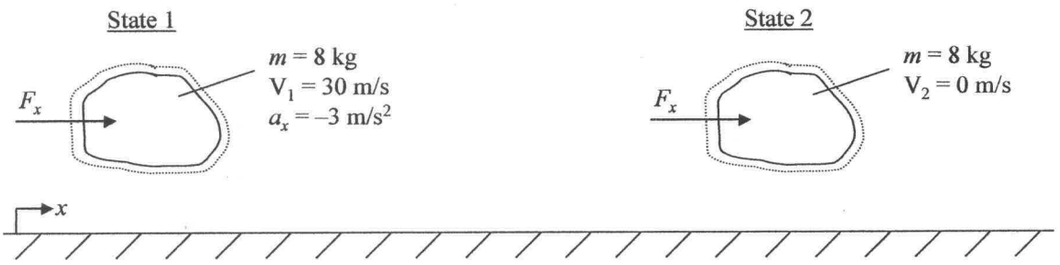
PROBLEM 2.18

KNOWN: A system of known mass and initial velocity experiences a constant deceleration due to the action of a resultant force and comes to rest.

FIND: Determine the magnitude of the resultant force, the amount of energy transfer by work, and the total distance that the system travels

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL:
1. The system is the 8-kg mass.
2. Horizontal deceleration is constant.

ANALYSIS:
The magnitude of the resultant force is determined by applying Newton's Second Law using a constant deceleration

$$F_x = ma_x = (8\,\text{kg})\left(-3\frac{\text{m}}{\text{s}^2}\right)\left|\frac{1\,\text{N}}{1\frac{\text{kg}\cdot\text{m}}{\text{s}^2}}\right| = \underline{\textbf{-24 N}}$$

The negative sign indicates the resultant force is acting in the negative x-direction (the direction opposite that shown in the schematic).

The work of the force, F_x, is found from Eq. 2.6.

$$\text{Work} = \tfrac{1}{2}\,m(V_2^2 - V_1^2) = \frac{1}{2}(8\,\text{kg})\left(\left(0\frac{\text{mi}}{\text{s}}\right)^2 - \left(30\frac{\text{m}}{\text{s}}\right)^2\right)\left|\frac{1\,\text{N}}{1\frac{\text{kg}\cdot\text{m}}{\text{s}^2}}\right|\left|\frac{1\,\text{kJ}}{1000\,\text{N}\cdot\text{m}}\right| = \underline{\textbf{-3.6 kJ}}$$

The negative sign denotes energy transfer out of the system.

The distance the system travels is determined with the concept of work from mechanics

$$\text{Work} = \int_{x_1}^{x_2} F_x\,dx = F_x(x_2 - x_1) = F_x\,(\Delta x) \quad \Rightarrow \quad \Delta x = \frac{\text{Work}}{F_x} = \left(\frac{-3.6\,\text{kJ}}{-24\,\text{N}}\right)\left|\frac{1000\,\text{N}\cdot\text{m}}{1\,\text{kJ}}\right| = \underline{\textbf{150 m}}$$