SAMPLE PROBLEM E

Conservation of Mechanical Energy

PROBLEM

Starting from rest, a child zooms down a frictionless slide from an initial height of 3.00 m. What is her speed at the bottom of the slide? Assume she has a mass of 25.0 kg.

SOLUTION

1. DEFINE

Given: $h = h_i = 3.00\ \text{m} \quad m = 25.0\ \text{kg} \quad v_i = 0.0\ \text{m/s} \quad h_f = 0\ \text{m}$

Unknown: $v_f = ?$

2. PLAN

Choose an equation or situation:

The slide is frictionless, so mechanical energy is conserved. Kinetic energy and gravitational potential energy are the only forms of energy present.

$$KE = \tfrac{1}{2}mv^2 \qquad PE = mgh$$

The zero level chosen for gravitational potential energy is the bottom of the slide. Because the child ends at the zero level, the final gravitational potential energy is zero.

$$PE_{g,f} = 0$$

The initial gravitational potential energy at the top of the slide is

$$PE_{g,i} = mgh_i = mgh$$

Because the child starts at rest, the initial kinetic energy at the top is zero.

$$KE_i = 0$$

Therefore, the final kinetic energy is as follows:

$$KE_f = \tfrac{1}{2}mv_f^2$$

3. CALCULATE

Substitute values into the equations:

$$PE_{g,i} = (25.0\ \text{kg})(9.81\ \text{m/s}^2)(3.00\ \text{m}) = 736\ \text{J}$$
$$KE_f = (\tfrac{1}{2})(25.0\ \text{kg})v_f^2$$

Now use the calculated quantities to evaluate the final velocity.

$$ME_i = ME_f$$
$$PE_i + KE_i = PE_f + KE_f$$
$$736\ \text{J} + 0\ \text{J} = 0\ \text{J} + (0.500)(25.0\ \text{kg})v_f^2$$

$$\boxed{v_f = 7.67\ \text{m/s}}$$

CALCULATOR SOLUTION

Your calculator should give an answer of 7.67333, but because the answer is limited to three significant figures, it should be rounded to 7.67.