Honors Physics
Winnetonka High School

Name: _____ Problem: _____ Score: _____

PROJECTILE PROBLEM SOLVING PAGE

Use the GUESS method and show all of your work. For more complex problems, you may need to redefine your frame of reference and make a new sketch. Use the back as needed.

BE SURE THAT YOUR BOX YOUR ANSWERS AND LABEL THEM.

1. A ball is tossed straight up from a ball launcher. The ball reaches the peak after 3.7 seconds. (EC- 3 pts.)
   a. Find the starting vertical velocity.
   b. Find the height of the ball at the peak.

1st Given

X direction

Y direction

$g = -10 m/s^2 \downarrow$

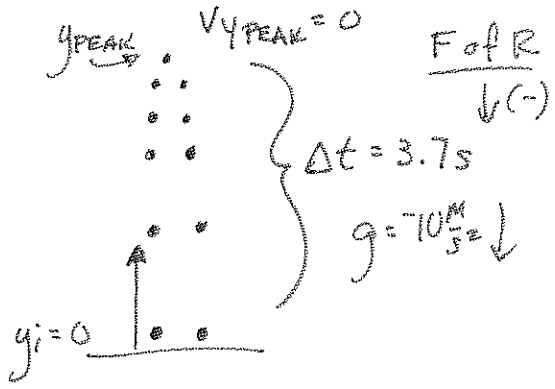
$V_{yPEAK} = 0$

$t_{PEAK} = 3.7 s$

$y_i = 0$

For PART A, Use V_{yPEAK} as V_{yf}

Draw and label the picture:



2nd Unknown:

A). $V_{y_i} =$ _____ B). $y_f =$ _____ (y_{PEAK})

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

PART A

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

$(0) = (V_{y_i}) + (-10)(3.7)$

$0 = V_{y_i} + -37$

(A) $V_{y_i} = 37 \frac{m}{s}$

PART B

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

$(y_f) = (0) + (37)(3.7) + \frac{1}{2}(-10)(3.7)^2$

$y_f = 1369 + (-5)(13.69)$

$y_f = 1369 + (-68.45)$

(B) $y_f = 1300 m$

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2. A child throws a ball straight up. The child catches the ball 2.4 seconds after throwing it. (EC- 5 pts.)
   a. Find the time for the ball to reach the peak.
   b. Find the height of the ball at the peak.
   c. Find the starting velocity of the ball when it is thrown upward.
   d. Find the ending velocity of the ball when the child catches it.

1st Given

X direction | Y direction

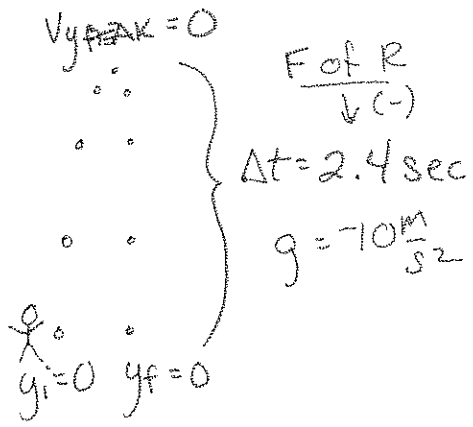
$\Delta t = 2.4s$

$g = -10 m/s^2$

$y_i = 0$

$V_{y_{PEAK}} = 0$

Draw and label the picture:



2nd Unknown:

A). t_{up} = ____ s

B). y_{PEAK} = ____ m

C). V_{y_i} = ____ m/s

D). V_{y_f} = ____ m/s

3rd Equations:

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

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

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

A). DEFINITION: Since $y_i = y_f$, the time up is $\frac{1}{2}$ the total time in the air.

$t_{up} = \frac{\Delta t}{2} = \frac{2.4s}{2} = \underline{1.2s}$

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

B). REFRAME: PEAK TO LANDING

$V_{yi} = 0$ $y_i = ?$ $y_f = 0$ $t = 1.2s$ $g = -10 \frac{m}{s^2}$

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

$(y_f) = (0) + (0)(1.2) + \frac{1}{2}(-10)(1.2)^2$

$y_f = (-5)(1.44) = \underline{-7.2m}$

The height at the peak is 7.2m.

C). $V_{yf} = V_{yi} + gt$ (Use V_{yf} as $V_{y_{PEAK}}$)

$(0) = (V_{yi}) + (-10)(1.2)$

$0 = V_{yi} + (-12)$

$\underline{V_{yi} = 12 m/s}$

D). $|V_{yi}| = |V_{yf}|$ but V_{yf} is (-)

$\underline{V_{yf} = -12 m/s}$

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3. A boulder falls from the edge of a cliff. It is falling at 43 m/s when it reaches the ground. (EC- 5 pts.)
   a. Find the starting velocity of the boulder.
   b. Find the amount of time the boulder is falling.
   c. Find the height of the cliff.

1st Given

X direction

Y direction

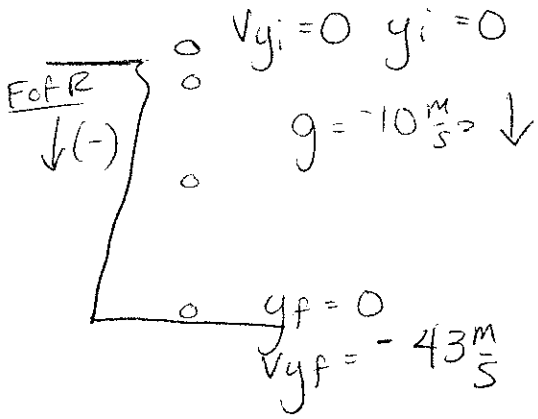
$g = -10\ m/s^2$

$v_{yi} = 0\ m/s$

$v_{yf} = -43\ m/s$

$y_i = 0$

Draw and label the picture:



2nd Unknown:

(A) $v_{yi} =$ ____ m/s

(B) $t_{AIR} =$ ____ s

(C) $y_f =$ ____

3rd Equations:

$\Delta x = v_x t$

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

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

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

(A) v_{yi} is given as implicit information. Since the boulder "falls" $v_{yi} = 0$

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

(B) $v_{yf} = v_{yi} + g t$

$(-43) = (0) + (-10)(t)$

$\frac{-43}{-10} = \frac{-10t}{-10}$

$t = 4.3\ sec$

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

$(-43)^2 = (0)^2 + 2(-10)\Delta y$

$1849 = -20\Delta y$

$\Delta y = 92.45\ m$

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4. A ball is tossed straight up from a ball launcher. The ball reaches the peak in 8.1 seconds. (EC- 5 pts.)
   a. Find the acceleration of the ball.
   b. Find the starting horizontal velocity.
   c. Find the starting vertical velocity.
   d. Find the peak height of the ball.

1st Given

X direction

Y direction

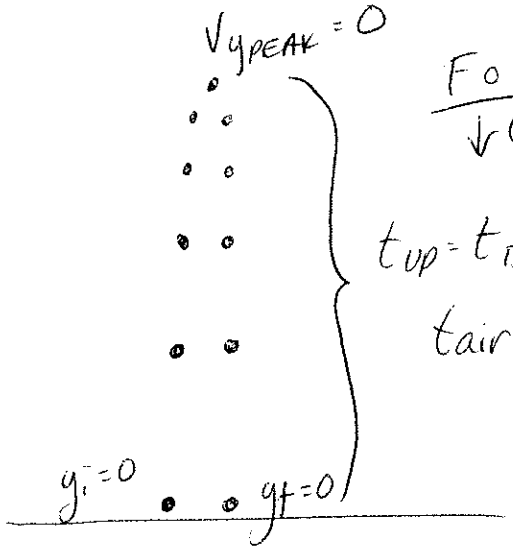
$g = -10\ m/s^2$

$V_{y\,PEAK} = 0$

$t_{up} = t_{down} = 8.1s$

$t_{air} = 16.2s$

Draw and label the picture:



2nd Unknown:

a) $a =$ ____

b) $V_{x_i} =$ ____

c) $V_{y_i} =$ ____

d) $y_{PEAK} =$ ____

3rd Equations:

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

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

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

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

a). The ball's acceleration is due to gravity

$g = -10\ m/s^2$ ↓

b). This is "launched straight up" so there is no motion in x-direction.

$V_x = 0$

c). REFRAME Launch to Peak

$V_{y_i} = ?$ $V_{y_f} = 0$ $g = -10\ m/s^2$ $t = 8.1s$

$V_{y_f} = V_{y_i} + g\,t$

$(0) = V_{y_i} + (-10)(8.1)$

$0 = V_{y_i} + -81$

$V_{y_i} = +81\ m/s$

d) $(V_{y_f})^2 = (V_{y_i})^2 + 2\,g\,\Delta y$

$(0)^2 = (81)^2 + 2(-10)\,\Delta y$

$-6561 = -20\,\Delta y$

$\Delta y = 328.05\ m$

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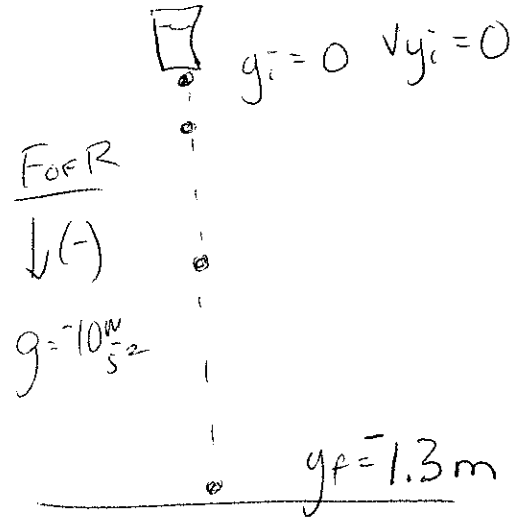
5. A glass of milk falls off the edge of a table that is 1.3 meters high. (EC- 3 pts.)
   a. Find the time for the glass to land on the floor beneath the table.
   b. Find the velocity of the glass just before it hits the floor.

1st Given

X direction | Y direction

$g = -10\ m/s^2$
$y_i = 0$
$y_f = -1.3\ m$
$v_{yi} = 0$

Draw and label the picture:



2nd Unknown:

a). $t_{AIR} =$ _____

b). $v_{yf} =$ _____

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

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

$(-1.3) = (0) + (0)(t) + \frac{1}{2}(-10)t^2$

$\frac{-1.3}{-5} = \frac{-5t^2}{-5}$

$0.26 = t^2$

$t^2 = 0.26$

$\sqrt{t^2} = \sqrt{0.26}$

$t = 0.509\ s$

$t = 0.51\ s$

b). $v_{yf} = v_{yi} + gt$

$(v_{yf}) = (0) + (-10)(0.51)$

$v_{yf} = -5.1\ m/s$

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BE SURE THAT YOUR BOX YOUR ANSWERS AND LABEL THEM.

6. A pebble drops off a bridge and falls for 5.6 seconds before hitting the ground. (EC- 5 pts.)
   a. Find how far it falls.
   b. Find the acceleration of the pebble.
   c. Find the starting velocity of the pebble.
   d. Find the ending velocity of the pebble.

1st Given

X direction

Y direction

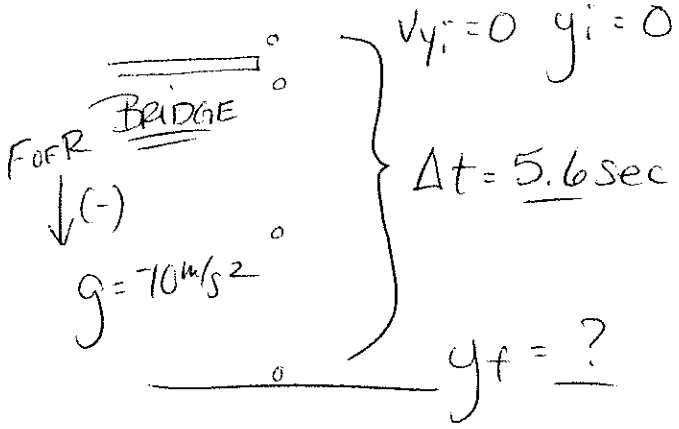
$g = -10\ m/s^2$

$V_{y_i} = 0$

$t = 5.6\ s$

$y_i = 0$

Draw and label the picture:



2nd Unknown:

a) y_f d) V_{y_f}

b) a

c) V_{y_i}

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

c). GIVEN

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

$(y_f) = (0) + (0)(5.6) + \frac{1}{2}(-10)(5.6)^2$

$y_f = (-5)(31.36) = \underline{-156.8\ m}$

b). The pebble accelerates due to gravity so $a = g = -10\ m/s^2$

d). $(V_{yf})^2 = (V_{y_i})^2 + 2g\Delta y$

$(V_{yf})^2 = 0^2 + 2(-10)(-156.8)$

$(V_{yf})^2 = 3136$

$V_{yf} = -56\ m/s \downarrow$

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7. A cannon mounted on the top of a fortress wall shoots the cannon ball straight out at a starting velocity of 34 m/s. The cannon ball lands 88 meters from the base of the cliff. (EC- 8 pts.)
   a. Find the acceleration of the ball.
   b. Find the starting horizontal velocity.
   c. Find the time the cannon ball is aloft.
   d. Find the starting vertical velocity.
   e. Find the horizontal velocity.

1st Given

X direction

$V_x = 34 \frac{m}{s}$

$\Delta x = 88 m$

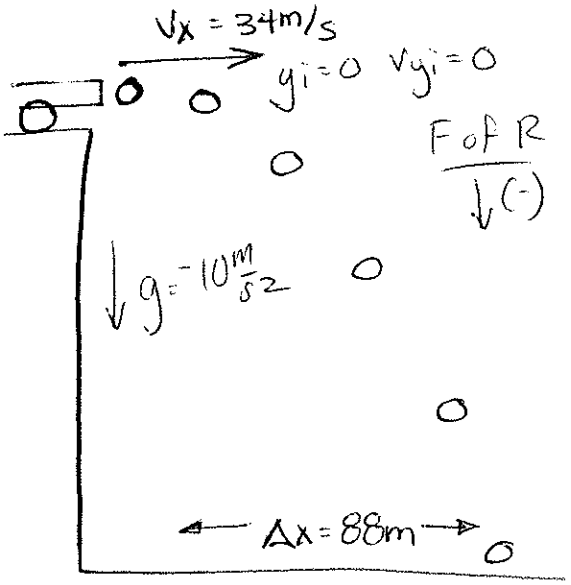
Y direction

$g = -10 m/s^2 \downarrow$

$V_{y_i} = 0$

$y_i = 0$

Draw and label the picture:



2nd Unknown:

a) $a =$ ____

b). $V_x =$ ____

c) $t =$ ____

d). $V_{y_i} = 0$

e). V_x

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

c). $\Delta x = V_x t$

$(88) = (34)(t)$

$t = 2.588 = 2.6$ seconds

a). Acceleration is due to gravity. $g = -10 m/s^2$

b & e) Given in the question

$V_x = V_{x_i} = 34 \frac{m}{s}$

d). $V_{y_i} = 0$ since it is horizontally launched.

PROJECTILE PROBLEM SOLVING PAGE

Use the GUESS method and show all of your work. For more complex problems, you may need to redefine your frame of reference and make a new sketch. Use the back as needed.

BE SURE THAT YOUR BOX YOUR ANSWERS AND LABEL THEM.

8. A child throws a ball straight out. The child releases the ball at a point that is 0.87 meters above the level ground. The ball lands 5.6 meters from the boy. (EC- 8 pts.)
   a. Find the time that the ball is airborne.
   b. Find the starting velocity of the ball's throw.
   c. Find the acceleration of the ball.

1st Given

X direction

$\Delta x = 5.6m$

Y direction

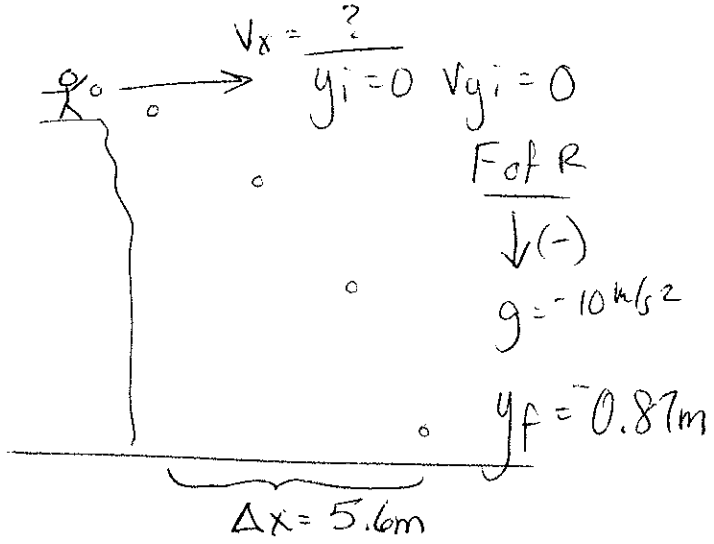
$g = -10 m/s^2$

$v_{y_i} = 0$

$y_i = 0$

$y_f = 0.87m$

Draw and label the picture:



2nd Unknown:

a) $t =$ ____

b) $v_x =$ ____

c) $a =$ ____

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

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

$(-.87) = (0) + (0)(t) + \frac{1}{2}(-10) t^2$

$-.87 = -5 t^2$

$t^2 = 0.174$

$t = 0.417 sec$

b). $\Delta x = v_x t$

$(5.6) = (v_x)(.417)$

$v_x = 13.43 m/s$

c). The acceleration is due to gravity.

$a = g = -10 m/s^2$

PROJECTILE PROBLEM SOLVING PAGE

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BE SURE THAT YOUR BOX YOUR ANSWERS AND LABEL THEM.

9. A projectile is launched with a starting vertical velocity of 11 m/s and a starting horizontal velocity of 22 m/s. (EC- 10 pts.)
   a. Find the time it takes for the projectile to reach the peak.
   b. Find the time it takes to land.
   c. Find the height at the peak.
   d. Find the range.
   e. Find the horizontal velocity just before landing.
   f. Find the vertical velocity just before landing.

1st Given

X direction

$V_x = 22 \frac{m}{s}$

Y direction

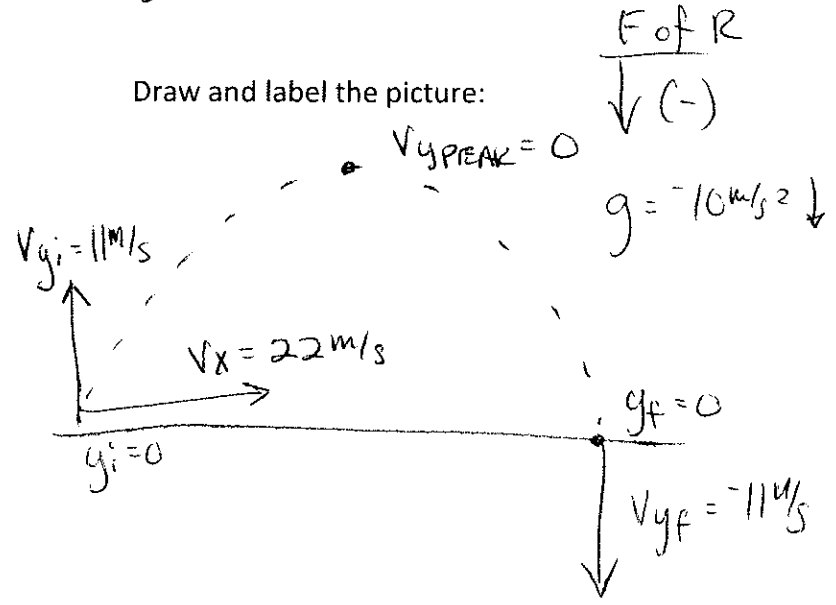
$g = -10 m/s^2$

$V_{yi} = 11 m/s$

$V_{yPEAK} = 0 m/s$

$V_{yf} = -11 m/s$

Draw and label the picture:



2nd Unknown:

a) $t_{PEAK} =$ ____

b). $t_{air} =$ ____

c). $y_{PEAK} =$ ____

d). $\Delta x =$ ____

e). $V_x = 22 m/s$

f). $V_{yf} = -11 m/s$

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

a). $V_{yf} = V_{yi} + gt$

$V_{yPEAK} = V_{yi} + gt$

$(0) = (11) + (-10)t$

$-11 = -10t$

$t = 1.1 s$ PEAK

b). $t_{AIR} = 2\, t_{PEAK} = 2.2 s$

c). $(V_{yf})^2 = (V_{yi})^2 + 2g\Delta y$

$(0)^2 = (11)^2 + 2(-10)\Delta y$

$-121 = -20\Delta y$

$\Delta y = 6.05 m$

d) $\Delta x = V_x t = (22)(2.2) = 48.4 m$

e). & f) Given or based on physics laws

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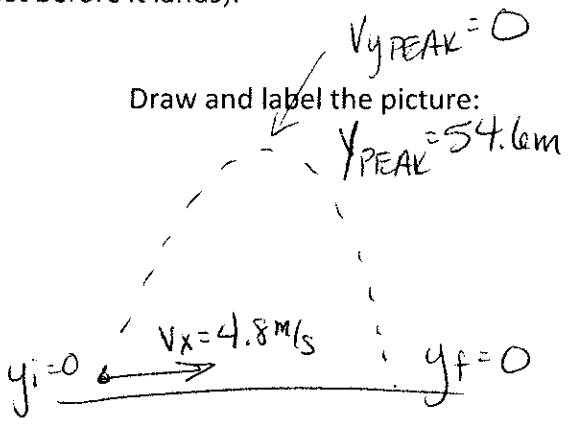
10. A projectile that is launched at an angle reaches a peak height of 54.6 meters above the launch point. Its horizontal velocity is 4.8 m/s. (EC- 10 pts.)
    a. Find the vertical velocity at the peak.
    b. Find the time to reach the peak.
    c. Find the time in the air.
    d. Find the range.
    e. Find the initial vertical velocity.
    f. Find the final vertical velocity (just before it lands).

1st Given

X direction: $V_x = 4.8 \frac{m}{s}$

Y direction: $V_{yPEAK} = 0$, $Y_{PEAK} = 54.6m$, $y_i = y_f = 0$

Draw and label the picture:



2nd Unknown:

a) $V_{yPEAK} = 0$

b). $t_{PEAK} =$ ____

c). $t_{AIR} =$ ____

d). $\Delta x =$ ____

e). $V_{y_i} =$ ____

f). $V_{y_f} =$ ____

3rd Equations:

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

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

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

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

b). REFRAME: PEAK TO LANDING

$V_{y_i} = 0$ $Y_{PEAK} = y_i = 54.6m$ $g = -10 m/s^2$ $y_f = 0$

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

$(0) = 54.6 + (0)(t) + \frac{1}{2}(-10)t^2$

$-54.6 = -5t^2$

$t^2 = 10.92$

$t = 3.3s$ (PEAK)

c). $t_{AIR} = (2)t_{PEAK} = 2(3.3) = 6.6s.$

d). $\Delta x = v_x t = (4.8)(6.6) = 31.68m$

e). $(V_{yf})^2 = (V_{y_i})^2 + 2g\Delta y$

$(0) = (V_{y_i})^2 + 2(-10)(54.6)$

$V_{y_i}^2 = 1092$

$V_{y_i} = \sqrt{1092} = 33 m/s \uparrow$

f). $V_{y_f} = -33 m/s \downarrow$

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11. A projectile launched at an angle reaches the peak of its trajectory in 14.7 seconds. Its landing position is 57.3 meters from its launch position (landing and launch positions are in the same horizontal plane). (EC- 12 pts.)
    a. Find the vertical velocity at the peak.
    b. Find the time in the air.
    c. Find the horizontal velocity.
    d. Find the initial vertical velocity.
    e. Find the final vertical velocity (just before it lands).

1st Given

X direction

$\Delta X = 57.3m$

Y direction

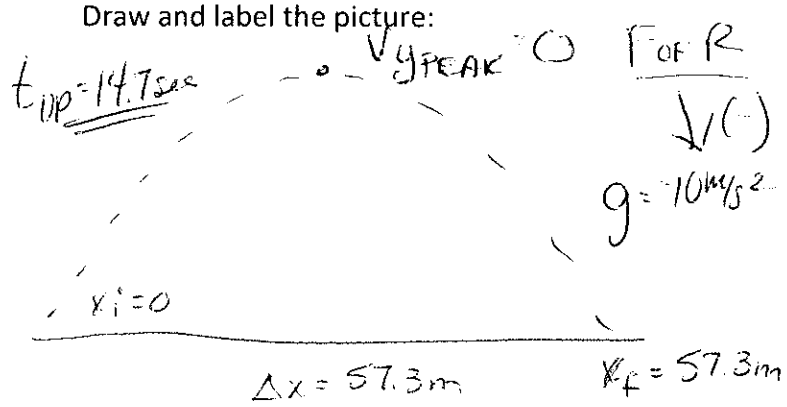
$V_{yPEAK} = 0$

$t_{up} = 14.7s$

$t_{air} = (2)(14.7s)$

$= 29.4s$

Draw and label the picture:



2nd Unknown:

a). $V_{yi} = 0$

b). $t_{air} = (t_{up})2$

$= 29.4s$

c). $V_x =$

d). $V_{yi} =$ _____

e). $V_{yf} =$ _____

3rd Equations:

$\Delta x = v_x t$

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

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

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

c). $\Delta X = V_X \; t$

$57.3 = (V_X)(29.4s)$

$V_X = 1.95 m/s$

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

d). $V_f = V_{yi} + g\,t$

$(0) = (V_{yi}) + (-10)(14.7)$

$0 = V_{yi} + -147$

$V_{yi} = 147 m/s$

e). $V_{yf} = -147 m/s$

PROJECTILE PROBLEM SOLVING PAGE

Use the GUESS method and show all of your work. For more complex problems, you may need to redefine your frame of reference and make a new sketch. Use the back as needed.

BE SURE THAT YOUR BOX YOUR ANSWERS AND LABEL THEM.

12. A cannon is launched at a 45° angle. The height of the cannonball at its peak is 18 meters. Determine the starting vertical velocity, the starting horizontal velocity and the range.

1st Given

X direction

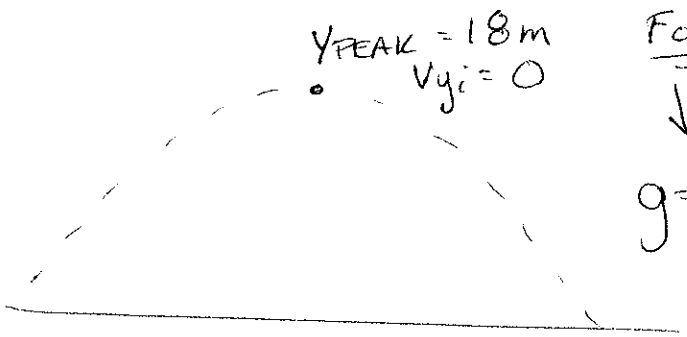
Y direction

$g = -10\ m/s^2$

$Y_{PEAK} = 18m$

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

Draw and label the picture:



FOR R

↓ (-)

$g = -10\ m/s^2$

2nd Unknown:

$V_x =$ _____

$V_{yi} =$ _____

$\Delta x =$ _____

Since the launch angle is 45°,

$|V_x| = |V_{yi}|$

3rd Equations:

$\Delta x = v_x t$

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

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

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

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

(2ND) $V_{yf} = V_{yi} + g t$

$(V_{yf}) = (0) + (-10)(1.9)$

$V_{yf} = -19\ m/s$

So $V_{yi} = 19\ m/s$ See note

(1ST) Peak to Landing

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

$0 = 18 + 0(t) = \frac{1}{2}(-10)t^2$

$-18 = -5t^2$

$t^2 = 3.6$

$t = \sqrt{3.6} = 1.897 = 1.9s$

DOWN

(3RD) $|V_x| = |V_{yi}| = 19\ m/s$

(4th) $\Delta x = V_x t$

$= (19)(1.9 \cdot 2)$

$= 72.2m$