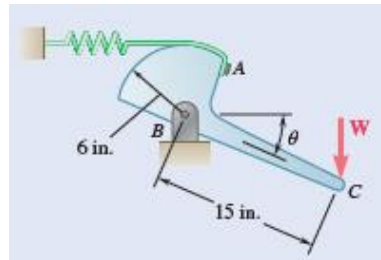
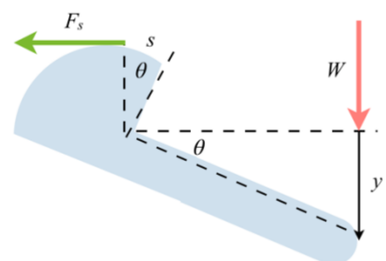
Quiz 13: Chapter 11

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. Each correctly identified error is worth 6 points, and the re-calculated result is worth 6 points. You must save your work in pdf format and submit via the Quiz 13 Assignment in the Quizzes folder of the Online Classroom in Blackboard. Please do not use any other file format than pdf (unless you submit an edited MS Word .docx file).



The spring shown has a constant $k = 20\frac{\text{lb}}{\text{in}}$ and is unstretched when $\theta = 0°$ and the rod BC is horizontal. The mass of the mechanism is negligible. If the applied force shown $W = 72\text{lb}$ is applied vertically at C, use the method of virtual work to find the angle of equilibrium θ.

A) Sketch the displacements of the spring and the applied force.
See figure below right.



B) Determine the virtual displacement of the applied for W:

$$y = l\sin\theta$$
$$\delta y = l\cos\theta\delta\theta$$

C) Determine the virtual displacement of the spring force F_s:

$$s = \frac{r}{\theta}$$
$$\delta s = -\frac{r}{\theta^2}\delta\theta$$

D) Write the expression for the virtual work done:

$$\delta U = -W\delta y + F_s\delta s = 0$$
$$-Wl\cos\theta\delta\theta + F_s\left(-\frac{r}{\theta^2}\delta\theta\right) = 0$$
$$Wl\cos\theta = -F_s\left(\frac{r}{\theta^2}\right)$$

E) Solve for the angle θ:

$$\theta^2\cos\theta = -F_s\left(\frac{r}{Wl}\right) = -\left(20\frac{\text{lb}}{\text{in}}\right)\frac{(6\text{in})}{(72\text{lb})(15\text{in})} = -0.111$$

Using WolframAlpha, and taking the smallest solution:

$$\theta = \pm 1.6135\text{rad} = \pm(1.6135\text{rad})\left(\frac{360°}{2\pi\text{rad}}\right) = \pm 92.4°$$