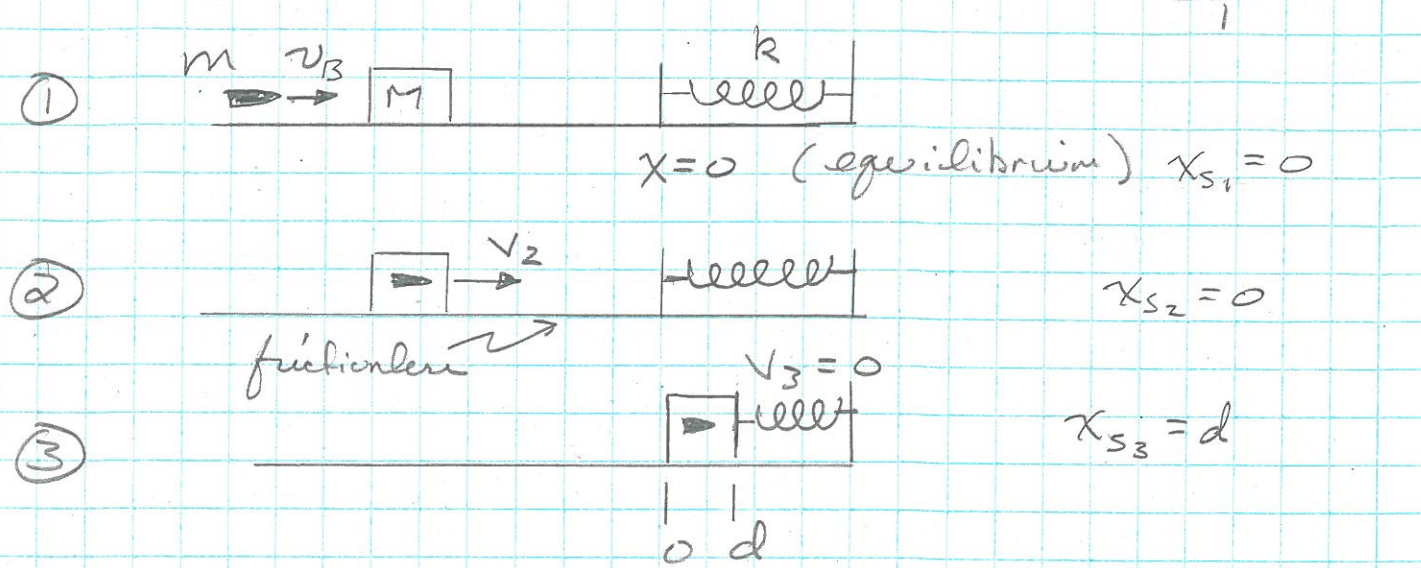

a.) Conserve x-component of momentum 1 → 2: (perfectly inelastic collision)

$$P_{x_1} = P_{x_2}$$

$$m v_B = (m+M) V_2$$

So: $V_2 = \frac{m}{(m+M)} v_B$

Conserve energy 2 → 3:

$$\Delta E_{mech} = \Delta K + \Delta U_s = 0$$

$$\tfrac{1}{2}(m+M)(V_3^2 - V_2^2) + \tfrac{1}{2}k(x_{s_3}^2 - x_{s_2}^2) = 0$$

$$-(m+M)V_2^2 + kd^2 = 0$$

$$\therefore\ d^2 = \frac{(m+M)}{k} V_2^2 = \frac{(m+M)}{k}\frac{m^2}{(m+M)^2} v_B^2$$

$$= \frac{m^2 v_B^2}{k(m+M)}$$

$$\therefore\ v_B^2 = \frac{d^2}{m^2} k(m+M)$$

or, $\underline{v_B = \frac{d}{m}\sqrt{k(m+M)}}$