Free fall Kinematics Worksheet II

1. To celebrate a victory, a pitcher throws her glove straight upward with an initial speed of 6.0 m/s.
   a. How long does it take for the glove to return to the pitcher?

$v_i = 6.0\ m/s$
$a = -9.8\ m/s^2$
$d = 0$
$t = ?$

$d = v_i t + \frac{1}{2}at^2$
$0 = 6t + \frac{1}{2}(-9.8)t^2$
$4.9t = 6$
$t = 1.2\ s$

   b. How long does it take for the glove to reach its maximum height?

$v_i = 6.0\ m/s$
$v_f = 0$
$a = -9.8\ m/s^2$
$t = ?$

$v_f = v_i + at$
$0 = 6 + -9.8t$
$t = 0.61\ s$

2. While riding on an elevator descending with a constant speed of 3.0 m/s, you accidentally drop a book from under your arm.
   a. How long does it take for the book to reach the elevator floor, 1.2 m below your arm?

book
$v_i = 0$
$d = -(1.2 + x)$
$t = $ ___
$a = -9.8\ m/s^2$

elevator
$v_e = -3.0\ m/s$
$d = -x$
$t = $ ___

$d = v_i t + \frac{1}{2}at^2$
$-(1.2 + x) = \frac{1}{2}at^2$
$-1.2 - x = \frac{1}{2}at^2$

$v_e = \frac{d}{t}$
$d = v_e t$
$-x = v_e t$

$-1.2 + v_e t = \frac{1}{2}at^2$
$-1.2 - 3t = -4.9t^2$
$4.9t^2 - 3t - 1.2 = 0$
$t = \frac{3 \pm \sqrt{3^2 - 4(4.9)(-1.2)}}{2(4.9)}$
$t = 0.89\ s$

   b. What is the book's speed when it hits the elevator floor?

$v_i = 0$
$d = 1.2 + x$
$t = 0.89\ s$
$a = -9.8\ m/s^2$
$v_f = ?$

$v_f = v_i + at$
$= 0 + (-9.8)(.89)$
$v_f = -8.7\ m/s$

3. On a hot summer day several swimmers decide to dive from a railroad bridge into the river below. The swimmers step off the bridge and hit the water approximately 1.5 s later.

a. How high is the bridge?

$v_i = 0$
$t = 1.5\ s$
$a = -9.8\ m/s^2$
$d = ?$

$d = v_i t + \frac{1}{2} a t^2$
$= \frac{1}{2}(-9.8)(1.5)^2$
$= 11\ m$

b. How fast are the swimmers moving when they hit the water?

$v_i = 0$
$t = 1.5\ s$
$a = -9.8\ m/s^2$
$v_f = ?$

$v_f = v_i + at$
$= 0 + -9.8(1.5)$
$= -14.7\ m/s$

4. An astronaut on the Moon drops a rock straight downward from a height of 0.95 m. The acceleration of gravity on the Moon is 1.62 m/s^2.

a. What is the speed of the rock when it lands?

$v_i = 0$
$v_f = ?$
$a = -1.62\ m/s^2$
$d = -0.95\ m$

$v_f^2 = v_i^2 + 2ad$
$= 2(-1.62)(-0.95)$
$v_f = 1.75\ m/s$ down

b. How long does the rock take to hit the ground?

$v_i = 0$
$a = -1.62\ m/s^2$
$d = -0.95\ m$
$t = ?$

$d = v_i t + \frac{1}{2} a t^2$
$-0.95 = \frac{1}{2}(-1.62) t^2$
$t = 1.1\ s$