

**Problem 6: (Conservation of Energy and Momentum)**

A mass  $m_1 = 1.5 \text{ kg}$  is initially moving with a velocity  $v_0$ . It collides completely inelastically with a block of mass  $m_2 = 2.0 \text{ kg}$ . The second block is attached to a spring with constant  $k = 5.6 \times 10^3 \text{ N/m}$ . The block and spring lie on a frictionless horizontal surface. The spring compresses a distance  $2.0 \times 10^{-1} \text{ m}$ .

- a) What is the velocity of the mass  $m_1$  and the block immediately after the collision?
- b) What is the initial velocity of the mass  $m_1$  immediately before the collision?
- c) If the block were attached to a very long string and hung as a pendulum, how high would the block and mass  $m_1$  rise after the collision? Let  $g = 9.8 \text{ m/s}^2$ .

**~~Problem 7: (Angular Dynamics)~~**

~~A playground merry-go-round has a radius of  $4.0 \text{ m}$  and has a moment of inertia equal to  $7.0 \times 10^3 \text{ kg}\cdot\text{m}^2$  with negligible friction about its vertical axis. Two children of mass  $25 \text{ kg}$  each were standing  $3.0 \text{ m}$  from the central axis on opposite sides from each other. The merry-go-round is initially at rest. A person on the ground applied a constant tangential force of  $2.5 \times 10^2 \text{ N}$  at the rim of the merry-go-round for  $1.0 \times 10^1$  seconds.~~

- ~~a) What was the angular acceleration of the merry-go-round?~~
- ~~b) What was the angular velocity of the merry-go-round when the person stopped applying the force?~~
- ~~c) What average power did the person put out while pushing the merry-go-round?~~
- ~~d) What was the rotational kinetic energy of the merry-go-round when the person stopped applying the force?~~

~~The two children then walked inward and stop a distance of  $1.0 \text{ m}$  from the central axis of the merry-go-round.~~

- ~~e) What was the angular velocity of the merry-go-round when the children reached their final position?~~
- ~~f) What was the change in rotational kinetic energy of the merry-go-round when the children reached their final position?~~

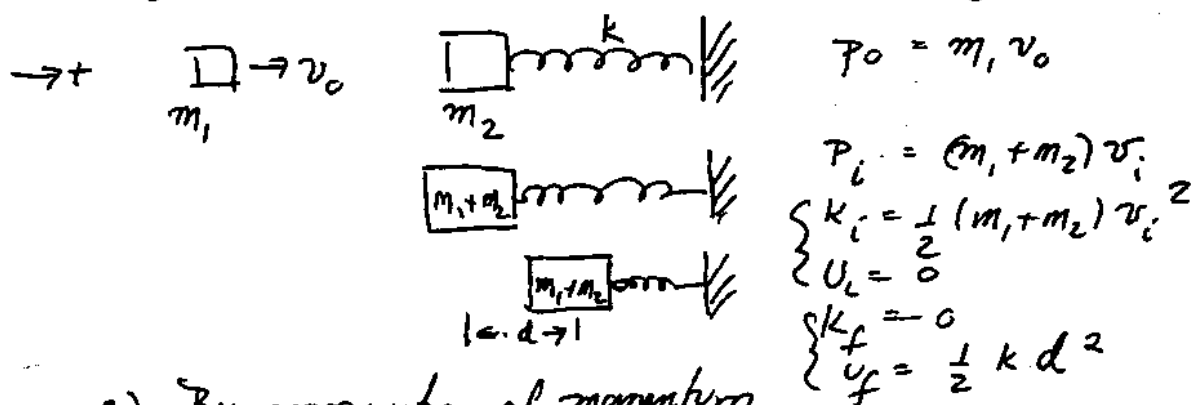
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a) What is the velocity of the mass  $m_1$  and the block immediately after the collision?

b) What is the initial velocity of the mass  $m_1$  immediately before the collision?

c) If the block were attached to a very long string and hung as a pendulum, how high would the block and mass  $m_1$  rise after the collision? Let  $g = 9.8 \text{ m/s}^2$ .



a) By conservation of momentum

$$P_0 = P_i \Rightarrow m_1 v_0 = (m_1 + m_2) v_i$$

$$\Rightarrow v_0 = \frac{(m_1 + m_2) v_i}{m_1}$$

By conservation of energy

$$\frac{1}{2} (m_1 + m_2) v_i^2 = \frac{1}{2} k d^2 \Rightarrow v_i = \left( \frac{k}{m_1 + m_2} \right)^{1/2} d$$

$$v_i = \left( \frac{5.6 \times 10^3 \text{ N/m}}{1.5 \text{ kg} + 2.0 \text{ kg}} \right)^{1/2} (2.0 \times 10^{-1} \text{ m}) = 8 \text{ m/s}$$

$$v_0 = \left( \frac{m_1 + m_2}{m_1} \right) v_i = \left( \frac{1.5 \text{ kg} + 2.0 \text{ kg}}{1.5 \text{ kg}} \right) \left( \frac{8 \text{ m}}{s} \right) = 18.7 \text{ m/s}$$

c)



$$\frac{1}{2} (m_1 + m_2) v_i^2 = (m_1 + m_2) g h$$

$$h = \frac{v_i^2}{2g} = \frac{(8 \text{ m/s})^2}{2(9.8 \text{ m/s}^2)} = 3.3 \text{ m}$$