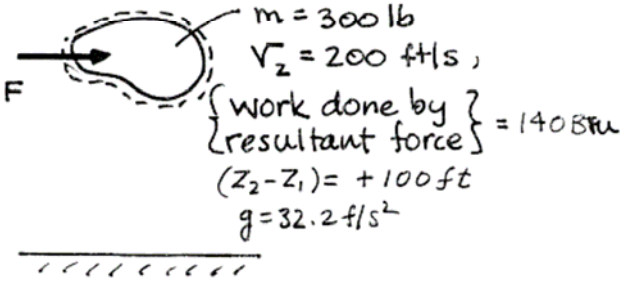
PROBLEM 2.10

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

$$V_1^2 = \frac{2[mg(Z_2 - Z_1) - \text{work}]}{m} + V_2^2, \quad \text{where } mg(Z_2 - Z_1) = (300)(32.2)(100)\left|\frac{1}{32.2}\right|\left|\frac{1}{778}\right| = 38.6 \text{ Btu}$$

$$= -\frac{2(101.4 \text{ Btu})}{(300 \text{ lb})}\left|\frac{778 \text{ ft·lbf}}{1 \text{ Btu}}\right|\left|\frac{32.2 \text{ lb·ft/s}^2}{1 \text{ lbf}}\right| + 200^2 \frac{\text{ft}^2}{\text{s}^2}$$

$$= 23065 \text{ ft}^2/\text{s}^2$$

or

① $V_1 = 151.9$ ft/s ← V_1

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.

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