Worksheet 5c
Free Fall

Study the following problems and solve for what is asked.

1. A stone is released from the railing of a bridge and strikes the water below the bridge in 1.50 s. How high is the bridge above water? **(Express all answers to 3 s.f.)**

   Given:

   $v_i =$ _____ m/s $t =$ _____ s

   Find: d
   Solution:

   $$d = v_i t + \frac{gt^2}{2}$$

   $$d = \left(\qquad \frac{m}{s}\right)\left(\qquad s\right) + \frac{\left(\qquad \frac{m}{s^2}\right)\left(\qquad s\right)^2}{2} = \qquad m$$

2. A ball is thrown vertically upward with a speed of 15.0 m/s from the roof of a tall building. The ball leaves the thrower's hand at a point even with the roof railing. On its way back down, it just misses the railing. What are (a) the position and (b) velocity of the ball 1.00 s and 4.00 s after it leaves the thrower's hand? **(Express all answers to 3 s.f.)**

   Given:

   $v_i =$ _____ m/s $t_1 =$ _____ s $t_2 =$ _____ s

   Find: (a) **d** of the ball at t = 1.00 s and t = 4.00 s
              (b) **v** of the ball at t = 1.00 s and t = 4.00 s

   Solution:
      (a) At t = 1.00 s

   $$d = v_i t + \frac{gt^2}{2}$$

   $$d = \left(\qquad \frac{m}{s}\right)\left(\qquad s\right) + \frac{\left(\qquad \frac{m}{s^2}\right)\left(\qquad s\right)^2}{2} = \qquad m$$

$$v_f = gt + v_i$$

$$v_f = \left(\qquad \frac{m}{s^2} \right) (\qquad s) + \left(\qquad \frac{m}{s} \right) = \qquad \frac{m}{s}$$

(b) At t = 4.00 s

$$d = v_i t + \frac{gt^2}{2}$$

$$d = \left(\qquad \frac{m}{s} \right) (\qquad s) + \frac{\left(\qquad \frac{m}{s^2} \right)(\qquad s)^2}{2} = \qquad m$$

$$v_f = gt + v_i$$

$$v_f = \left(\qquad \frac{m}{s^2} \right) (\qquad s) + \left(\qquad \frac{m}{s} \right) = \qquad \frac{m}{s}$$

3. A ball is thrown directly downward, with an initial speed of 10.0 m/s, from a height of 50.0 m. After what time interval does the ball strike the ground? **(Express all answers to 3 s.f.)**

Given:

$v_i =$ _____ m/s $d =$ _____ m

Find: **t** *when the ball strikes the ground*

Solution:

$$d = v_i t + \frac{gt^2}{2}$$

$$m = \left(\qquad \frac{m}{s} \right) (t) + \frac{\left(\qquad \frac{m}{s^2} \right) t^2}{2}$$

This follows a quadratic trinomial: ***ax² + bx + c = 0.***
The value of the variable can be computed using the quadratic formula.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$t = \frac{(- \qquad) \pm \sqrt{(\qquad)^2 - 4(\qquad)(\qquad)}}{2(\qquad)}$$

This will yield two roots (answers) for t.

$t = \qquad s$ $t = \qquad s$