4. EVALUATE The expression for the square of the final speed can be written as follows:

$$v_f^2 = \frac{2\cancel{m}gh}{\cancel{m}} = 2gh$$

Notice that the masses cancel, so the final speed does not depend on the mass of the child. This result makes sense because the acceleration of an object due to gravity does not depend on the mass of the object.

PRACTICE E

Conservation of Mechanical Energy

1. A bird is flying with a speed of 18.0 m/s over water when it accidentally drops a 2.00 kg fish. If the altitude of the bird is 5.40 m and friction is disregarded, what is the speed of the fish when it hits the water?

2. A 755 N diver drops from a board 10.0 m above the water's surface. Find the diver's speed 5.00 m above the water's surface. Then find the diver's speed just before striking the water.

3. If the diver in item 2 leaves the board with an initial upward speed of 2.00 m/s, find the diver's speed when striking the water.

4. An Olympic runner leaps over a hurdle. If the runner's initial vertical speed is 2.2 m/s, how much will the runner's center of mass be raised during the jump?

5. A pendulum bob is released from some initial height such that the speed of the bob at the bottom of the swing is 1.9 m/s. What is the initial height of the bob?

Energy conservation occurs even when acceleration varies

If the slope of the slide in Sample Problem E was constant, the acceleration along the slide would also be constant and the one-dimensional kinematic formulas could have been used to solve the problem. However, you do not know the shape of the slide. Thus, the acceleration may not be constant, and the kinematic formulas could not be used.

But now we can apply a new method to solve such a problem. Because the slide is frictionless, mechanical energy is conserved. We simply equate the initial mechanical energy to the final mechanical energy and ignore all the details in the middle. The shape of the slide is not a contributing factor to the system's mechanical energy as long as friction can be ignored.

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