Free Fall Practice

Name:_____

1. A ball is shot straight into the air from the ground, it reaches a maximum height of 15m.

   a. What is the velocity of the ball at its highest point?

At highest point velocity is zero

   b. Determine the initial velocity they threw the ball upwards with.

$V_f = 0$
$d = 15m$
$a = -9.8 m/s^2$
$V_0 = ?$

Use $V_f^2 = V_0^2 + 2ad$

$V_0 = 17.1464 m/s \approx 17 m/s$

   c. Determine the total time the ball spent in the air.

$V_f = -17.1464 m/s$
$V_0 = 17.1464 m/s$
$a = -9.8 m/s^2$
$d = 0m \quad t = ?$

Use $V_f = V_0 + at$

$t = 3.4993 \approx 3.5 sec$

   d. Determine the two different velocities when the ball was 8.0 m above where it was thrown.

$V_0 = 17.1464 m/s$
$d = 8.0m$
$a = -9.8 m/s^2$
$V_f = ?$

Use $V_f^2 = V_0^2 + 2ad$

$V_f = 11.7132 m/s$

since we took a square root it could be positive or negative $V_f = \pm 12 m/s$

   e. Determine the two different times when the ball was 8.0 m above where it was thrown.

Could use quadratic formula but since we already know V_f we can use

$V_f = V_0 + at$

$t = 0.55 sec$ if $V_f = 11.7132$
or
$t = 2.9 sec$ if $V_f = -11.7132$

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2. A ball is thrown upwards with a velocity of 5.6 m/s, and it is caught at the same height it was thrown with.

   a. What is the velocity of the ball when it is caught?

Final velocity = negative of initial velocity

$-5.6\ m/s$

   b. What is the velocity of the ball when it is at its highest point?

$V = 0$

   c. What is height of the ball at its highest point?

From start to max height:
$V_f = 0$
$V_0 = 5.6\ m/s$
$a = -9.8\ m/s^2$
$d = ?$

Use $V_f^2 = V_0^2 + 2ad$

$d = 1.6\ m$

   d. How long in total was the ball be in the air?

Values From start to end:
$V_f = -5.6\ m/s$
$V_0 = 5.6\ m/s$
$a = -9.8\ m/s^2$
$t = ?$

Use $V_f = V_0 + at$

$t = 1.1\ sec$

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3. A helicopter is ascending vertically with a velocity of 8.0 m/s at a height of 120 m when a package is dropped out of the door. How much time passes before the package hits the ground?

$V_0 = 8.0 m/s$

$d = -120 m$

$a = -9.8 m/s^2$

$t = ?$

Use $d = v_0 t + \frac{1}{2} a t^2$ with quadratic formula

$0 = \frac{1}{2} a t^2 + v_0 t - d$

a b c

$a = -4.9 \quad b = 8.0 \quad c = 120$

$t = -4.2$ or $5.8 sec$

Negative solution is silly

4. A stone is dropped off a cliff. 2.0 s later a second stone is dropped off the same cliff. How far apart are the two stones when the first stone reaches a velocity of – 40.0 m/s?

(1) How far has first stone fallen when it is moving at $-40.0 m/s$?

Use $v_f^2 = v_0^2 + 2ad$

$d = -81.63 m$

$v_0 = 0$

$v_f = -40 m/s$

$a = -9.8 m/s^2$

$d = ?$

(2) How long did it take to fall that far?

Use $v_f = v_0 + at$

$t = 4.0816 sec$

(3) How far did the second stone fall in $4.0816 - 2 = 2.0816$ seconds?

$v_0 = 0, \; a = -9.8 m/s^2, \; t = 2.0816 sec, \; d = ?$

Use $d = v_0 t + \frac{1}{2} a t^2$ $\quad d = -21.23 m$

(4) How far apart are the stones? $81.63 - 21.23 = 60.4 m$

$\approx 6.0 \times 10^1 m$

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5. A basketball is thrown downwards at 20.0 m/s off a 100.0 m cliff. Find...
   a. the velocity at which it hits the ground.

$d = -100.0\,m$

$a = -9.8\,m/s^2$

$V_0 = -20.0\,m/s$

$V_f = ?$

Use $V_f^2 = V_0^2 + 2ad$

$V_f = \pm 48.58\,m/s$

It is moving downwards so $-49\,m/s$

   b. the time between throw and impact.

Since we know V_f we can use

$V_f = V_0 + at$

$t = 2.9\,sec$

Use 48.58, not rounded version

Use these to find t

   c. the displacement when it is traveling at –34.7 m/s.

$a = -9.8\,m/s^2$

$V_0 = -20\,m/s$

$V_f = -34.7\,m/s$

$d = ?$

Use $V_f^2 = V_0^2 + 2ad$

$d = -41\,m$