

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

~~A mass  $m_1 = 1.5$  kg is initially moving with a velocity  $v_0$ . It collides completely inelastically with a block of mass  $m_2 = 2.0$  kg. The second block is attached to a spring with constant  $k = 5.6 \times 10^3$  N/m. The block and spring lie on a frictionless horizontal surface. The spring compresses a distance  $2.0 \times 10^{-1}$  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  $g = 9.8$  m/s<sup>2</sup>.~~

**Problem 7: (Angular Dynamics)**

A playground merry-go-round has a radius of 4.0 m and has a moment of inertia equal to  $7.0 \times 10^3$  kg-m<sup>2</sup> with negligible friction about its vertical axis. Two children of mass 25 kg each were standing 3.0 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  $2.5 \times 10^2$  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 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?

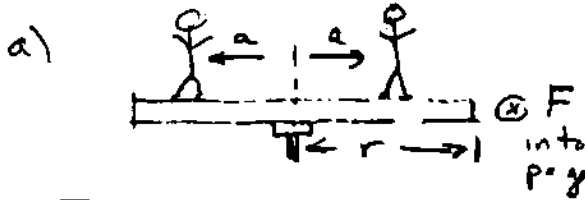
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$$\tau_{cm} = I_{cm} \alpha$$

$$rF = (2ma^2 + I_p) \alpha$$

$$I^T = (2ma^2 + I_p) = 7.450 \times 10^3 \text{ kg}\cdot\text{m}^2$$

$$\alpha = \frac{rF}{2ma^2 + I_p} = \frac{(4.0\text{m})(2.5 \times 10^2 \text{ N})}{((2)(25\text{kg})(3.0\text{m})^2 + 7.0 \times 10^3 \text{ kg}\cdot\text{m}^2)} = 1.3 \times 10^{-1} \frac{\text{rad}}{\text{sec}^2}$$

b)  $\omega_1 = \alpha t = (1.3 \times 10^{-1} \frac{\text{rad}}{\text{sec}})(1.0 \times 10^1 \text{ sec}) = 1.3 \frac{\text{rad}}{\text{sec}}$

c)  $P = \tau \omega_{ave} = rF \frac{\omega_1}{2} = (4.0\text{m})(2.5 \times 10^2 \text{ N})(1.3 \frac{\text{rad}}{\text{sec}}) = 6.5 \times 10^2 \text{ W}$

d)  $K_1 = \frac{1}{2} I_1 \omega_1^2 = (\frac{1}{2})(2ma^2 + I_p) \omega_1^2 = 6.3 \times 10^3 \text{ J}$

e)  $\tau_{PA} = 0 \Rightarrow L_1 = L_2 = (2ma^2 + I_p) \omega_1 = (2ma_f^2 + I_p) \omega_2$   
 $\omega_2 = \frac{(2ma^2 + I_p) \omega_1}{2ma_f^2 + I_p} = \frac{(7450 \text{ kg}\cdot\text{m}^2) 1.3 \frac{\text{rad}}{\text{sec}}}{7050 \text{ kg}\cdot\text{m}^2} = 1.4 \frac{\text{rad}}{\text{sec}}$

f)  $\Delta K = \frac{1}{2} I_f \omega_f^2 - \frac{1}{2} I_i \omega_i^2 = 6.9 \times 10^3 \text{ J} - 6.3 \times 10^3 \text{ J} = .6 \text{ J}$