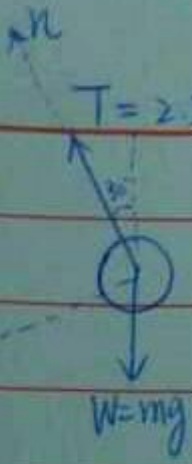
1.



n: $\Sigma F_n = ma_n$

$2.5mg - mg\cos 30° = m a_n$, $a_n = 16.03 m$

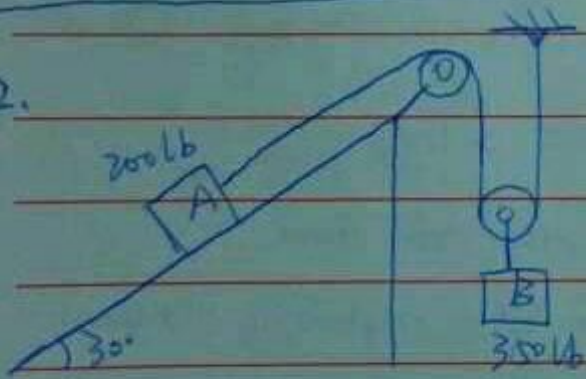
t: $\Sigma F_t = ma_t$

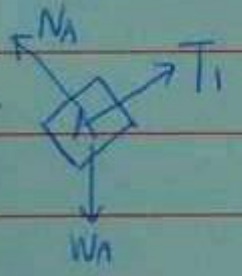
$mg\sin 30° = ma_t$, $a_t = 4.90\ m/s^2$

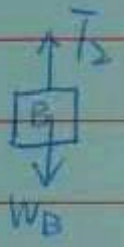
Since $a_n = \frac{v^2}{r}$, $r = 2m$

$\therefore v = \pm 5.66\ m/s$ (up or down)

2.







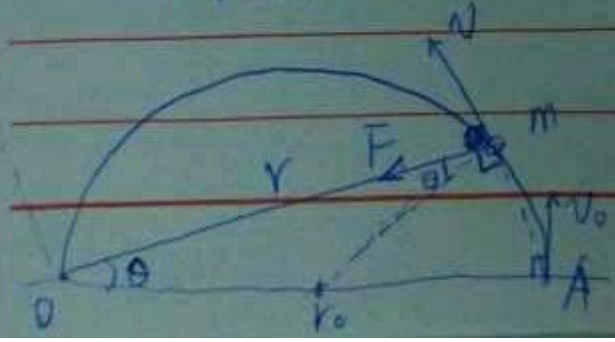
$T_1 - W_A \sin 30° = \left(\frac{W_A}{g}\right) a_A$

$W_B - T_2 = \left(\frac{W_B}{g}\right) a_B$

because $T_1 = \frac{1}{2} T_2$, $a_A = 2a_B$

hence .....

$r = r_0 \cos\theta$



$\vec{H}_0 = \vec{r}_0 \times m\vec{v}_0 = r_0 m v_0 \sin 90°$

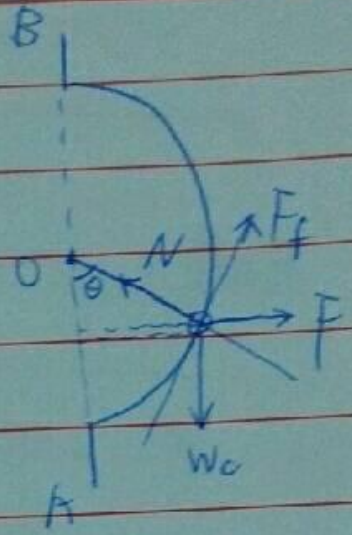
$= r_0 m v_0$

$\vec{H}_1 = \vec{r} \times m\vec{v} = r_0 \cos\theta \cdot mv \sin 90°$

$= r_0 m v \cos^2\theta$

$H_0 = H_1$, hence $v_0 = v\cos^2\theta$

(a) When $\theta = 75°$



$F = a_n m = m\omega^2 r \sin\theta$

$= 6.79\,N$

$W_c = mg = 2.45\,N$

$N = F\sin\theta + W_c\cos\theta$

$= 7.19\,N$

$F_{f\,max} = N \cdot \mu_s = 1.80\,N$

$W_c \sin\theta - F\cos\theta = 0.61\,N$

because $0.61 \le F_{f\,max}$

So the collar couldn't slide.

and $F_f = 0.61\,N$

(b) When $\theta = 40°$

$F = m\omega^2 r \sin\theta = 4.52\,N$

$N = F\sin\theta + W_c\cos\theta = 4.78\,N$

$F_{f\,max} = N \cdot \mu_s = 1.20\,N$

$W_c \sin\theta - F\cos\theta = -1.88\,N$

$1.88 > F_{f\,max}$

So the collar will slide

$F_f = N \cdot \mu_k = 0.96\,N$