Honors Physics
Winnetonka High School

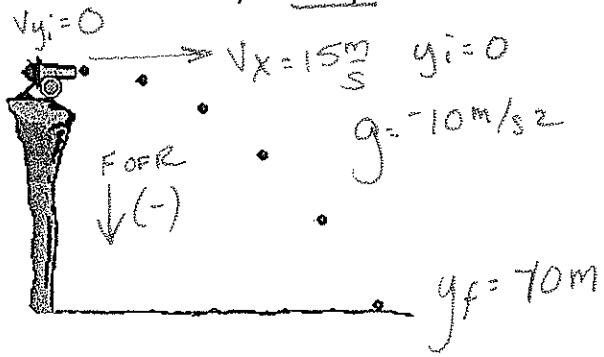
Name: KEY Due Date: _____ Score: _____

Horizontally Launched Projectiles

Use the GUESS method and show all of your work.

CALCULATIONS: CANNON LAUNCH HEIGHT

1. A ball is launched straight out from a 10 meter tall cliff. It is launched horizontally at 15 m/s.
   a. How long is the ball in the air?
   b. How far does it land from the cliff?



1st Given (label the picture):

X direction

$V_x = 15 \frac{m}{s}$

Y direction

$V_{yi} = 0$
$y_i = 0$
$y_f = -10m$
$g = -10 m/s^2$

2nd Unknown:

a). $t_{AIR} =$ _____

b). $\Delta x =$ _____

3rd Equations: (Circle the equation)

$\Delta x = v_x t$

$v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

$y_f = y_i + v_{yi} t + \frac{1}{2} g t^2$

$(-10) = (0) + (0)(t) + \frac{1}{2}(-10)(t)^2$

$-10 = -5 t^2$

$t^2 = 2$

$t = \sqrt{2} = 1.4 \text{ sec}$

$\Delta x = v_x t = (15)(1.4)$

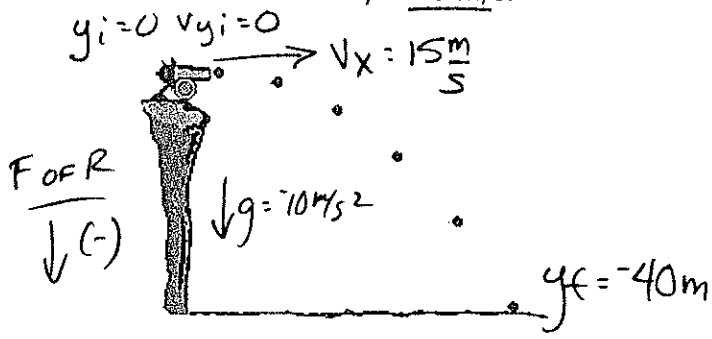
$\Delta x = 21 m$

5th State the answer:

a). The time in the air is 1.4 sec.

b). The range is 21 meters.

2. A ball is launched straight out from a 40 meter tall cliff. It is launched horizontally at 15 m/s.
   a. How long is the ball in the air?
   b. How far does it land from the cliff?



1st Given (label the picture):

X direction: $v_x = 15\frac{m}{s}$

Y direction: $g = -10 m/s^2$, $y_i = 0$, $y_f = -40m$, $v_{yi} = 0$

2nd Unknown:

a). $t_{air} =$ _____

b). $\Delta x =$ _____

3rd Equations: (Circle the equation)

$\Delta x = v_x t$

$v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

a). $y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

$(-40) = (0) + (0)(t) + \frac{1}{2}(-10)t^2$

$-40 = -5t^2$

$t^2 = 8$

$t = \sqrt{8} = 2.8s$

b). $\Delta x = v_x t = (15)(2.8) = 42$ meters

5th State the answer:

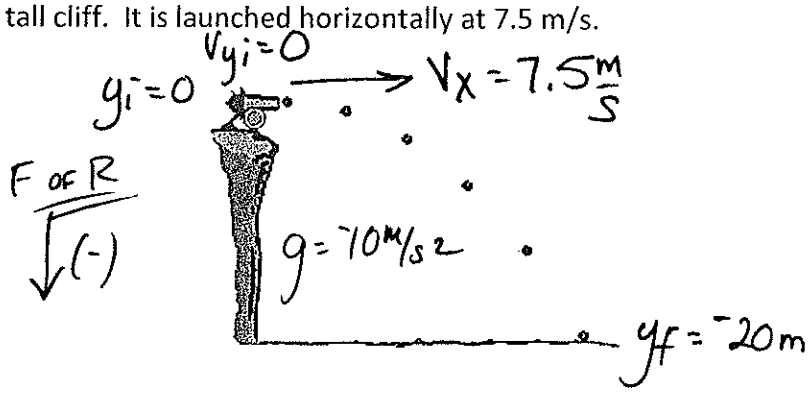
a). The ball is airborne for 2.8 sec.

b). The range is 42 meters.

3. Why does the ball's range increase when the cliff is higher?

CALCULATIONS: INITIAL HORIZONTAL VELOCITY

4. A ball is launched straight out from a 20 meter tall cliff. It is launched horizontally at 7.5 m/s.
   a. How long is the ball in the air?
   b. How far does it land from the cliff?



1st Given (label the picture):

X direction: $V_x=7.5\frac{m}{s}$

Y direction: $y_i=0$, $y_f=-20m$, $g=-10m/s^2$, $V_{yi}=0$

2nd Unknown:

a). $t_{AIR}=$ _____

b). $\Delta x=$ _____

3rd Equations: (Circle the equation)

$\Delta x = v_x t$

$v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

a). $y_f = y_i + V_{yi}t + \frac{1}{2}gt^2$

$(-20) = (0) + (0)(t) + \frac{1}{2}(-10)(t)^2$

$-20 = -5t^2$

$t^2 = 4$

$t = 2s$

b). $\Delta x = V_x t = (7.5)(2) = 15m$

5th State the answer:

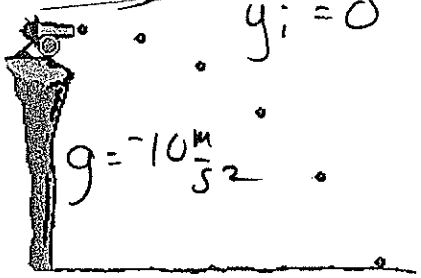
a). The ball is in the air for 2 seconds.

b). The range is 15 meters.

5. A ball is launched straight out from a 20 meter tall cliff. It is launched horizontally at 15 m/s.
   a. How long is the ball in the air?
   b. How far does it land from the cliff?

$V_{yi} = 0$ $V_x = 15\ m/s$

FOR ↓(-)



$y_f = -20m$

1st Given (label the picture):

X direction	Y direction
$V_x = 15 m/s$	$V_{yi} = 0$
	$g = -10 m/s^2$
	$y_i = 0$
	$y_f = -20\ m$

2nd Unknown:

a). $t_{AIR} =$ ____

b). $\Delta x =$ ____

3rd Equations: (Circle the equation)

$\Delta x = v_x t$ $\quad v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

a). $y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

$(-20) = (0) + (0)(t) + \frac{1}{2}(-10)(t)^2$

$-20 = -5t^2$

$t^2 = 4$

$t = 2s$

b). $\Delta x = v_x t = (15)(2) = 30m$

5th State the answer:

a). The time in the air is 2 seconds.

b). The range is 30m.

6. Does does the time in the air stay the same? (Compare #4 & #5)

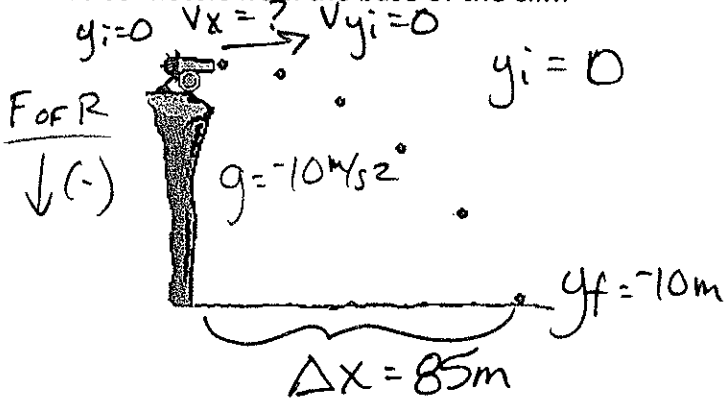
Since the cliff height is the same, the time in the air is the same for #4 & #5.

7. Why does the ball's range increase when the initial horizontal velocity is faster?

When an objects velocity ↑'s, it's displacement will increase also (when the time is the same).

MORE CALCULATIONS

8. A ball is launched straight out from a 10 meter tall cliff. It lands 85 meters from the base of the cliff.
   a. How long is the ball in the air? (see number one since you know the time in the air depends on the height) t = _____
   b. How fast is it travelling when it is fired?



1st Given (label the picture):

X direction

$\Delta x = 85m$

Y direction

$g = -10m/s^2$

$v_{yi} = 0$

$y_i = 0$

$y_f = -10m$

2nd Unknown:

a). #1 has a 10meter tall cliff. The time in the air will be 1.4 sec since this height is also 10m.

3rd Equations: (Circle the equation)

$\Delta x = v_x t$

$v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

b). $\Delta x = V_x t$

$85 = (V_x)(1.4s)$

$V_x = 60.7 m/s$

5th State the answer:

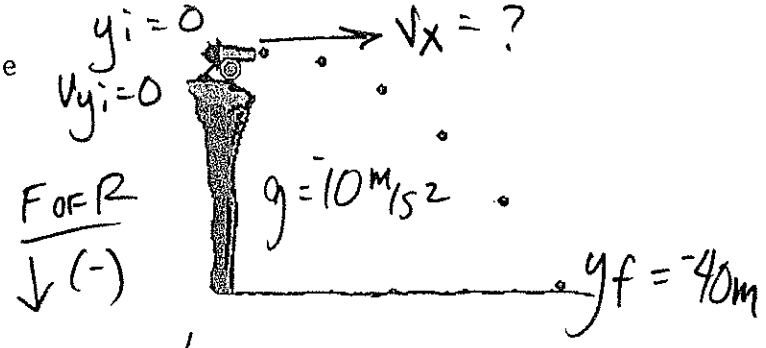
a). The time in the air is 1.4 seconds.

b). The horizontal velocity is 60.7 m/s.

9. A ball is launched straight out from a **40** meter tall cliff. It lands 85 meters from the base of the cliff.

a. How long is the ball in the air? (see number two since you know the time in the air depends on the height) t = 2.8s

b. How fast is it travelling when it is fired?



$t_{AIR} = 2.8\ s$

$\Delta X = 85m$

1st Given (label the picture):

X direction: $\Delta X = 85m$, $t_{AIR} = 2.8s$

Y direction: $y_i = 0$, $y_f = -40m$, $g = -10\ m/s^2$, $t_{AIR} = 2.8s$

2nd Unknown:

b). $V_X =$? m/s

3rd Equations: (Circle the equation)

$\Delta x = v_x t$

$v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

$\Delta X = V_X t$

$(85) = (V_X)(2.8)$

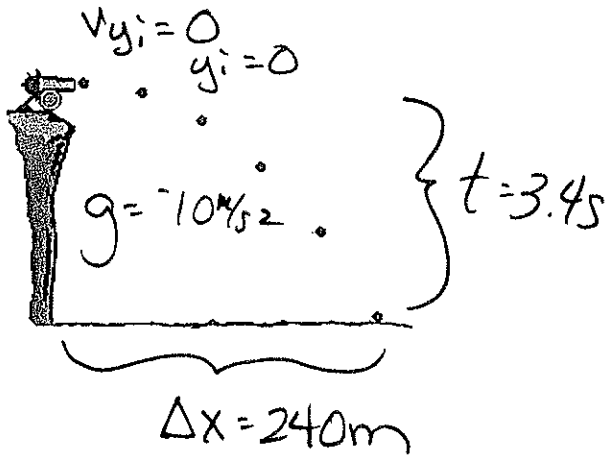
$V_X = 30.4\ m/s$

5th State the answer:

a). The ball is airborne for 2.8 seconds.

b). The horizontal velocity is 30.4 m/s.

10. A ball that is launched straight out from cliff lands on the valley below 3.4 seconds after it is released. The range of the ball is 240 m.
    a. How tall is the cliff?
    b. How fast is it travelling when it is fired?



1st Given (label the picture):

X direction

$\Delta x = 240m$

$t = 3.4s$

Y direction

$g = -10 m/s^2$

$v_{yi} = 0$

$y_i = 0$

$t = 3.4s$

2nd Unknown:

a) $y_f =$ _____

b). $v_x =$ _____

3rd Equations: (Circle the equation)

$\Delta x = v_x t$

$v_{yf} = v_{yi} + gt$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

4th Substitute and Solve: Write out the equation first, then substitute values in.

a). $y_f = y_i + v_{yi}t + \frac{1}{2}gt^2$

$(y_f) = (0) + (0)(3.4) + \frac{1}{2}(-10)(3.4)^2$

$y_f = (-5)(11.56)$

$y_f = 57.8m$

b). $\Delta x = v_x t$

$(240) = (v_x)(3.4)$

$v_x = \frac{240}{3.4} = 70.6 \frac{m}{s}$

5th State the answer:

a). The cliff is 57.8 meters tall.

b). The horizontal velocity is $70.6 \frac{m}{s}$.

11. Why does the ball's range increase when the cliff is higher?

The range increases when the cliff is higher b/c the ball is in the air for a longer time.