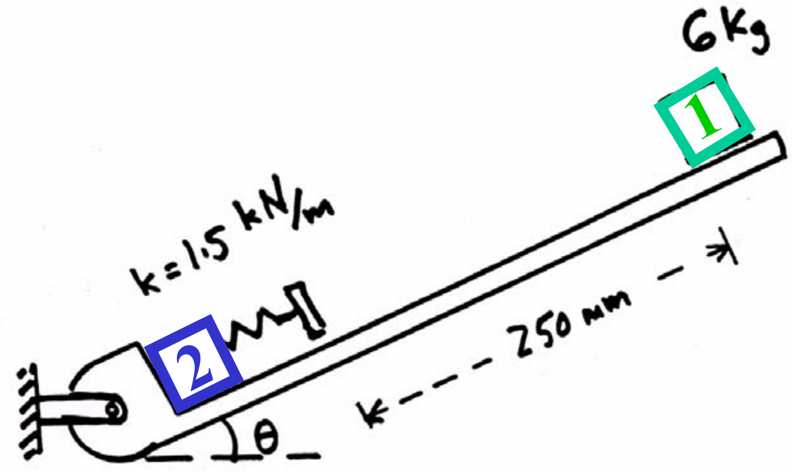
Non-Conservative Force Example 2

13.70 As the bracket ABC is slowly rotated. The 6-Kg block starts to slide toward the spring when $\theta = 20°$. The maximum deflection of the spring is observed to be 50 mm. Determine the value of the coefficients of static and kinetic friction.

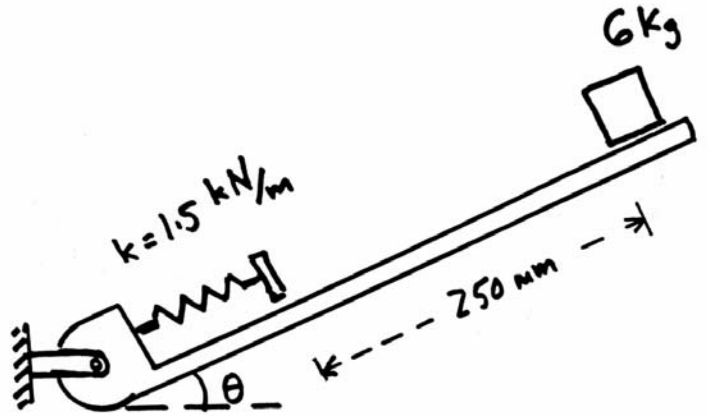


1: Initial position

2: Maximum deflection of the spring, 0.05 m

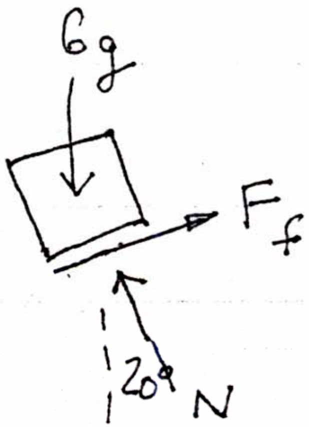
$$\int_1^2 \mathbf{F_n} \cdot d\mathbf{r} = (T_2 + V_2) - (T_1 + V_1)$$

Static Coefficient of Friction μ_s



$$\boxed{N = 6g \cos 20^\circ}$$

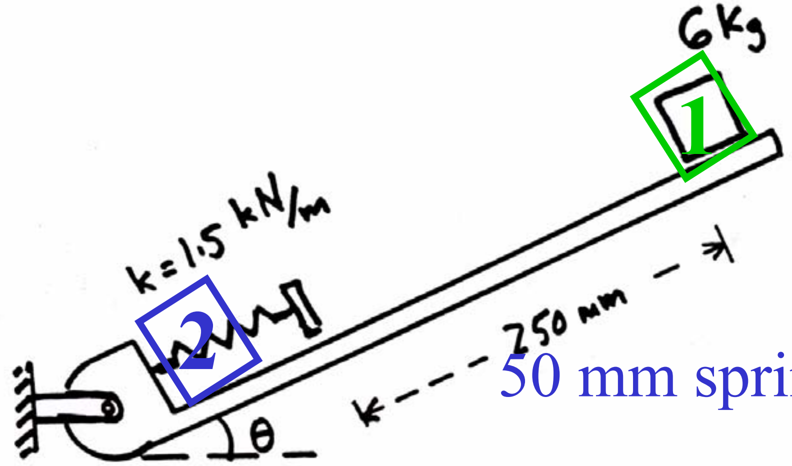
$$\boxed{F_f = 6g \sin 20^\circ}$$



On the verge of sliding, $F = \mu_s N$

$$\mu_s = \frac{F_f}{N} = \tan 20^\circ = 0.364$$

Kinetic Coefficient of Friction μ_k



$$\underbrace{\underbrace{\boxed{\tfrac{1}{2}\times 1500 \times (0.05)^2}}_{V_{spring}} + \underbrace{0}_{V_{gravity}}}_{(V_2} + \underbrace{0}_{T_2)} - \underbrace{\underbrace{0}_{V_{spring}} - \underbrace{\boxed{6g(0.3\sin 20^\circ)}}_{V_{gravity}}}_{(V_1} - \underbrace{\ }_{T_1)}$$

$$(V_2 + T_2) - (V_1 + T_1)$$

$$\boxed{= -\int_{s_1}^{s_2} F_f \, ds = -\mu_k \underbrace{(6g \cos 20^\circ)}_{N}(0.25 + 0.05)}$$

Kinetic Coefficient of Friction μ_k

$$\underbrace{\underbrace{\tfrac{1}{2}\times 1500\times(0.05)^2}_{V_{spring}} + \underbrace{0}_{V_{gravity}}}_{V_2} + \underbrace{0}_{T_2} - \underbrace{\underbrace{0}_{V_{spring}} - \underbrace{6g(0.3\sin 20^\circ)}_{V_{gravity}}}_{V_1} - \underbrace{0}_{T_1}$$

$$= -\int_{s_1}^{s_2} F_f\, ds = -\mu_k\,(6g\cos 20^\circ)(0.25+0.05)$$

$$\therefore\ \mu_k = \frac{6\times 9.81\times 0.3\sin 20^\circ - \tfrac{1}{2}\times 1500\times(0.05)^2}{0.3\times 6\times 9.81\times\cos 20^\circ}$$

$$= \frac{6.039 - 1.875}{16.593} = 0.251$$