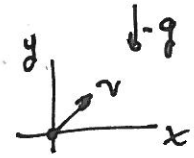
1. 

need to go to $x_m = 50.3$, $y_m = 3.35$. already goes through origin. 2 points is enough to determine parabola

$$y(x) = x\tan\theta - \frac{gx^2}{2v_i^2\cos^2\theta}$$ goes thru (x_m, y_m)

$$y_m = x_m\tan\theta - \frac{gx_m^2}{2v_i^2\cos^2\theta} = x_m\tan\theta - \frac{gx_m^2\sec^2\theta}{2v_i^2}$$ $1+\tan^2=\sec^2$

$$y_m = x_m\tan\theta - \frac{gx_m^2}{2v_i^2}(1+\tan^2\theta)$$

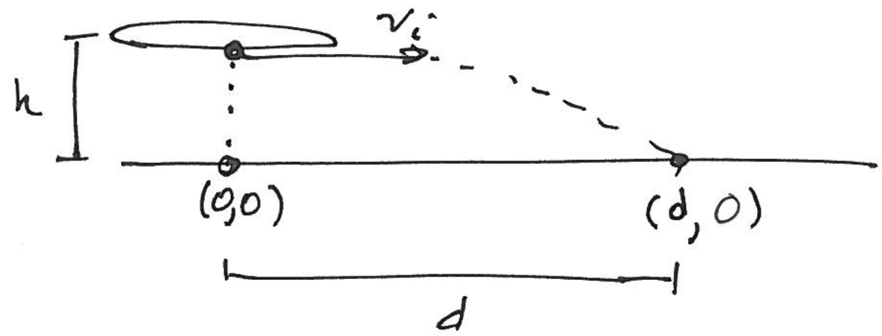
$$0 = -\frac{gx_m^2}{2v_i^2}\tan^2\theta + x_m\tan\theta - \left(y_m + \frac{gx_m^2}{2v_i^2}\right)$$ quadratic in $\tan\theta$

$$\tan\theta = \frac{-x_m \pm \sqrt{x_m^2 - \frac{2gx_m^2}{v_i^2}\left(y_m + \frac{gx_m^2}{2v_i^2}\right)}}{-gx_m^2/v_i^2}$$

$$\tan\theta = \left(\frac{v_i^2}{gx_m}\right)\left[1 \pm \sqrt{1 - \frac{2g}{v_i^2}\left(y_m + \frac{gx_m^2}{2v_i^2}\right)}\right] \simeq \{31^\circ, 63^\circ\}$$

- all angles in $\theta \in [31^\circ, 63^\circ]$ also work
- larger or smaller $\theta \Rightarrow$ less range $\Rightarrow$ miss

2.



$a_c = \frac{v_i^2}{R}$ can get v_i from projectile motion

parabola goes thru $(0,h)$ and $(0,d)$. $\theta = 0$ for launch

$$y(x) = h + x\tan\theta - \frac{gx^2}{2|v_i|^2\cos^2\theta} = h - \frac{gx^2}{2v_i^2}$$

$$y(d) = 0 = h - \frac{gd^2}{2v_i^2}$$

$$d^2 = \frac{2hv_i^2}{g} \Rightarrow v_i^2 = \frac{gd^2}{2h}$$

$$\Rightarrow \boxed{a_c = \frac{v_i^2}{R} = \frac{gd^2}{2Rh} \simeq 470\ m/s^2}$$

units OK

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3. if $|\vec{v}| = \text{const}$, $F_{net} = 0$ (because $a = 0$ if $v = \text{const}$)

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = 2\hat{i} - 6\hat{j} + F_{2x}\hat{i} + F_{2y}\hat{j}$$

$$\Rightarrow F_{2x} = -2, \quad F_{2y} = +6$$

$$\boxed{\vec{F}_2 = (-2\hat{i} + 6\hat{j})N}$$

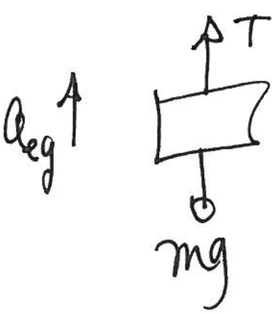
4. if $a_{coin} = -8\ m/s^2$ rel. to the elevator,

must be that $a_{elevator}$ is $+1.8\ m/s^2$ rel. to the ground

such that $a_{coin} + a_{elev.} = -g$

careful: g is $\downarrow$

a_{eg} is $\uparrow$



$$T - mg = m\,a_{el\text{-}gr}$$

$$T = mg + m a_{eg} = m(a_{eg} + g) \simeq 16\,kN$$

$$= m(+1.8 - 9.8)$$

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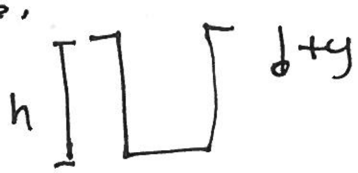
5. a) $R_e \simeq 6.37 \times 10^6\ m$ $\qquad v = \dfrac{\text{circumph}}{(T = 24\,hrs)} = \dfrac{2\pi R_e}{86400\,sec} \simeq 463\ m/s$

$$a = \frac{v^2}{R} = \frac{4\pi R_e^2}{R_e T^2} = \frac{4\pi^2 R_e}{T^2} \simeq \underline{\underline{0.034\ m/s^2}}$$

b) $T^2 = \dfrac{4\pi^2 R_e}{a_c}$ $\qquad$ want $a_c = g$

$$T = 2\pi\sqrt{\frac{R_e}{a_c}} = 2\pi\sqrt{\frac{R_e}{g}} \simeq 5060\,s = \underline{\underline{84\,min}}$$

6.

a) 

$y(t) = y_0 + v_{0y} t + \frac{1}{2} a t^2$

$y_0 = 0 \quad v_{0y} = 0 \quad a = +g$

$y(t) = \frac{1}{2} g t^2 = h \Rightarrow \boxed{t = \sqrt{\frac{2h}{g}} \simeq 11.1 \text{ sec}}$

b) $v_y(t) = v_{0y} + at = gt = g\sqrt{\frac{2h}{g}} = \sqrt{2gh} \simeq \boxed{109 \text{ m/s}}$

c) halfway*, $y(t) = \frac{h}{2} = \frac{1}{2} g t^2 \Rightarrow t = \sqrt{\frac{h}{g}}$
(distance)

$t_{bott} = \sqrt{2}\, t_{half}$

$v_y(t_{half}) = gt = g\sqrt{\frac{h}{g}} = \sqrt{gh} \simeq \boxed{77 \text{ m/s}}$

* I meant half the distance, but was not clear enough. If you did half the time, I counted it OK.