Worksheet: Projectile Problems **Name**_____*KEY*_____

To solve projectile problems, you must divide up your information into two parts: _____*horizontal*_____ which has _____*uniform*_____ motion and _____*vertical*_____ which has _____*accelerated*_____ motion. What equations will you use for each type of motion? *horizontal: v=d/t*
vertical: acceleration equations

1. A ball rolls off a 1.0 m high table and lands on the floor, 3.0 m away from the table.
   a. How long is the ball in the air?
   b. With what horizontal velocity did the ball roll off the table?
   c. What is the vertical velocity of the ball just before it hits the floor?
   d. What is the horizontal velocity of the ball just before it hits the floor?

Vertical
$d = 1.0\ m$
$a = 9.8\ m/s^2$
$v_i = 0$

Horizontal
$d = 3.0\ m$

a) *Use vertical information...*
$t = ?$
$d = \frac{1}{2}at^2$
$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(1.0\ m)}{9.8\ \frac{m}{s^2}}} = \boxed{0.45\ s}$

b) *Use horizontal information...*
$v = ?$
$v = \frac{d}{t} = \frac{3.0\ m}{0.45\ s} = \boxed{6.7\ \frac{m}{s}}$

c) $v_f^2 = v_i^2 + 2ad$
$v_f = \sqrt{2ad} = \sqrt{2(9.8\ \frac{m}{s^2})(1.0\ m)} = \boxed{4.4\ \frac{m}{s}}$

d) *Horizontal motion is uniform; velocity is same as when it started (from part b)*
$\boxed{6.7\ \frac{m}{s}}$

2. A carpenter tosses a shingle off a 9.4 m high roof, giving it an initial horizontal velocity of 7.2 m/s.
   (a) What is the final vertical velocity of the ball?
   (b) How long does it take to reach the ground?
   (c) How far does it move horizontally in this time?

Vertical
$d = 9.4\ m$
$a = 9.8\ m/s^2$
$v_i = 0$

Horizontal
$v = 7.2\ m/s$

a) $v_f = ?$
$v_f^2 = v_i^2 + 2ad$
$v_f = \sqrt{2ad} = \sqrt{2(9.8\ \frac{m}{s^2})(9.4\ m)} = \boxed{14\ \frac{m}{s}}$

b) *Use vertical information...*
$t = ?$
$d = \frac{1}{2}at^2$
$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(9.4\ m)}{9.8\ \frac{m}{s^2}}} = \boxed{1.4\ s}$

c) *Use horizontal information...*
$d = ?$ $\quad v = \frac{d}{t}$
$d = vt = (7.2\ \frac{m}{s})(1.4\ s) = \boxed{10.\ m}$

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3. A tiger leaps horizontally from a 12 m high rock with a speed of 4.5 m/s. How far from the base of the rock will she land?

Vertical
$d = 12\ m$
$a = 9.8\ m/s^2$
$v_i = 0$

Horizontal
$v = 4.5\ m/s$

Use vertical information...

$t = ?$

$d = \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(12\ m)}{9.8\ \frac{m}{s^2}}} = 1.56\ s$

Use horizontal information...

$d = ?$ $\quad v = \frac{d}{t}$

$d = vt = (4.5\ \frac{m}{s})(1.56\ s) = \boxed{7.0\ m}$

4. A diver running 1.6 m/s dives out horizontally from the edge of a vertical cliff and reaches the water 3.0 s later. How high was the cliff and how far from its base did the diver hit the water?

Vertical
$d = ?$
$a = 9.8\ m/s^2$
$v_i = 0$
$t = 3.0\ s$

Horizontal
$v = 1.6\ m/s$
$d = ?$
$t = 3.0\ s$

$d_{vert} = \frac{1}{2}at^2 = \frac{1}{2}(9.8\ \frac{m}{s^2})(3.0\ s)^2 = \boxed{44\ m}$

$v = \frac{d}{t}$

$d = vt = (1.6\ \frac{m}{s})(3.0\ s) = \boxed{4.8\ m}$

Either can be solved for first.

5. You toss an apple horizontally at 9.5 m/s from a height of 1.8 m. Simultaneously, you drop a peach from the same height. How long does it take the peach to reach the ground?

Vertical
$d = 1.8\ m$
$a = 9.8\ m/s^2$
$v_i = 0$
$t = ?$

Horizontal
$v = 9.5\ m/s$

Use vertical information...

$t = ?$

$d = \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(1.8\ m)}{9.8\ \frac{m}{s^2}}} = \boxed{0.61\ s}$

6. An arrow fired horizontally at 41 m/s travels 23 m horizontally before it hits the ground. From what height was it fired?

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

Horizontal
$v = 41\ m/s$
$d = 23\ m$

Use horizontal information to find t

$t = ?$ $\quad v = \frac{d}{t}$

$t = \frac{d}{v} = \frac{23\ m}{41\ \frac{m}{s}} = 0.56\ s$

$d_{vert} = \frac{1}{2}at^2 = \frac{1}{2}(9.8\ \frac{m}{s^2})(0.56\ s)^2 = \boxed{1.5\ m}$

7. A ball is thrown horizontally from the roof of a building 50. m tall and lands 45 m from the base. What was the ball's initial speed?

Vertical
$d = 50\ m$
$a = 9.8\ m/s^2$
$v_i = 0$
$t = ?$

Horizontal
$v = ?$
$d = 45\ m$

Use vertical information...

$t = ?$

$d = \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(50\ m)}{9.8\ \frac{m}{s^2}}} = 3.19\ s$

Use horizontal information...

$v = ?$

$v = \frac{d}{t} = \frac{45\ m}{3.19\ s} = \boxed{14\ \frac{m}{s}}$