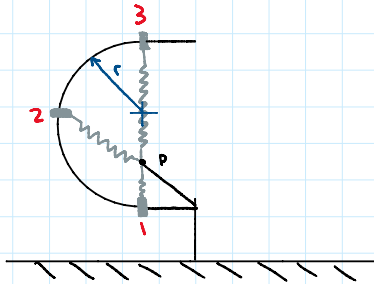20-R-WE-DK-14   Beginner   Potential Energy

Inspiration: None

A modern art sculpture consists of a collar, a spring, and a circular track. The collar has a mass $m = 5\ kg$ and the radius of the track is $r = 0.6\ m$. If the spring is attached to a point P which is a vertical distance $d = 0.4\ m$ away from the perimeter of the circular track, determine the change in potential energy between state 1 and state 2, and between state 1 and state 3. The unstretched length of the spring is $0.15\ m$ and the spring constant is $k = 50\ N/m$.

Setting the height at State 1 as the datum $h_1 = 0$

$$V_s = \tfrac{1}{2}ks^2 = \tfrac{1}{2}(50)(\underbrace{0.4 - 0.15}_{d - l_o})^2 \qquad V_1 = V_{G_1} + V_{S_1} = V_{S_1} = 1.5625$$

State 2: $V_{G_2} = (\underset{m}{5})(\underset{g}{9.81})(\underset{h}{0.6}) = 29.43\ J \qquad V_{S_2} = \tfrac{1}{2}(50)(\overbrace{\sqrt{0.6^2 + (0.6-0.4)^2}}^{s} - 0.15)^2 = 5.819$

$V_2 = 35.2490q\ldots \qquad \Delta V = V_2 - V_1 = \boxed{33.6865\emptyset\ J}$

State 3: $V_{G_3} = (5)(9.81)(0.6+0.6) = 58.86\ J \qquad V_{S_3} = \tfrac{1}{2}(50)(0.6 + (0.6-0.4) - 0.15)^2$

$V_3 = 69.4225 \qquad\qquad\qquad\qquad\qquad = 18.5625\ J$

$$\boxed{\Delta V = V_3 - V_2 = 34.17342\ J}$$

$$\Delta V = V_3 - V_1 = \boxed{67.86\ J}$$