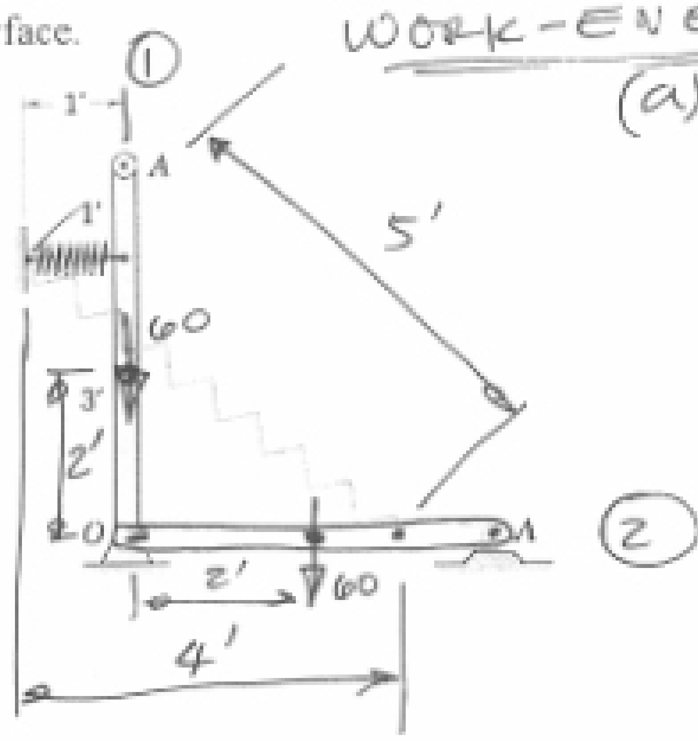
1. (30 pts) The uniform slender bar weighs 60 lb and is released from rest in the near-vertical position shown, where the spring is unstretched. The spring is linear with stiffness = 10 lb/ft. The pin at O is frictionless. (a) Calculate the velocity of end A just before it strikes the horizontal surface. (b) If the coefficient of restitution between the bar and the surface is 0.8, calculate the velocity of A just after it hits the horizontal surface.

WORK-ENERGY:



(a) Using I_O:

$$T_1 + U_{1\to 2} = T_2$$

$$0 + 60(2) - \frac{10}{2}\left((5-1)^2 - 0^2\right) = \frac{1}{2}\left(\frac{1}{3}\frac{60}{32.2}(4)^2\right)\omega_2^2$$

$\omega_2 = 2.837$ rad/sec ↻

$v_{A2} = 4\omega_2 = 11.35$ ft/sec ↓

(a) OR using I_G + $v_G = 2\omega$:

$$T_1 + U_{1\to 2} = T_2 = \frac{1}{2} I_G \omega_2^2 + \frac{1}{2} m v_G^2$$

$$0 + 60(2) - \frac{10}{2}\left((5-1)^2 - 0^2\right) = \frac{1}{2}\left(\frac{1}{12}\frac{60}{32.2}(4)^2\right)\omega_2^2 + \frac{1}{2}\frac{60}{32.2}(2\omega_2)^2$$

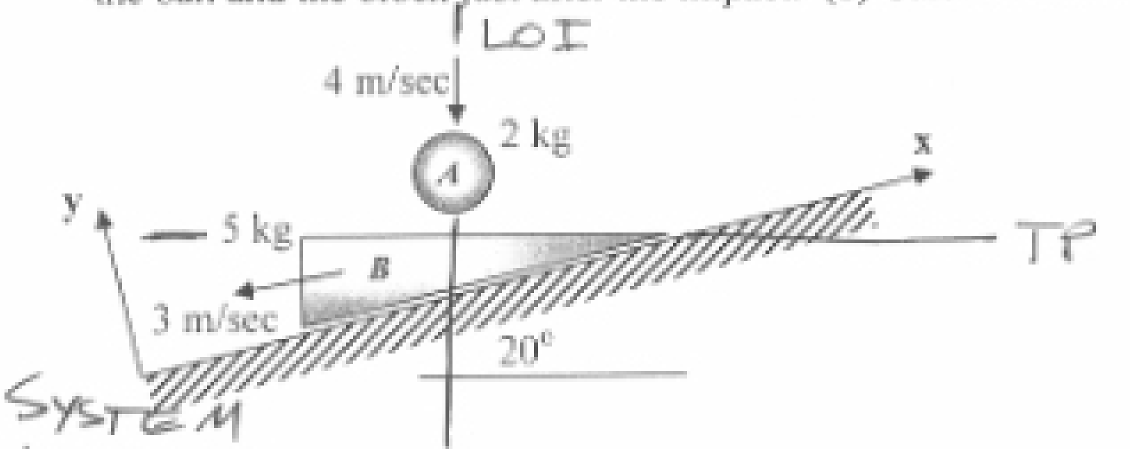
same solution

Coef. Restitution:

(b) $+\uparrow$ $e = 0.8 = \dfrac{v_{A3} - 0}{0 - (-11.35)}$

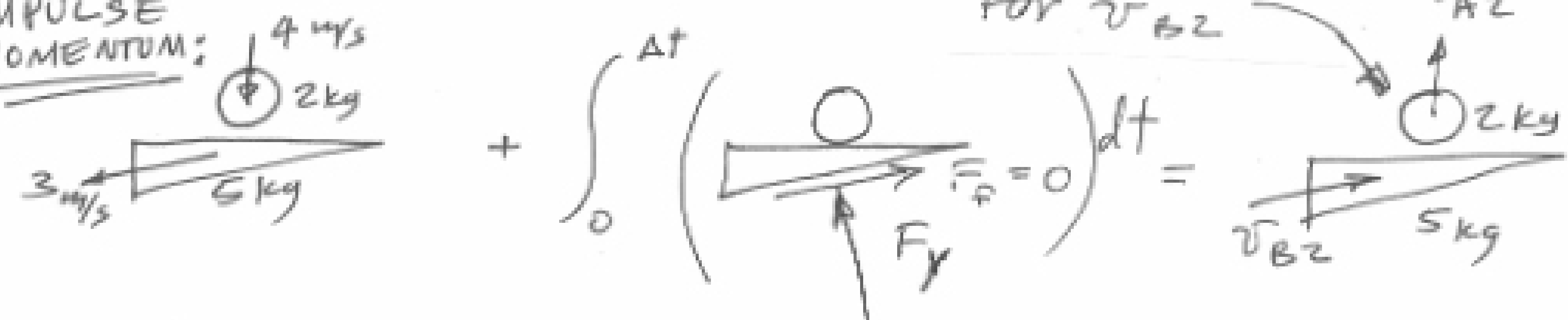
$v_{A3} = 9.079$ ft/sec ↑

2. (35 pts) The 2-kg ball A is going straight down at 4 m/sec just before it impacts the 5-kg triangular block $\boldsymbol{B}$. Just before the impact, the block is sliding down the frictionless 20-degree slope at 3 m/sec. The coefficient of restitution between the ball and block is 0.8. Assume the block does not bounce off the slope after impact but keeps moving along the slope. The top of the block is horizontal. The size of the ball and block and friction between them are negligible. Identify and show the TP and LOI. (a) Find the speed of the ball and the block just after the impact. (b) Calculate the kinetic energy lost due to the impact.



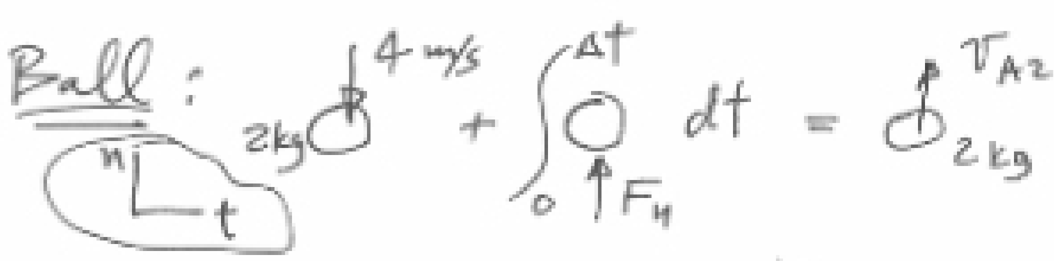
Note: Even though I know the wedge will be going down slope, I assumed upward + expect to get negative for v_{B2}

SYSTEM IMPULSE MOMENTUM:



Reaction F_y is impulsive but $F_x = F_f = 0$ ∴ we have conservation of system linear momentum in the x-direction but NOT in the y-direction OR the vertical direction ↑.

Ball:



no → force on ball so no change in horiz velocity of ball

$v_{A1_T} = 0 = v_{A2_T}$

Materials

$(+\uparrow)\quad e = 0.8 = \dfrac{v_{A2} - v_{B2}\sin 20}{(-3\sin 20) - (-4)}$ ∴ $v_{A2} = 2.379 + .3420\, v_{B2}$ (*)

System x-direction: $\nearrow \Sigma F_x = 0$ ∴ $\Sigma m v_{x_1} = \Sigma m v_{x_2}$

(+) ↗ x, 20°: $m_A v_{A1x} + m_B v_{B1} = m_A v_{A2x} + m_B v_{B2}$

$2(-4\sin 20) + 5(-3) = 2(+v_{A2}\sin 20) + 5(v_{B2})$

$-17.74 = 0.6840\, v_{A2} + 5\, v_{B2}$ (*)

Solve (*): $v_{B2} = -3.70 = 3.70$ m/sec ↙ $\qquad v_{A2} = 1.113$ m/sec ↑

Energy Loss:

$$T_1 = \frac{1}{2}2(4)^2 + \frac{1}{2}5(3)^2 = 106 \text{ N-m}$$

$$T_2 = \frac{1}{2}2(1.113)^2 + \frac{1}{2}5(3.7)^2 = 35.46 \text{ N-m}$$

$$\Delta T = -70.54 \text{ N-m}$$

$$= 66.54\% \text{ loss}$$