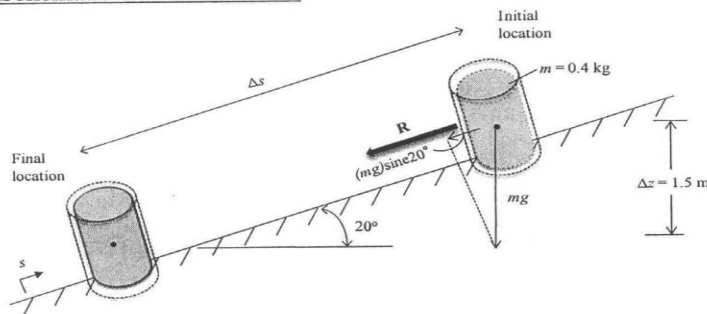


PROBLEM 2.15

Known: Can moves down a surface that is inclined relative to the horizontal. The can is acted upon by a constant force parallel to the incline and by the force of gravity.

Find: Can's change in kinetic energy, in J, and whether it is *increasing* or *decreasing*. If friction between the can and the inclined surface were significant, what effect would that have on the value of the change in kinetic energy?

Schematic and Given Data:



Engineering Model:

- (1) The can is a closed system.
- (2) The acceleration of gravity is constant.
- (3) The applied force \mathbf{R} is constant.
- (4) Ignore friction between the can and inclined surface.

Analysis:

Begin with Eq. 2.6

$$\int_{s_1}^{s_2} \mathbf{F} \cdot d\mathbf{s} = \frac{1}{2} m (V_2^2 - V_1^2) = \Delta KE \quad (1)$$

From the free body diagram in the schematic, the dot product can be expressed as

$$\mathbf{F} \cdot d\mathbf{s} = (\mathbf{R} + (mg) \sin 20^\circ) ds$$

Substituting into Eq. (1)

$$\int_{s_1}^{s_2} \mathbf{F} \cdot d\mathbf{s} = \int_{s_1}^{s_2} (\mathbf{R} + (mg) \sin 20^\circ) ds = \Delta KE \quad (2)$$

Since $\Delta z = \Delta s \sin 20^\circ$, Eq. (2) becomes

$$\int_{s_1}^{s_2} (\mathbf{R}) ds + (mg) \Delta z = (\mathbf{R}) \Delta s + (mg) \Delta z = \Delta KE \quad (3)$$

Evaluate Δs

$$\Delta s = \frac{\Delta z}{\sin 20^\circ} = \frac{1.5 \text{ m}}{0.342} = 4.39 \text{ m}$$

PROBLEM 2.15 (Continued)

Substituting all known and calculated data into Eq. (3)

$$\Delta KE = (0.05\text{N})(4.39\text{m}) \left| \frac{1\text{J}}{1\text{N} \cdot \text{m}} \right| + (0.4\text{kg}) \left(9.8 \frac{\text{m}}{\text{s}^2} \right) (1.5\text{m}) \left| \frac{1\text{N}}{1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}} \right| \left| \frac{1\text{J}}{1\text{N} \cdot \text{m}} \right| =$$

#1

$$\Delta KE = 0.22 \text{ J} + 5.88 \text{ J} = 6.1 \text{ J}$$

Which corresponds to an *increase* in kinetic energy.

If friction were significant, the magnitude of the net force acting in the direction of motion would be less, and thus the kinetic energy change would be less than calculated.

-
1. Observe that in the absence of the force **R** the can is acted on only by gravity, and the can's change in kinetic energy is 5.88 J.