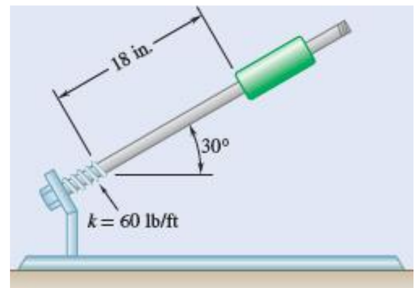
Quiz 07: Chapter 14 Due: Tuesday 14 Feb 23

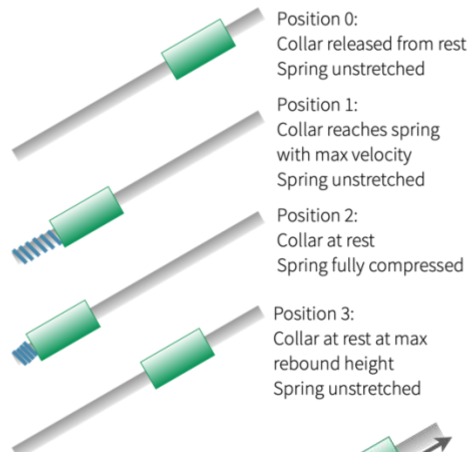
Examine the solved problem below. There are four errors in the solution below. Your task is to locate and identify those errors, then correct them and calculate the proper result. If the same error occurs more than once, only count it as a single error, even if you have to correct it in more than one instance.

Each correctly identified error is worth 4 points, and the re-calculated results are worth 4 points as well. You must save your work in pdf format and submit via the Quiz 07 Assignment in the Chapter 14 folder in the Quizzes folder of the Online Classroom in Blackboard. Please do not use any other file format than pdf.



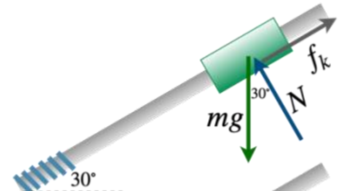
A collar with weight $W = 8\text{lb}$ is released from rest in the position shown, slides down the inclined rod, and compresses a spring with constant $k = 50\frac{\text{lb}}{\text{ft}}$. The direction of motion is then reversed and the collar slides back up the rod. The maximum deflection of the spring is $\Delta l = 6\text{in}$. Use work-energy methods to determine the coefficient of kinetic friction μ_k between the collar and the rod, the maximum speed v_{max} of the collar, and the maximum rebound distance l_{max} the collar travels up the rod.

A) Identify the energy state(s) of the collar at the required points and construct the necessary free body diagrams:
See figures on the right!



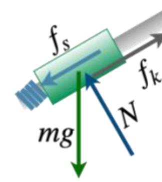
B) To calculate the coefficient μ_k, apply the work-energy theorem to the collar from Position 0 to Position 2:
You cannot go from 0 to 1 because you will have two unknowns, μ_k and v_1!

$$T_0 + U_{0\to 2} = T_2$$
$$\tfrac{1}{2}mv_0^2 + \left(U_g + U_f + U_s\right) = \tfrac{1}{2}mv_2^2$$
$$0 + mgh_0 - f_k l_{0\to 2} + \tfrac{1}{2}k(\Delta l)^2 = 0$$
$$mg[(18\text{in} + \Delta l)\sin 30°] - (\mu_k N)(18\text{in} + \Delta l) + \tfrac{1}{2}k(\Delta l)^2 = 0$$
$$\mu_k[(8\text{lb})\cos 30°](18\text{in} + 6\text{in}) = (8\text{lb})[(18\text{in} + 6\text{in})\sin 30°] + \tfrac{1}{2}\left(50\tfrac{\text{lb}}{\text{ft}}\right)(6\text{in})^2$$
$$\mu_k = \frac{(8\text{lb})[(18\text{in} + 6\text{in})\sin 30°] + \frac{1}{2}\left(50\frac{\text{lb}}{\text{ft}}\right)(6\text{in})^2}{[(8\text{lb})\cos 30°](18\text{in} + 6\text{in})} = 0.167$$



C) To calculate v_{max} of the collar, apply the work-energy theorem from Position 0 to Position 1:

$$T_0 + U_{0\to 1} = T_1$$
$$\tfrac{1}{2}mv_0^2 + \left(U_g + U_f\right) = \tfrac{1}{2}mv_1^2$$
$$0 + mgh_o - f_k l_{0\to 1} = \tfrac{1}{2}mv_1^2$$
$$(8\text{lb})[(18\text{in} + 6\text{in})\sin 30°] - (0.167)[(8\text{lb})\cos 30°](18\text{in} + 6\text{in})$$
$$= \frac{1}{2}\left(\frac{8\text{lb}}{32.2\frac{\text{ft}}{\text{s}^2}}\right)v_1^2$$
$$v_1 = v_{max} = 23.4\frac{\text{ft}}{\text{s}}$$



D) Find the maximum rebound distance l_{max} the collar travels up the rod. Apply the work-energy theorem from Position 2 to Position 3:

$$T_2 + U_{2\to 3} = T_3$$
$$\tfrac{1}{2}mv_2^2 + \left(U_g + U_s + U_f\right) = \tfrac{1}{2}mv_3^2$$
$$0 - mgh_3 + \tfrac{1}{2}k(\Delta l)^2 - f_k l_{2\to 3} = 0$$
$$\tfrac{1}{2}k(\Delta l)^2 = mg(l_3 \sin 30°) + (\mu_k N)l_3$$
$$\tfrac{1}{2}k(\Delta l)^2 = mg(l_3 \sin 30°) + \mu_k(mg\cos 30°)l_3$$
$$l_3 = \frac{k(\Delta l)^2}{2[mg(\mu_k \cos 30° + \sin 30°)]}$$
$$l_3 = l_{max} = \frac{\left(50\frac{\text{lb}}{\text{ft}}\right)(6\text{in})^2}{2(8\text{lb})(0.167\cos 30° + \sin 30°)} = 175\text{in}$$