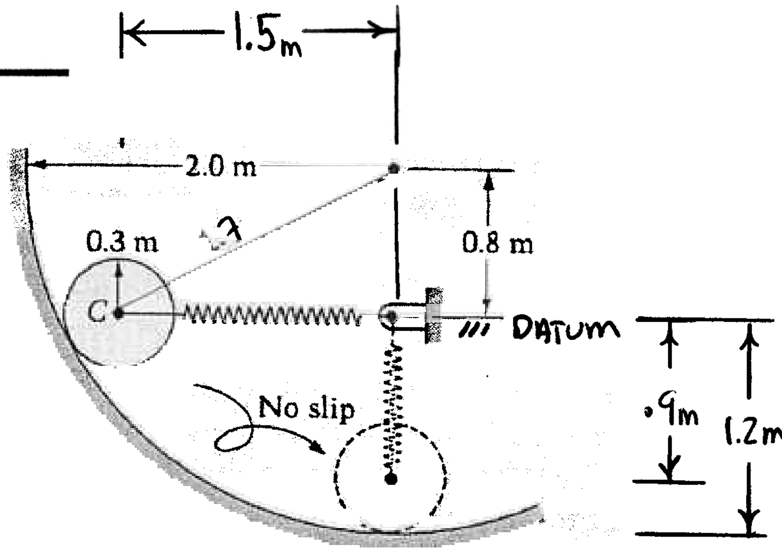
NAME: SOLUTION

Problem 1: The spring shown has an unstretched length of 0.8m and a modulus of 60n/m. The 20 kg wheel is released from rest in the upper position. The radius of gyration of the wheel is k_c=0.2m ($I_c = m \cdot k_c^2$). Find the angular velocity of the wheel when it passes through the lower dashed position.



USING CONSERVATION OF ENERGY

$$T_1 + V_1 = T_2 + V_2$$

SINCE THE WHEEL IS INITIALLY AT REST AND AT THE DATUM, THE ONLY ENERGY ASSOCIATED WITH THE SYSTEM IS THE POTENTIAL ENERGY IN THE SPRING

$T_1 = 0$

$$\frac{1}{2}kx^2 = \frac{1}{2}\cdot(60\tfrac{N}{m})\cdot(1.5m - 0.8m)^2 = 14.7 \text{ N}\cdot\text{m}$$

$$T_2 = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}(20kg)(.3m\cdot\omega)^2 + \frac{1}{2}[20kg\cdot(0.2m)^2]\omega^2 = 1.30\omega^2$$

$$-20kg\cdot 9.81\tfrac{m}{s^2}\cdot .9m + \frac{1}{2}(60\tfrac{N}{m})(.9m - .8m)^2 = -176.88 \text{ N}\cdot\text{m}$$

$$\Rightarrow 14.7 \text{N}\cdot\text{m} = -176.88 \text{ N}\cdot\text{m} + 1.30 kg\cdot m^2 \cdot \omega^2$$

$$147.4 \tfrac{1}{s^2} \quad \Rightarrow \boxed{\omega = 12.14 \tfrac{1}{s}}$$

$$V = \omega r = (12.14\tfrac{1}{s})(.3m) = 3.64 \tfrac{m}{s}$$

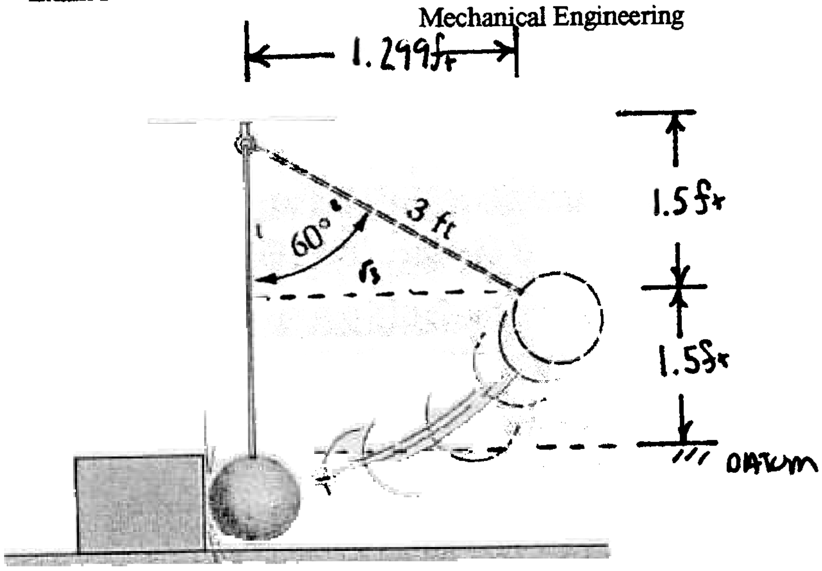
191.53

Problem 2: A 4lb sphere is released from rest in the position shown and two observations are made:

a. The sphere comes immediately to rest after the impact

b. The 5lb block slides 3ft before coming to rest.

Using these observations, find the coefficients of restitution (between sphere and block) and friction (between block and floor).



$$e = \frac{v_b - v_a}{v_a - v_b}$$

FIRST PART OF PROBLEM IS TO DETERMINE THE VELOCITY OF THE SPHERE WHEN IT IMPACTS THE BLOCK USING CONSERVATION OF ENERGY

$$T_1 + V_1 = T_2 + V_2$$

$T_1 = 0$ $\qquad T_2 = \frac{1}{2} \cdot \frac{4\,lb}{32.2\,ft/s^2} \cdot v^2$

$V_1 = 4lb \cdot 1.5ft$ $\qquad V_2 = 0$

$$\Rightarrow 0 + 4lb \cdot 1.5ft = \frac{1}{2} \cdot \frac{4lb}{32.2\,ft/s^2} \cdot v^2 \Rightarrow v^2 = \frac{(4lb)(1.5ft) \cdot 2 \cdot (32.2\frac{ft}{s^2})}{4\,lb}$$

$$v = 9.829\,ft/s$$

NOW CONSERVATION OF MOMENTUM CAN BE USED TO DETERMINE THE POST IMPACT VELOCITIES

$$m_{Bi} \cdot \cancel{v_{Bi}}^{0} + m_{si} \cdot v_{si} = m_{Bf} \cdot v_{Bf} + m_{sf} \cdot \cancel{v_{sf}}^{0}$$

$$\frac{4lb}{32.2ft/s^2} \cdot 9.829\,ft/s = \frac{5\,lb}{32.2\,ft/s^2} \cdot v_{Bf} \Rightarrow v_{Bf} = \frac{4lb}{32.2ft/s^2} \cdot \frac{32.2\,ft/s^2}{5\,lb} \cdot 9.829\frac{ft}{s} = 7.863\frac{ft}{s}$$

$$e = \frac{7.863\,ft/s - 0}{9.829\,ft/s - 0} = \boxed{0.8}$$

CONSERVATION OF ENERGY IS NOW USED TO DETERMINE THE COEFFICIENT OF FRICTION

$T_1 + V_1 + W_{1-2} = T_2 + V_2 \quad \therefore \quad V_1 = V_2 = 0$ AND $T_2 = 0$

$T_1 = \frac{1}{2} \frac{5lb}{32.2\,ft/s^2} \cdot (7.863\frac{ft}{s})^2 = 4.800\,lb \cdot ft$; $W_{1\to2} = -\mu \cdot 5lb \cdot 3ft$

$$\Rightarrow 4.800\,lb \cdot ft - \mu \cdot 15\,lb \cdot ft = 0 \Rightarrow \mu = \frac{4.8\,lb \cdot ft}{15\,lb \cdot ft} = \boxed{0.32}$$