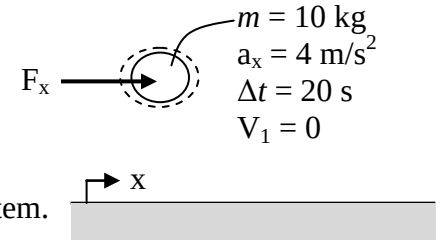
Problem 2.19

An object of mass 10 kg, initially at rest, experiences a constant horizontal acceleration of 4 m/s^2 due to the action of a resultant force applied for 20 s. Determine the total amount of energy transfer by work, in kJ.

KNOWN:
A system of known mass experiences a constant horizontal acceleration due to an applied force for a specified length of time.

FIND: Determine the amount of energy transfer by work.

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL: (1) The object is a closed system. (2) The horizontal acceleration is constant.

ANALYSIS: The work of the resultant force is determined using Eq. 2.6

$$\int_{x_1}^{x_2} F_x dx = \frac{1}{2} m(V_2^2 - \cancel{V_1^2}^{\,0})$$

To find V_2, use the fact that the acceleration is constant

$$A_x = \frac{dV}{dt} \quad \rightarrow \quad dV = a_x dt \quad \rightarrow \quad \int_{V_1}^{V_2} dV = \int_{t_1}^{t_2} a_x \, dt$$

or

$$(V_2 - \cancel{V_1}^{\,0}) = a_x(t_2 - t_1) = a_x \Delta t$$

Thus

$$V_2 = (4 \text{ m/s}^2)(20 \text{ s}) = 80 \text{ m/s}$$

Finally, the work of the resultant force is

$$\int_{x_1}^{x_2} F_x dx = \frac{1}{2} m V_2^2$$

$$= \frac{1}{2}(10 \text{ kg})(80^2) \frac{\text{m}^2}{\text{s}^2} \left| \frac{1 \text{ N}}{1 \text{ kg·m/s}^2} \right| \left| \frac{1 \text{ kJ}}{10^3 \text{ N·m}} \right| = 32 \text{ kJ} \quad \longleftarrow$$