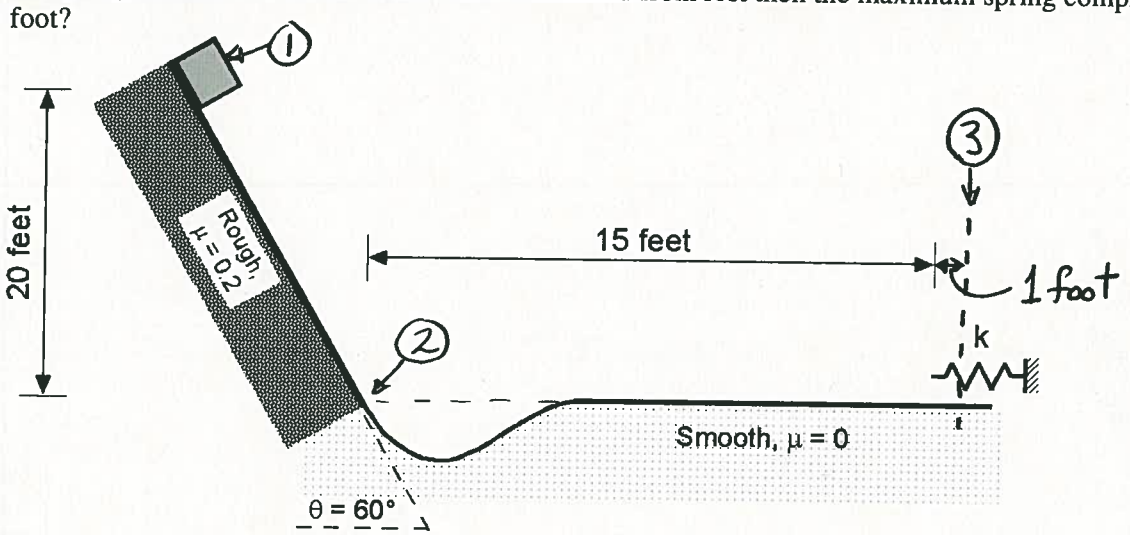
DIP in the ROAD

Problem: (Old Exam Problem). A 15 pound block is initially at rest on a rough inclined surface at a vertical distance of 20 feet above a horizontal plane (see figure below). The coefficient of friction (static and kinetic) between the block and the inclided surface is $\mu = 0.2$, while the transition and the horizontal surfaces are perfectly smooth ($\mu = 0.0$). A spring with unknown stiffness, k, is positioned at the end of the horizontal surface – a horizontal distance of 15 feet from the end of the rough slope. What should be the spring stiffness, k, so that if the block is released from rest then the maximum spring compression is 1 foot?



$$E_{①} = mgh = (15\,\text{pound})(20\,\text{feet}) = 300\ \text{ft-lb}$$

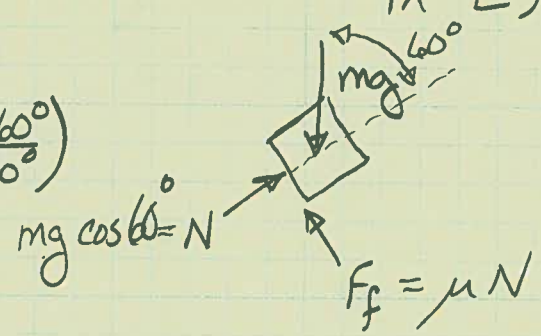
$$E_{②} = E_{①} - \underbrace{\text{Work}_{1\to 2}}$$

Careful, Friction only (gravity included in E)

$$E_{②} = 300 - F_f * \frac{20}{\cos 30^\circ}$$

$$E_{②} = 300 - 0.2(15)\left(\frac{20\cos 60^\circ}{\cos 30^\circ}\right)$$

$$E_{②} = 265.4\ \text{ft}\cdot\text{lb}$$



btwn ② and spring energy is conserved

$$\therefore\ 265.4\ \text{ft}\cdot\text{lb} = \tfrac{1}{2} k \Delta^2 = \text{energy stored in spring @ ③}$$

finally $\boxed{k = 530.8\ \frac{\text{lb}}{\text{ft}}}$

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