Understanding Horizontal Projectiles

- The **x-component** is there from the start, and stays the same the entire time.
- The **y-component** doesn't even exist at the beginning, but grows bigger as the object falls.
- The shape of the path that it follows is actually a parabola . If you've studied those in math class, great! Don't worry about it if you haven't, just as long as you recognize the shape and know the name.

To understand how to actually figure out questions involving these situations, it's probably best to look at an example.

- Keep in mind the characteristics of the object as it falls while you go through the example.
- When you are doing a part of a question that has to do with **vertical movement**"**THINK VERTICAL**" and only use vertical ideas (like gravity).
- When you are doing a part of a question that has to do with **horizontal movement** "**THINK HORIZONTAL**" and only use horizontal ideas (no gravity/acceleration).

Example 1: I throw a ball off the edge of a 15.0m tall cliff. I threw it horizontally at 8.0m/s.

a. **Determine** how much time it takes to fall.
b. **Determine** how far from the base of the cliff it hits the ground.
c. **Determine** how fast it is moving vertically when it hits the ground.
d. **Determine** what its total velocity is when it hits the ground.

a) THINK VERTICAL

We're talking about something falling, and that is **vertical motion**, so we will only use vertical ideas and numbers. It actually would take the exact same amount of time for the object to hit the ground if I just dropped it straight down from the edge of the cliff, so let's just calculate the time to fall that way. Remember to think vertically...

$d = v_i t + 1/2\ at^2$ <- Initial vertical velocity is zero so...

$d = 1/2\ at^2$

t = sqr root (2d/a) = sqr root (2 x 15.0 / 9.81)

t = 1.75 s

b) THINK HORIZONTAL

Well, we know it was in the air for 1.75s (from the previous question), and it was moving at a constant speed of 8.0m/s in the **x-direction** the whole time, so...

$v = d/t$

$d = v\,t = (8.0\text{m/s})(1.75\text{s})$

$d = 14\text{m}$

It will move 14m **horizontally**, so it hits the ground 14m away from the base of the cliff.

c) THINK VERTICAL

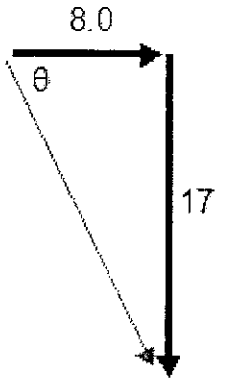
It has been accelerating down the whole time. We know that gravity is causing this acceleration, and that it wasn't moving vertically at the start, so we can figure out how fast it is going (vertically) when it hits the ground.

$v_f^2 = v_i^2 + 2ad$

$v_f = \sqrt{(v_i^2 + 2ad)} = \sqrt{(0 + 2 \times 9.81 \times 15.0)}$

$v_f = 17\text{ m/s}$

d) Combination!



It's total velocity is found by adding the**horizontal** and **final vertical** components of the velocity to find the **resultant**.

$c^2 = a^2 + b^2$

$= \sqrt{[(8.0\text{m/s})^2 + (17\text{m/s})^2]}$

$c = 19\text{m/s}$ *This is the magnitude of the final velocity

$\tan\Theta = \text{opp/adj}$

$\theta = \tan^{-1}(17\text{m/s} / 8.0\text{m/s})$

$\theta = 64.8^0$ *This is the direction of the final velocity just before impact

Figure 3

The object is moving at 19m/s at an angle of 25° below the horizontal when it hits the ground.

Although there will always be slight differences in actual problems, this is the standard sort of questions that you will be asked for these types of questions.