

Free Fall

A pot falls from a window. Unless it is attached to a parachute, there is very little air resistance, and it is in free fall. Before it fell, its speed was 0 m/s. As it fell, it sped up or accelerated. The speed kept increasing the entire time it was falling because of gravity. The acceleration of gravity, g , is 9.8 m/s^2 . The final speed of an object with a constant acceleration after a given amount of time has passed is also called the **instantaneous speed**. For an object in free fall with an initial speed of 0 m/s, the final speed is the acceleration of gravity times the time: $v_f = gt$. If the initial speed of the falling object, v_i , is not zero, it needs to be added to get the instantaneous or final speed: $v_f = gt + v_i$. When the acceleration is constant, the average speed between any two measurements is the midpoint. It is found by adding the two values and dividing by two: $v_{avg} = (v_f + v_i)/2$. The distance the object falls can be determined using the average velocity and the time or using the equation $d = v_i t + \frac{1}{2}at^2$.



Sample Problem

A child drops a toy out of a window. It falls for 3.0 seconds. How fast is it going just before it hits?

Step 1: Write the values of the variables

- $v_i = 0 \text{ m/s}$
- $t = 3 \text{ s}$
- $g = 9.8 \text{ m/s}^2$

Step 2: Substitute values into the equation

- $v_f = gt + v_i$
- $v_f = (9.8 \text{ m/s}^2)(3 \text{ s}) + 0 \text{ m/s} = 29.4 \text{ m/s}$

Sample Problem

A child drops a toy out of a window. It falls for 3.0 seconds and reaches a final speed of 29.4 m/s. What is the average speed?

$$v_{avg} = \frac{v_f + v_i}{2} = \frac{29.4 \frac{\text{m}}{\text{s}} + 0}{2} = 14.7 \frac{\text{m}}{\text{s}}$$

Sample Problem

A child drops a toy out of a window. It falls for 3.0 seconds. How far does it fall?

$$d = v_i + \frac{1}{2}gt^2 = 0 + \frac{1}{2}(9.8 \frac{\text{m}}{\text{s}^2})(3\text{s})^2 = 44.1\text{m}$$

or

$$d = v_{avg} t = (14.7 \frac{\text{m}}{\text{s}})(3\text{s}) = 44.1\text{m}$$

Answer the questions below based on the reading above and on your knowledge of physics.

- A ball is tossed down with an initial speed of 3.0 m/s . If it hits the ground in 0.20 s :
 - How fast was it going just before it hit?
 - What is its average speed?
 - From what height was it thrown?
- A flower pot falls from a window and crashes to the ground in 6.0 s :
 - How fast was it going just before it hit?
 - What is its average speed?
 - From what height did it fall?