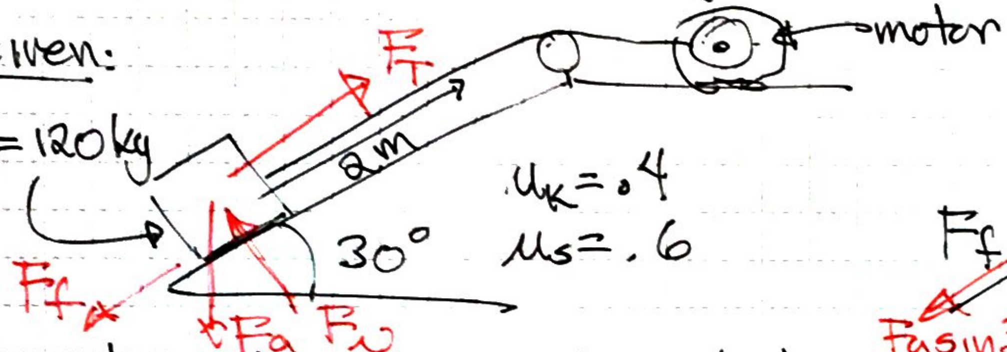
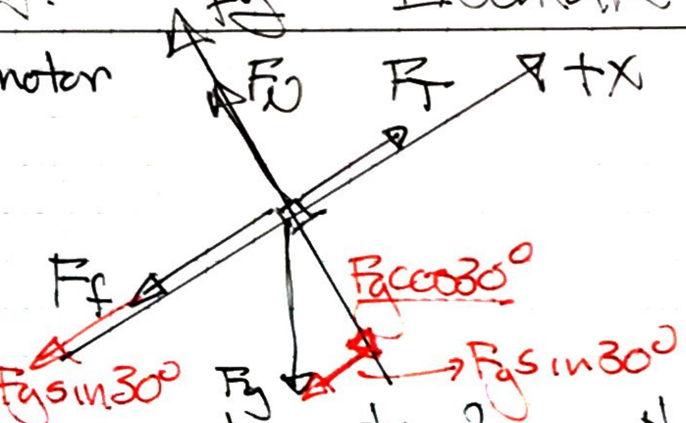
Given:

$m = 120\,kg$



$\mu_k = .4$

$\mu_s = .6$



Req'd: How fast will crate be moving when its 2m up the ramp. What is Tension when it starts moving

Assump: F_T is constant after start. F_f "=" μF_N, $g = 10\,m/s^2$

Strategy: Freebody: $F_{net_x} = ma_x$, $F_{net_y} = m\cancel{a_y}^{0} = 0$

Estimate: Estimate a_x: $F_N = F_g \cos 30°$ $F_g = 1.2\,kN = mg$

$F_N = 1.2\,kN(.9) \cong 1\,kN \Rightarrow F_f \rightarrow$ 600N static, 400N kinetic

To start $F_f + \overset{600N}{F_g \sin 30°} \sim 1.2\,kN \Rightarrow F_T$ to start $= 1.2\,kN$

After move F_f drops to 400N $\Rightarrow F_{net_y} \cong 200N$.

$\Rightarrow a_y = \dfrac{200N}{120\,kg} = 1.7\,m/s^2 \Rightarrow$ after 1s, $v = 1.7\,m/s$, $2s \rightarrow 3.4\,m/s$

$\Rightarrow$ takes between 1 & 2s to go 2m $\Rightarrow v\big|_{2m} \cong 2\text{-}2.5\,m/s$

Soln: Basics $F_g = mg = 120\,kg \cdot 9.81\,m/s^2 = 1.18\,kN$

$F_g \cos(30^\circ) = 1.02\,kN \quad F_g \sin 30^\circ = 589\,N$

in y direction: $\overline{F}_{nety} = m\,a_y = 0 \Rightarrow F_N - F_g \cos 30^\circ = 0$

$F_N = F_g \cos 30^\circ$

$F_N = 1.02\,kN$

Friction:

$F_{f_s} \leq .6\,F_N \quad (\mu_s F_N)$

$F_{f_s} \leq 612\,N$

$F_{f_k} = .4\,F_N = 408\,N$

$\overline{F}_{netx} = m\overline{a}_x$

$F_T - F_f - F_g \sin 30^\circ = m\overline{a}_x$

initially not moving $\Rightarrow \overline{a}_x = 0$.

$\Rightarrow F_T = F_{f_s} + F_g \sin 30^\circ$

$= 612\,N + 590\,N = 1.2\,kN$

F_T constant as it moves but

$F_f \rightarrow 408\,N$

$F_T - F_{f_k} - F_g \sin 30^\circ = m a_x$

$1.2\,kN - 408\,N - 590\,N = m a_x$

$202\,N = 120\,kg\, a_x$

$\frac{202\,kg\,m/s^2}{120\,kg} = a_x = 1.68\,m/s^2$

Now, back to CH 13 w/ constant a!!

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Soln: Cont $a_x = \text{const}$ $\Rightarrow$ $a_x = \frac{dv_x}{dt} \Rightarrow a_x dt = dv$

$$\Rightarrow \int_{t_0}^{t} a_x dt = \int_{v_0}^{v} dv \Rightarrow a_x(t - \underset{\to 0}{t_0}) = v - \underset{\to 0}{v_0} \qquad v(t) = a_x t = \frac{dx}{dt}$$

$$\int_0^t a_x t\,dt = \int_0^{2m} dx \Rightarrow a_x \frac{t^2}{2}\Big|_0^t = x\Big|_0^{2m} = 2m$$

$$a_x \frac{t^2}{2} = 2m \Rightarrow t = \sqrt{\frac{2 \cdot 2m}{1.68\ m/s^2}} = \sqrt{\frac{4}{1.68} s^2} = \underline{1.54s}$$

$$v(t) = a_x t = 1.68\ m/s^2 \cdot 1.54s = \boxed{2.59\ m/s = v(t)\Big|_{x=2m}}$$

Discussion: All seems to line up well w/ estimates and expectations. Seems like it would have been easier in physics without all the machinery!