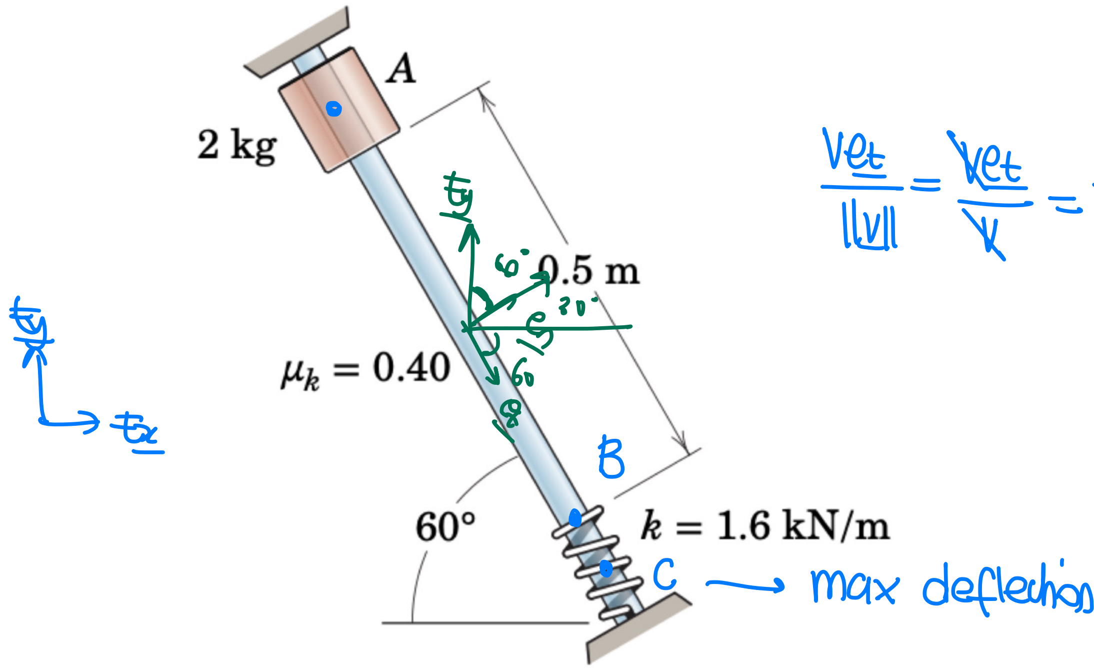
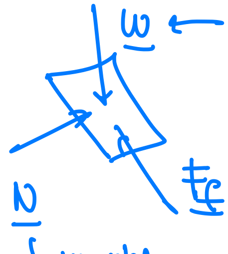
3/84 The 2-kg collar is released from rest at A and slides down the inclined fixed rod in the vertical plane. The coefficient of kinetic friction is 0.40. Calculate (a) the velocity v of the collar as it strikes the spring and (b) the maximum deflection x of the spring.

$$\frac{\underline{V e_t}}{\|V\|} = \frac{\cancel{V}\underline{e_t}}{\cancel{V}} = \underline{e_t}$$



PROBLEM 3/84

Between A and B,



$\underline{w} = -mg\,\underline{e_y}$

$\underline{F_f} = -\mu_k \|\underline{N}\|\,\underline{e_t}$

$\underline{N} = N\,\underline{e_n}$

W_E theorem

$$T_B - T_A = W_{\underline{w}} + W_{\underline{F_f}} + \underbrace{\cancel{W_{\underline{N}}}}_{0 \text{ because } \underline{N}\cdot\underline{v}=0}$$

$$\underline{F_f} = \mu_k \|\underline{N}\| \left(-\frac{\underline{v_{rel}}}{\|\underline{v_{rel}}\|}\right)$$

$$= -\mu_k \|\underline{N}\| \frac{\underline{v_{rel}}}{\|\underline{v_{rel}}\|}$$

$$W_{\underline{w}} = -U_B + U_A$$

$$= -mg\,y_B + mg\,y_A$$

$$= mg(y_A - y_B)$$

$$W_{\underline{F_f}} = \int_{t_A}^{t_B} \underline{F_f}\cdot\underline{v}\,dt$$

$$\underline{F} = m\underline{a}$$

$$-mg\,\underline{e_y} - \mu_k\|\underline{N}\|\,\underline{e_t} + N\underline{e_n} = m(\dot{v}\,\underline{e_t})$$

$$\cdot\,\underline{e_n}\quad -mg\,\underline{e_y}\cdot\underline{e_n} + N = 0$$

$$N = mg\cos 60^\circ$$

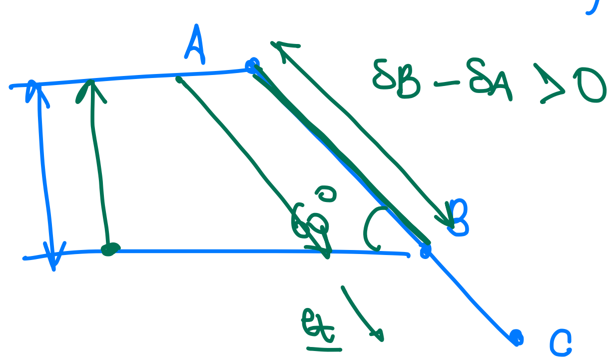
$$= \int_{t_A}^{t_B} -\mu_k \|\underline{N}\|\,\underline{e_t}\cdot v\underline{e_t}\,dt$$

$$= -\mu_k\, mg\cos 60^\circ \underbrace{\int_{t_A}^{t_B} v\,dt}_{}\qquad \int_{s_A}^{s_B} ds$$

$$= -\mu_k\, mg\cos 60^\circ\,(s_B - s_A)$$

$$\frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2 = mg(y_A - y_B) - \mu_k\, mg\cos 60^\circ (s_B - s_A).$$

$y_A - y_B > 0$



$$v = \frac{ds}{dt}$$

$v > 0$

along $\underline{e_t}$, $ds > 0$

s increases

$$y_A - y_B = (s_B - s_A)\cos 60^\circ$$

* between B and C.

$$\frac{1}{2}mv_C^2 - \frac{1}{2}mv_B^2 = mg(y_B - y_C) - \mu_k mg\cos 60^\circ (s_C - s_B)$$

$$- \frac{1}{2}k\underbrace{\varepsilon_C^2}_{=(s_C - s_B)^2} + \cancel{\frac{1}{2}k\varepsilon_B^2}_{0}$$

$$\frac{1}{2}mv_C^2 - \frac{1}{2}mv_B^2 = mg\underbrace{(y_B - y_C)} - \mu_k mg\cos 60^\circ \underbrace{(s_C - s_B)} - \frac{1}{2}k\underbrace{(s_C - s_B)}^2$$

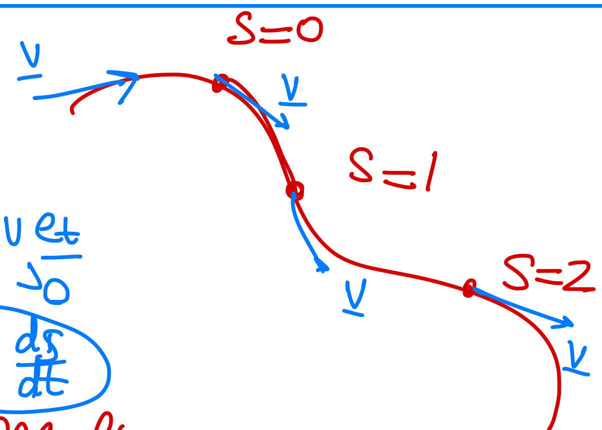
$$y_B - y_C = (s_C - s_B)\cos 60^\circ$$

$$\underline{v} = v\underline{e_t} = \frac{ds}{dt}\underline{e_t}$$

$$v = \frac{ds}{dt} > 0$$

$$\underline{v} = v\underline{e_t}$$
$$>0$$

$$v = \frac{ds}{dt}$$



s increases as you travel along $\underline{e_t}$.