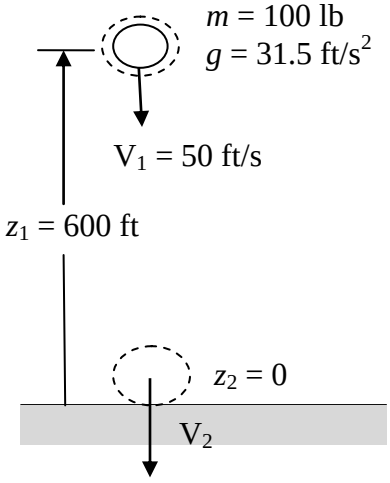
Problem 2.14

An object whose mass is 100 lb falls freely under the influence of gravity from an initial elevation of 600 ft above the surface of Earth. The initial velocity is downward with a magnitude of 50 ft/s. The effect of air resistance is negligible. Determine the velocity, in ft/s, of the object just before it strikes Earth. Assume $g = 31.5$ ft/s^2.

KNOWN: An object of known mass falls freely from a known elevation and with a given initial velocity. The only force acting is the force of gravity.

FIND: Determine the velocity of the object just before it strikes Earth.



SCHEMATIC AND GIVEN DATA:

ENGINEERING MODEL: (1) The object is a closed system. (2) The acceleration of gravity is constant. (3) The only force acting on the object is the force of gravity.

ANALYSIS: Since the only force acting on the object is the force of gravity, Eq. 2.11 applies. Thus

① $$\frac{1}{2}\cancel{m}(V_2^2 - V_1^2) + \cancel{m}g(\overset{0}{\cancel{z_2}} - z_1) = 0$$

Solving for V_2

$$V_2 = \sqrt{V_1^2 + 2gz_1}$$

Inserting values

$$V_2 = \sqrt{50^2 \frac{\text{ft}^2}{\text{s}^2} + 2\left(31.5 \frac{\text{ft}}{\text{s}^2}\right)(600 \text{ ft})} = 200.7 \text{ ft/s} \longleftarrow$$

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1. Note that the mass cancels out. Any object falling freely under the influence of gravity, with no effects of air resistance, would reach the same final velocity.