PHYSICS IN MOTION
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Unit 2G
Horizontally Launched Projectiles
Practice Problems TEACHER

Work each of the following problems. SHOW ALL WORK.

1. A soccer ball is kicked horizontally off a cliff with an initial speed of 8 m/s and lands 16 m from the base of the cliff.

x	y
$v_x = 8\,m/s$	$v_{iy} = 0$
$d_x = 16\,m$	$a = g = 9.8\,m/s^2$
$v_x = \frac{d_x}{t}$	$d_y = ?$

   a. What is the time of flight of the soccer ball?

$$v_x = \frac{d_x}{t}$$
$$8\,m/s = \frac{16\,m}{t}$$
$$t = \frac{16\,m}{8\,m/s}$$
$$t = 2\,s$$

   b. What is the height of the cliff?

$$d_y = v_i t + \frac{1}{2}at^2$$
$$d_y = (0\,m/s)t + \frac{1}{2}(9.8\,m/s^2)(2\,s$$
$$d_y = 19.6\,m$$

2. A ball is thrown horizontally from a height of 1 m and lands 5 m away.

x	y
$v_x = ?$	$v_{iy} = 0$
$d_x = 5\,m$	$a = g = 9.8\,m/s^2$
$v_x = \frac{d_x}{t}$	$d_y = 1\,m$

   a. What is the time of flight of the ball?

$$d_y = v_{iy} t + \frac{1}{2}at^2$$
$$1\,m = (0\,m/s)t + \frac{1}{2}(9.8\,m/s^2)t^2$$
$$1\,m = (4.9\,m/s^2)t^2$$
$$0.204\,s^2 = t^2$$
$$t = 0.452\,s$$

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b. What is the initial velocity of the ball?

$$v_x = \frac{d_x}{t}$$

$$v_x = \frac{5\,m}{0.452\,s}$$

$$v_x = 11.06\,{}^{m}\!/\!_{s}$$

3. A potato gun is fired horizontally from a height of 1.5 meters with the potato launched at 25 m/s.

x	y
$v_x = 25\,{}^{m}\!/\!_{s}$	$v_{i_y} = 0$
$d_x = ?$	$a = g = 9.8\,{}^{m}\!/\!_{s^2}$
$v_x = \frac{d_x}{t}$	$d_y = 1.5\,m$

a. What is the time of flight of the potato?

$$d_y = v_{i_y}t + \frac{1}{2}at^2$$

$$1.5\,m = (0\,{}^{m}\!/\!_{s})t + \frac{1}{2}(9.8\,{}^{m}\!/\!_{s^2})t^2$$

$$1.5\,m = (4.9\,{}^{m}\!/\!_{s^2})t^2$$

$$0.306\,s^2 = t^2$$

$$t = 0.553\,s$$

b. How far from the gun will the potato land?

$$v_x = \frac{d_x}{t}$$

$$25\,{}^{m}\!/\!_{s} = \frac{d_x}{0.553\,s}$$

$$d_x = 13.83\,m$$

4. A water park is designing a new water slide that finishes with the rider flying horizontally off the bottom of the slide. The slide is designed to end 1.2 m above the water level, and the average rider is estimated to leave the bottom of the slide at 25 m/s. How far will the rider fly through the air before hitting the water?

x	y
$v_x = 25\,{}^{m}\!/\!_{s}$	$v_{i_y} = 0$
$d_x = ?$	$a = g = 9.8\,{}^{m}\!/\!_{s^2}$
$v_x = \frac{d_x}{t}$	$d_y = 1.2\,m$

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Work each of the following problems. SHOW ALL WORK.

Solve for time of flight first using y-components:

$$d_y = v_{i_y} t + \frac{1}{2} a t^2$$

$$1.2\,m = (0\,^m/_s)t + \frac{1}{2}(9.8\,^m/_{s^2})t^2$$

$$1.2\,m = (4.9\,^m/_{s^2})t^2$$

$$0.245\,s^2 = t^2$$

$$t = 0.495\,s$$

Next solve for d_x:

$$v_x = \frac{d_x}{t}$$

$$25\,^m/_s = \frac{d_x}{0.495\,s}$$

$$d_x = 12.38\,m$$

5. A marble rolls horizontally off a table that is 0.8 m tall. If the marble lands 0.6 m from the base of the table, what is the initial velocity of the marble?

x	y
$v_x = ?$	$v_{i_y} = 0$
$d_x = 0.6\,m$	$a = g = 9.8\,^m/_{s^2}$
$v_x = \frac{d_x}{t}$	$d_y = 0.8\,m$

Solve for time of flight first using y-components:

$$d_y = v_{i_y} t + \frac{1}{2} a t^2$$

$$0.8\,m = (0\,^m/_s)t + \frac{1}{2}(9.8\,^m/_{s^2})t^2$$

$$0.8\,m = (4.9\,^m/_{s^2})t^2$$

$$0.163\,s^2 = t^2$$

$$t = 0.404\,s$$

Next solve for v_x:

$$v_x = \frac{d_x}{t}$$

$$v_x = \frac{0.6\,m}{0.404\,s}$$

$$v_x = 1.49\,^m/_s$$

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Work each of the following problems. SHOW ALL WORK.

6. The launch velocity of a toy car launcher is determined to be 5 m/s. If the car is to be launched from a height of 0.5 m, where should a target be placed so that the toy car lands on it?

x	y
$v_x = 5\,{}^{m}\!/\!_{s}$	$v_{i_y} = 0$
$d_x = ?$	$a = g = 9.8\,{}^{m}\!/\!_{s^2}$
$v_x = \frac{d_x}{t}$	$d_y = 0.5\,m$

Solve for time of flight first using y-components:

$$d_y = v_{i_y} t + \frac{1}{2}at^2$$

$$0.5\,m = (0\,{}^{m}\!/\!_{s})t + \frac{1}{2}(9.8\,{}^{m}\!/\!_{s^2})t^2$$

$$0.5\,m = (4.9\,{}^{m}\!/\!_{s^2})t^2$$

$$0.102\,s^2 = t^2$$

$$t = 0.319\,s$$

Next solve for d_x:

$$v_x = \frac{d_x}{t}$$

$$5\,{}^{m}\!/\!_{s} = \frac{d_x}{0.319\,s}$$

$$d_x = 1.60\,m$$

7. A stunt car traveling at 20 m/s flies horizontally off a cliff and lands 39.2 m from the base of the cliff. How tall is the cliff?

x	y
$v_x = 20\,{}^{m}\!/\!_{s}$	$v_{i_y} = 0$
$d_x = 39.2\,m$	$a = g = 9.8\,{}^{m}\!/\!_{s^2}$
$v_x = \frac{d_x}{t}$	$d_y = ?$

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Work each of the following problems. SHOW ALL WORK.

Solve for time of flight first using x-components:

$$v_x = \frac{d_x}{t}$$

$$20\,{}^{m}\!/\!_{s} = \frac{39.2\,m}{t}$$

$$t = \frac{39.2\,m}{20\,s}$$

$$t = 1.96\,s$$

Next solve for d_y:

$$d_y = v_{i_y} t + \frac{1}{2} a t^2$$

$$d_y = (0\,{}^{m}\!/\!_{s})t + \frac{1}{2}(9.8\,{}^{m}\!/\!_{s^2})(1.96\,s)^2$$

$$d_y = 18.82\,m$$

8. **A blow dart is fired horizontally from a height of 1.2 meters. If the dart hits a target that is 0.6 m high and 12 m away, what is the initial velocity of the dart?**

x	y
$v_x = ?$	$v_{i_y} = 0$
$d_x = 12\,m$	$a = g = 9.8\,{}^{m}\!/\!_{s^2}$
$v_x = \frac{d_x}{t}$	$d_y = 1.2\,m$

Solve for time of flight first using y-components:

$$d_y = v_{i_y} t + \frac{1}{2} a t^2$$

$$1.2\,m = (0\,{}^{m}\!/\!_{s})t + \frac{1}{2}(9.8\,{}^{m}\!/\!_{s^2})t^2$$

$$1.2\,m = (4.9\,{}^{m}\!/\!_{s^2})t^2$$

$$0.245\,s^2 = t^2$$

$$t = 0.495\,s$$

Next solve for v_x:

$$v_x = \frac{d_x}{t}$$

$$v_x = \frac{12\,m}{0.495\,s}$$

$$v_x = 24.24\,{}^{m}\!/\!_{s}$$

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Work each of the following problems. SHOW ALL WORK.

9. A B-52 bomber jet flies at a horizontal velocity of 286.2 m/s and at an altitude of 7500 m above the ground. How far away horizontally should a payload be dropped to land on a target?

x	y
$v_x = 286.2\ m/s$	$v_{i_y} = 0$
$d_x = ?$	$a = g = 9.8\ m/s^2$
$v_x = \frac{d_x}{t}$	$d_y = 7500\ m$

Solve for time of flight first using y-components:

$$d_y = v_{i_y} t + \frac{1}{2} a t^2$$

$$7500\ m = (0\ m/s)t + \frac{1}{2}(9.8\ m/s^2$$

$$7500\ m = (4.9\ m/s^2)t^2$$

$$1530.6\ s^2 = t^2$$

$$t = 39.12\ s$$

Next solve for d_x:

$$v_x = \frac{d_x}{t}$$

$$286.2\ m/s = \frac{d_x}{39.12\ s}$$

$$d_x = 11197\ m$$