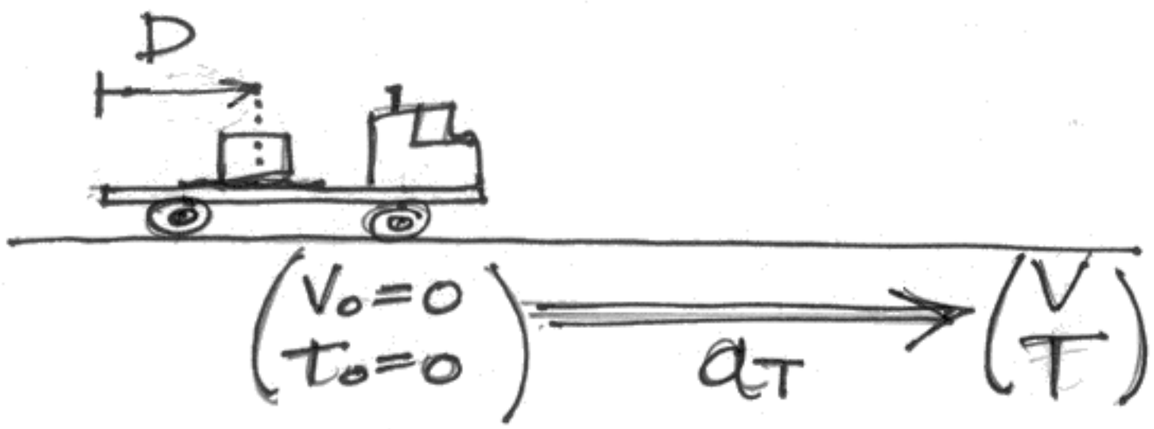
C:(10 pts) Cargo Safety?

A driver has to transport a cargo crate which sits on the bed of his truck, at a distance $D=4m$ from the tail of the truck. (I.e., that's how far it is from falling off the back!) The crate is not attached to the truck in any way, and is prevented from sliding only by friction with the bed surface. Starting from rest, the driver must reach a speed $V=60mph=26.82m/s$, with constant acceleration, over a time period of $T=20s$. What's a_T, the acceleration of the truck? Static friction (coefficient: μ_s) must be sufficient to keep the crate on the truck bed. What is the minimum value of μ_s that will prevent the crate from sliding?

- $(2pts)$ $a_T =$_____
- $(3pts)$ $\mu_s^{min} =$_____



Unfortunately, the bed of the truck is too greasy, so there is not enough friction to keep the crate from sliding. In fact, we have $\mu_s=0.1$ and $\mu_k=0.08$, so the crate will slide. What is a_C, the acceleration of the crate? How long does it take for the crate to fall off the back of the truck?

- $(2pts)$ $a_C =$_____
- $(3pts)$ $T_{fall} =$_____

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$V_0 = 0 \rightarrow V = 26.82 \frac{m}{s}$

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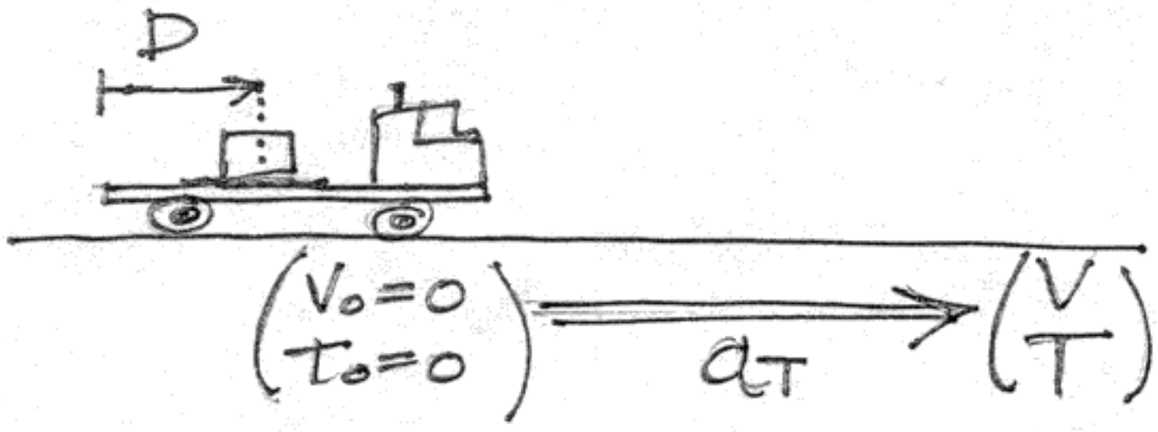
- (2pts) $a_T =$ 1.341 m/s^2
- (3pts) $\mu_s^{min} =$ .137

$a_T = \frac{V}{T} = \boxed{1.341\ m/s^2}$



CRATE: $f_s \leq f_{s,MAX}$

$= \mu_s N = \mu_s mg$

$F = ma_T = m\frac{V}{T}$

$F = f_{s,MAX} \Rightarrow \cancel{m}\frac{V}{T} = \mu_s \cancel{m} g$

$\mu_s = \frac{V}{gT} = \boxed{.136837}$

Unfortunately, the bed of the truck is too greasy, so there is not enough friction to keep the crate from sliding. In fact, we have $\mu_s = 0.1$ and $\mu_k = 0.08$, so the crate will slide. What is a_C, the acceleration of the crate? How long does it take for the crate to fall off the back of the truck?

- (2pts) $a_C =$ .784 m/s^2
- (3pts) $T_{fall} =$ 3.79 s

($\mu_s = .1 < .137$)

$F = f_K = \mu_K N = \mu_K mg$

$a_c = \frac{F}{m} = \mu_K g = \boxed{.784\ m/s^2}$

Fall: $X_T = \frac{1}{2} a_T t^2$, $X_C = \frac{1}{2} a_c t^2$ $\Rightarrow$ $X_T = X_C + D$

$\frac{1}{2} a_T t^2 = \frac{1}{2} a_c t^2 + D$

$\frac{a_T - a_c}{2} t^2 = D$

$t = \sqrt{\frac{2D}{a_T - a_c}} = \boxed{3.78981\ s}$