

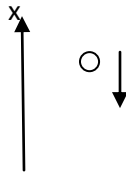
## Free Fall Motion

How long does it take a pencil to fall 0.5 meters?

Problem Solving Steps:

1. Draw a diagram

Use up direction as positive x direction:



2. Known properties:

Displacement  $\Delta x = -0.5 \text{ m}$

Initial velocity  $v_0 = 0 \text{ m/s}$  ( $v_i$  counts as correct too)

Acceleration for free fall is a constant  $a = -9.8 \text{ m/s}^2$

3. Theory

Of the three equations of motion, the middle one 2.9 can be used

$$\Delta x = v_0 t + \frac{1}{2} a t^2$$

The only unknown property in this equation is time,  $t$ .

4. Solve for  $t$

$$T = \sqrt{2 * \Delta x / a} = 0.3 \text{ s}$$

Notes:

The time for any object to free fall half a meter is the same if we neglect air resistance. This time happens to be close to the limit of human reaction time. You may do a “catch the pencil” test: one person hold a short pencil and drop, another person try to catch it half a meter lower.

For free fall the simplified formula can also be used:

$$\Delta x = \frac{1}{2} g t^2$$

where  $g = 9.8 \text{ m/s}^2$  and the displacement also points “down”.