

A cat chases a mouse across a 1.5 m high table. The mouse steps out of the way, and the cat slides off the table and strikes the floor 2.1 m from the edge of the table. What was the cat's speed when it slid off the table? The acceleration of gravity is 9.81 m/s<sup>2</sup>. Answer in units of m/s

### Solution

We need to find the time it took the cat to hit the floor in order to find the cat's speed.

To find this time, we need to consider the vertical component of motion. We can assume the cat slid horizontally off the edge of the table, so the vertical component of the speed is zero. We have enough information to find the time it took the cat to hit the floor using one of the kinematic equations of motion in the vertical direction, taking downwards to be the positive direction.

$$H = \text{height} = 1.5 \text{ m}$$

$$d = \text{horizontal distance} = 2.1 \text{ m}$$

$$u = \text{initial velocity} = 0 \text{ m/s}$$

$$g = \text{acceleration (due to gravity)} = 9.8 \text{ m/s}^2$$

$$t = \text{time} = ?$$

$$v = \text{the cat's speed} = ?$$

$$h = ut + \frac{1}{2}gt^2. \text{ Since } u = 0, \text{ this reduces to } h = \frac{1}{2}gt^2 \text{ and rearranges to}$$

$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 * 1.5}{9.8}} = 0.55 \text{ s.}$$

Now we turn our attention to the horizontal direction. What horizontal forces acted on the cat as it fell? None. So that means no horizontal acceleration and therefore the horizontal speed is constant. So the average horizontal speed is equal to its speed, when it slid off the table, and when speed is constant, horizontal speed is just horizontal distance divided by time

$$v = \frac{d}{t} = \frac{2.1 \text{ m}}{0.55 \text{ s}} = 3.8 \frac{\text{m}}{\text{s}}$$

**Answer:**  $3.8 \frac{\text{m}}{\text{s}}$