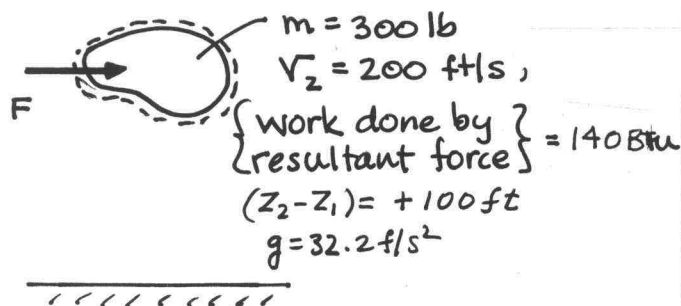


PROBLEM 2.10

KNOWN: An object of known mass undergoes a change of kinetic energy due to the action of a resultant force. The final velocity, the work done by the force, and the change in elevation are given.

FIND: Determine the initial velocity.

SCHEMATIC & GIVEN DATA:



ENGR. MODEL: (1) The object is a closed system. (2) The force of gravity acts on the object. (3) The resultant force accounts for all other forces acting on the object.

ANALYSIS: By assumption (3), the work of the resultant force must equal the sum of the changes in kinetic energy and gravitational potential energy. Thus, with Eq. 2.9

$$\text{work} = \frac{1}{2} m (v_2^2 - v_1^2) + mg(z_2 - z_1)$$

Solving for v_1^2 , inserting values, and converting units

$$\begin{aligned}
 v_1^2 &= \frac{2[mg(z_2 - z_1) - \text{work}]}{m} + v_2^2, \text{ where } mg(z_2 - z_1) = \frac{(300)(32.2)(100)}{32.2} \left| \frac{1}{778} \right| \\
 &= \frac{2(101.4 \text{ Btu})}{(300 \text{ lb})} \left| \frac{778 \text{ ft} \cdot \text{lb} \cdot \text{f}}{1 \text{ Btu}} \right| \left| \frac{32.2 \text{ lb} \cdot \text{ft/s}^2}{1 \text{ lbf}} \right| + 200^2 \frac{\text{ft}^2}{\text{s}^2} \\
 &= 23065 \text{ ft}^2/\text{s}^2
 \end{aligned}$$

or

$$\textcircled{1} \quad v_1 = 151.9 \text{ ft/s} \leftarrow \text{-----} v_1$$

- The increase in velocity reflects the increase in kinetic energy of the object as a result of energy transferred to it by the work of the resultant force. Carefully observe that in Eq. 2.9 the work of the resultant force acting on the body is positive.