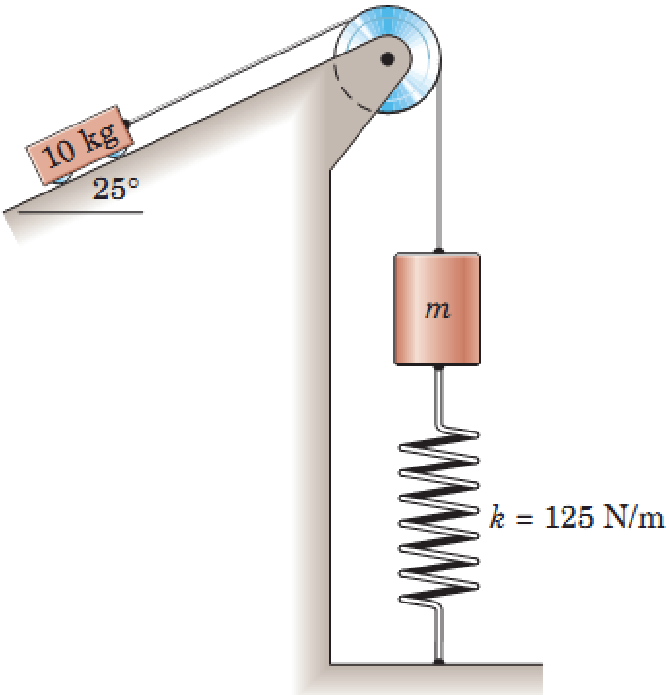
ME 206 – DYNAMICS – SPRING 2017
STUDY PROBLEMS-6 (PARTICLE KINETICS-WORK AND ENERGY)

PROBLEM 3/107

The system is released from rest with no slack in the cable and with the spring unstretched. Determine the distanced s traveled by the 10-kg cart before it comes to rest (*a*) if m approaches zero and (*b*) if m = 2 kg. Assume no mechanical interference.



3/107 Let s be the slant distance down the incline traveled by the 10-kg cart.

(a) $T_1 + U_{1-2} = T_2$

$$0 + m_{10} g s \sin 25° + \frac{1}{2}k\left(x_1^2 - s^2\right) = 0$$

$$10(9.81)\sin 25° - \frac{1}{2}(125)s = 0$$

$s = 0.663$ m

(b) $T_1 + U_{1-2} = T_2$

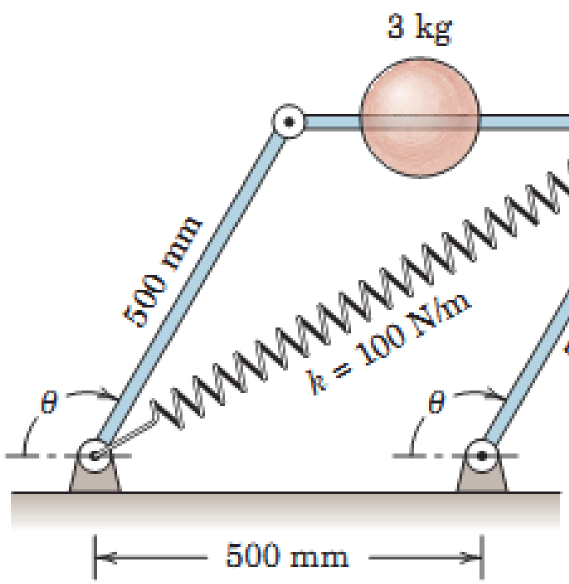
$$0 + m_{10} g s \sin 25° - m_2 g s - \frac{1}{2}ks^2 = 0$$

$$10(9.81)\sin 25° - 2(9.81) - \frac{1}{2}(125)s = 0$$

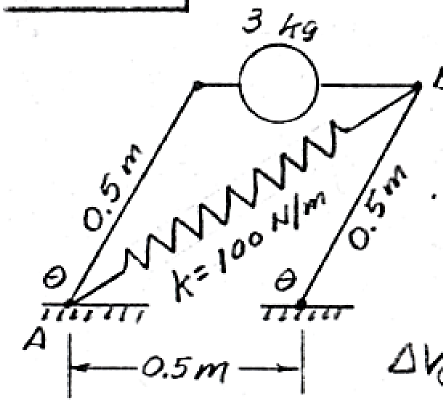
$s = 0.349$ m

PROBLEM 3/169

The 3-kg sphere is carried by the parallelogram linkage where the spring is unstretched when $\theta = 90°$. If the mechanism is released from rest at $\theta = 90°$, calculate the velocity v of the sphere when the position $\theta = 135°$ is passed. The links are in the vertical plane, and their mass is small and may be neglected.



3/169 Spring deformation is



$$\delta = \overline{AB} - 0.5\sqrt{2}$$

$$\overline{AB} = \sqrt{2(0.5)^2 - 2(0.5)^2\cos\theta}$$

$$= 0.5\sqrt{2}\sqrt{1 - \cos 135°}$$

$$\delta = 0.5\sqrt{2}\left[\sqrt{1 + 0.7071} - 1\right]$$

$$= 0.217 \text{ m}$$

$$\Delta V_e = \tfrac{1}{2}k\delta^2 = \tfrac{1}{2}(100)(0.217)^2 = 2.35 \text{ J}$$

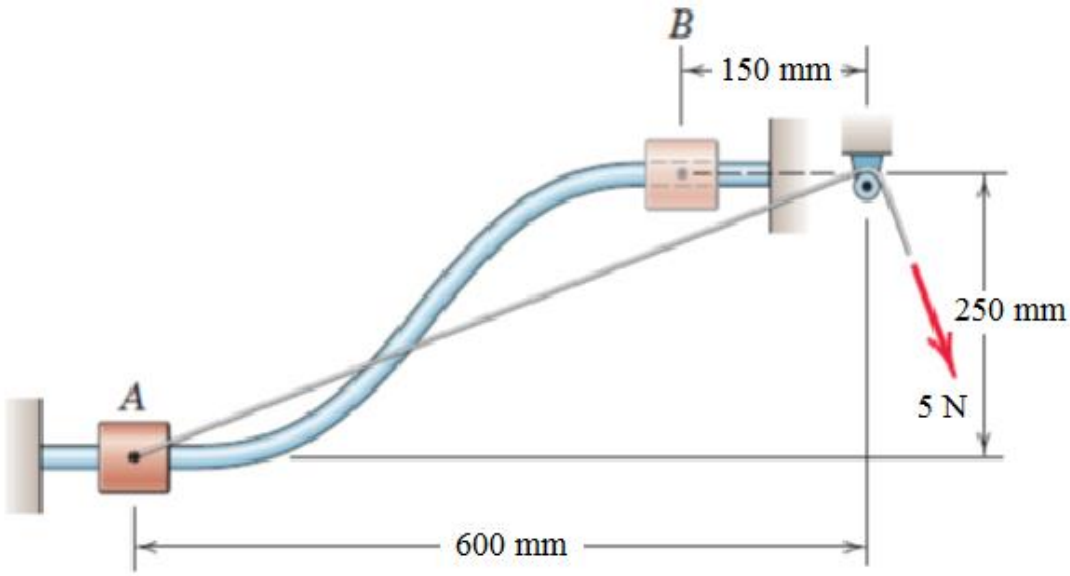
$$\Delta V_g = -mg\Delta h = -3(9.81)(0.5)(1 - \sin 135°) = -4.31 \text{ J}$$

$$\Delta T + \Delta V_g + \Delta V_e = 0; \quad \tfrac{1}{2}3v^2 - 4.31 + 2.35 = 0$$

$$v^2 = 1.307, \quad \underline{v = 1.143 \text{ m/s}}$$

PROBLEM 3/121

The 0.2 kg slider moves freely along the fixed curved rod from A to B in the vertical plane under the action of the constant 5 N tension in the cord. If the slider is released from rest at A, calculate its velocity v as it reaches B.



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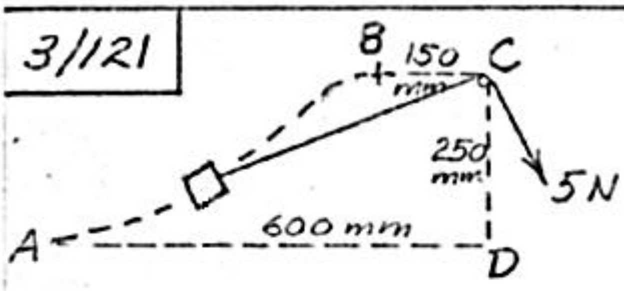


$$U'_{A-B} = \Delta T + \Delta V_g$$

System = slider, cord, & pulley at C

Length of cord passing over pulley is $\overline{AC} - \overline{BC}$

$= \sqrt{(600)^2 + (250)^2} - 150 = 500$ mm

$U'_{A-B} = 5(0.500)$

$\Delta V_g = 0.2(9.81)(0.250)$

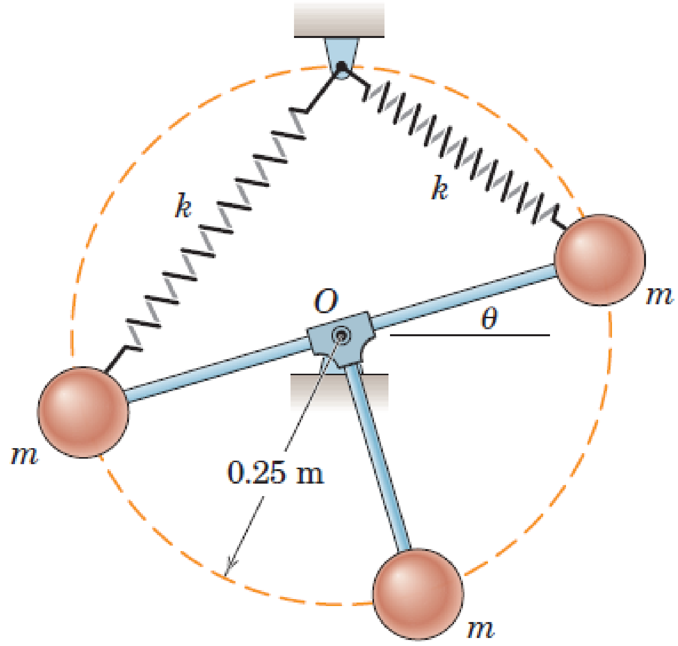
$\Delta T = \frac{1}{2}(0.2)(v^2 - 0)$

Thus $\quad 5(0.500) = \frac{1}{2}(0.2)v^2 + 0.2(9.81)(0.250)$

$v^2 = 20.10\,(\text{m/s})^2, \quad \underline{v = 4.48\text{ m/s}}$

PROBLEM 3/151

The two springs, each of stiffness $k = 1.2$ kN/m, are of equal length and undeformed when $\theta = 0$. If the mechanism is released from rest in the position $\theta = 20°$, determine its angular velocity $\dot{\theta}$ when $\theta = 0$. The mass m of each sphere is 3 kg. Treat the spheres as particles and neglect the masses of the light rods and springs.



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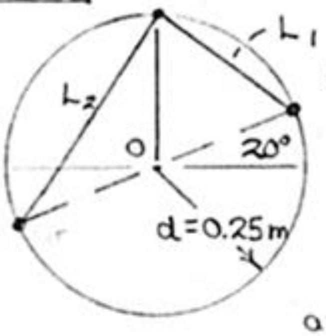

$$L_1 = 2d\sin(90°-20°)/2 = 0.287 \text{ m}$$

$$\delta_1 = 0.25\sqrt{2} - L_1 = 0.0668 \text{ m}$$

$$L_2 = 2d\sin\left(\frac{90°+20°}{2}\right) = 0.410 \text{ m}$$

$$\delta_2 = L_2 - 0.25\sqrt{2} = 0.0560 \text{ m}$$

We may ignore the equal and opposite potential energy changes associated with two of the masses.

$T_1 + V_1 = T_2 + V_2$, datum at O. (V includes V_g and V_e)

$$0 - mgd\cos 20° + \tfrac{1}{2}k\delta_1^2 + \tfrac{1}{2}k\delta_2^2 = 3\left(\tfrac{1}{2}md^2\dot{\theta}^2\right) - mgd$$

$$0 - 3(9.81)(0.25)\cos 20° + \tfrac{1}{2}1200(0.0668)^2 + \tfrac{1}{2}1200(0.0560)^2 = \tfrac{3}{2}3(0.25)^2\dot{\theta}^2 - 3(9.81)(0.25)$$

Solving, $\underline{\dot{\theta} = 4.22 \text{ rad/s}}$