

## 21-R-WE-SS-26

A uniform rigid rod with a weight of 5kg is attached to a frictionless pivot on one end, and held horizontal with a spring ( $k=1000 \text{ N/m}$ ) on the other end. Determine the energy stored in the spring.

If a 2kg block is dropped from a height of 2m at the midpoint of the rod, calculate the maximum deflection of the spring.

### Solution

-The block falls further than  $2m$ . Since the rod is rigid, the center of the bar deflects by half of that of the spring.

-There is energy stored in the spring in the initial state since it doesn't start at its natural length

$$\begin{aligned}\Sigma M_{(A)} : \quad \frac{1}{2}l \cdot mg - l \cdot F_{spring} &= 0 \\ F_{spring} &= \frac{5}{2}g\end{aligned}$$

$$\begin{aligned}E_{spring} &= \frac{1}{2}k(\Delta x)^2 \\ &= \frac{1}{2}k\left(\frac{F_{spring}}{k}\right)^2 \\ &= \frac{25g^2}{8k} \\ &\approx 0.301 \text{ [J]}\end{aligned}$$

$$\begin{aligned}U_g + U_{e1} &= U_{e2} && \text{(Conservation of energy)} \\ m_{block}g\left(h + \frac{1}{2}\Delta x_2\right) + \frac{1}{2}k(\Delta x_1)^2 &= \frac{1}{2}k(\Delta x_2)^2 && \text{(Quadratic equation in terms of } \Delta x_2. \text{ Solve for } \Delta x_2) \\ \Rightarrow \Delta x_2 &= 0.291 \text{ [m]}\end{aligned}$$