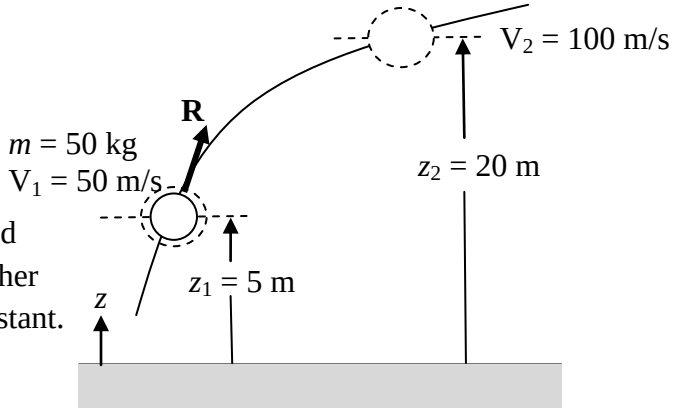
Problem 2.18

An object initially at an elevation of 5 m relative to Earth's surface and with a velocity of 50 m/s is acted on by an applied force **R** and moves along a path. Its final elevation is 20 m and its velocity is 100 m/s. The acceleration of gravity is 9.81 m/s^2. Determine the work done on the object by the applied force, in kJ.

KNOWN: An object moves along a path due to the action of an applied force. The elevation and velocities are known initially and finally.

FIND: Determine the work of the applied force.

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL: (1) The object is a closed system. (2) **R** is the only force acting on the object other than the force of gravity. (3) g = 9.81 m/s^2 and is constant.

ANALYSIS: To find the work of force **R** we use

$$\text{Work} = \int_1^2 \mathbf{R}\cdot d\mathbf{s} = \frac{1}{2}m(\mathrm{V}_2^2 - \mathrm{V}_1^2) + mg(z_2 - z_1)$$

Inserting values and converting units

$$\text{Work} = \left\{\frac{1}{2}(50\text{ kg})(100^2 - 50^2)\frac{\mathrm{m}^2}{\mathrm{s}^2} + (50\text{ kg})\left(9.81\frac{\mathrm{m}}{\mathrm{s}^2}\right)(20-5)\mathrm{m}\right\}\left|\frac{1\text{ N}}{1\text{ kg}\cdot\mathrm{m/s}^2}\right|\left|\frac{1\text{ kJ}}{10^3\mathrm{N}\cdot\mathrm{m}}\right|$$

$$= 187.5 + 7.36 = 194.9\text{ kJ}$$