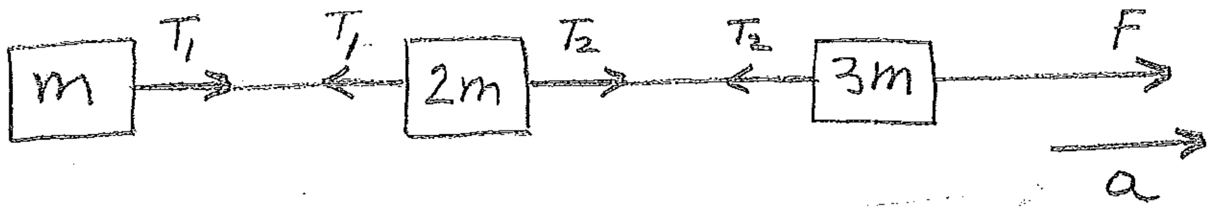
$$0 = 8^2 + 2a\left(\tfrac{1}{2}\right)$$

$$|a| = 64 \ ft/s^2$$

So the force is $F = ma = \frac{20 \text{ pounds}}{32 \ ft/s^2} \ 64 \ ft/s^2$

F = 40 pounds

(4)



$T_1 = ma$ $\quad T_2 - T_1 = 2ma$ $\quad F - T_2 = 3ma$

Newton's 2nd law applied to each mass

adding the equations gives:

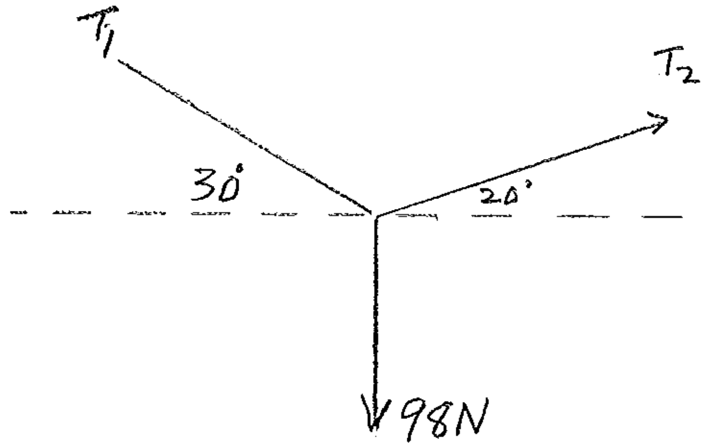
$$T_1 = ma$$
$$T_2 - T_1 = 2ma$$
$$F - T_2 = 3ma$$
$$F = 6ma$$
$$\boxed{a = \frac{F}{6m}}$$

$$T_1 = ma = m\left(\frac{F}{6m}\right)$$
$$\boxed{T_1 = F/6}$$

$$T_2 - T_1 = 2ma$$
$$T_2 = T_1 + 2ma = \frac{F}{6} + 2m\left(\frac{F}{6}\right) = \boxed{F/2}$$

(5) (a) Since there is no acceleration, $\vec{v}$ = constant,

$\Sigma \vec{F}_i = 0$



$T_1 \cos 30 = T_2 \cos 20$

$98 = T_1 \sin 30 + T_2 \sin 20$

$T_1 = T_2 \dfrac{\cos 20}{\cos 30}$

$98 = T_2 \left(\dfrac{\cos 20}{\cos 30} \sin 30 + \sin 20\right)$

$\boxed{T_2 \approx 110.8\ N}$

$T_1 = 110.8 \left(\dfrac{\cos 20}{\cos 30}\right) = \boxed{120.2\ N}$

(b) Viewed from outside the elevator, we have

$\vec{T}_2 + \vec{T}_1 + 10\vec{g} = 10\,\vec{a}$ In part a) $\vec{a} = 0$

Now, $\vec{a} \neq 0$ but it is in the $-\vec{g}$ direction.

let $\vec{a} = -x\vec{g}$.

$\vec{T}_2' + \vec{T}_1' + 10\vec{g} = -x\,10\vec{g}$ where $\vec{T}_1'$ and $\vec{T}_2'$ are the new tensions

or $\vec{T}_2' + \vec{T}_1' + (1+x)10\vec{g} = 0$

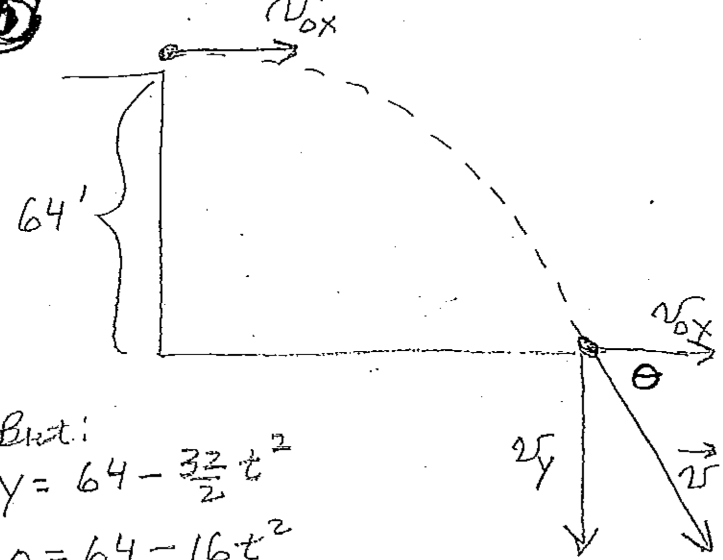
So the new tensions are $\vec{T}_2' = (1+x)\vec{T}_2$

and $\vec{T}_1' = (1+x)\vec{T}_1$

$160 = 120.2(1+x)$

Since T_1 is the largest: $x \approx .33$ So $a_{max} = .33g \simeq \boxed{3.24\ m/s^2}$

(6)



v_{0x} stays constant

$|\vec{v}| = 2v_{0x}$

So

$(v_{0x})^2 + v_y^2 = (2v_{0x})^2$

$v_y^2 = 3v_{0x}^2$

$v_y = \sqrt{3}\, v_{0x}$

But:

$y = 64 - \frac{32}{2}t^2$

$0 = 64 - 16t^2$

$t = 2$ sec before it lands

$v_y = 0 - 32t = 64$ ft/s

$64 = \sqrt{3}\, v_{0x}$

$v_{0x} = \frac{64}{\sqrt{3}} = \boxed{36.95 \text{ ft/s}}$

$\cos\theta = \frac{v_{0x}}{2v_{0x}} = \frac{1}{2} \Rightarrow \boxed{\theta = 60^\circ}$

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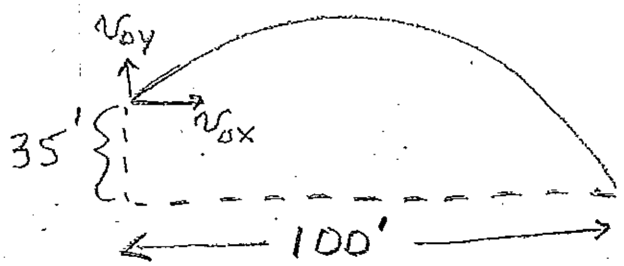
(7)



$v_{0x} = \frac{100 \text{ ft}}{5 \text{ sec}} = 20$ ft/s

$-35 = v_{0y}(5) - 16(5)^2$

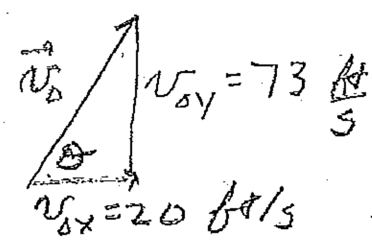
$v_{0y} = \frac{16(5)^2 - 35}{5} = 73$ ft/s

So $|\vec{v}_0| = \sqrt{20^2 + 73^2} = \boxed{75.7 \text{ ft/s}}$

at an angle

$\tan\theta = \frac{73}{20}$

$\boxed{\theta = 74.7^\circ}$



(8)

(a) The time to fall 64 ft is

$$64 = \frac{32}{2}t^2 \Rightarrow t = 2 \text{ sec.}$$

To travel 50 ft in 2 sec, her initial speed v_0 should be $v_0 = \frac{50}{2} = \boxed{25 \text{ ft/s}}$

(b) She is in the air for 2 sec.