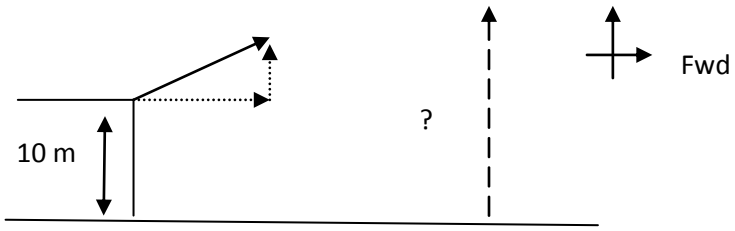
Projectiles & Vector Components

If I launch a rock off a 10 m cliff at 20˚ above the horizontal, it will have an upward component of velocity and a forward component of velocity as it leaves my hand. After that, the rock is affected by gravity. If I can throw my rock at 8 m/s, what is the maximum height above ground it will attain?

- Note: gravity acts downward and does not affect horizontal motion at all. It only affects vertical motion. Air resistance would affect horizontal motion but we ignore this in grade 11 Physics. So horizontal velocity is **constant**

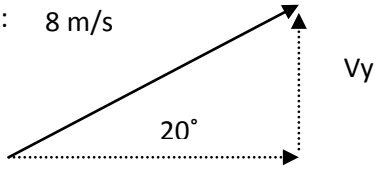
G:

R:



A: Break the initial velocity into initial forward velocity (Vx) and initial upward velocity (Vy) . the 'x' and 'y' refer to horizontal and vertical axes just like a graph.

S:



Sin 20˚ = Vy/8 Vy = sin 20 (8) **Vy = 2.7 m/s [up]**

So initial upward velocity is 2.7 m/s . v_{1y} = +2.7 m/s

Gravity only affects vertical motion.

When using formulas, you can only put in values from one plane. ie: only 'y' values or only 'x' values.

At maximum height (that's Δd in the vertical plane), v_2 = 0 m/s

$V_{2y}^2 = V_{1y}^2 + 2ad$

0 = 2.7 + 2 (-9.8) d * acceleration due to gravity is –ve !

d = -2.7 / -19.6

d = 0.37 m So the rock goes 0.37 m above the launch point. But I want maximum height above ground, so add the 10m of the cliff.

P: The rock goes a maximum height of 10.37 m above the ground.

The **vertical motion** requires you to use the 5 acceleration formulas.
The **horizontal motion** is assumed to be constant so you have just the simple $v = \Delta d/t$ formula!

Time and only time is the same in both planes. Basically, the 'trip' is over when the 'trip' is over. So time in x plane = time in y plane.
Often we need to find time in the 'y' plane and use it in the 'x' plane.

Extra Practice Questions

1. Platform divers receive lower marks if they enter the water a distance away from the platform, whereas speed swimmers dive as far out into the pool as they can. Compare and contrast the horizontal and vertical components of each type of athlete's initial motion. A sketch could help.

2. For a fixed speed, how does the range (maximum horizontal distance) depend on the angle, Θ?

3. A baseball is thrown 35˚ above the horizontal with an initial velocity of 27.0 m/s .
   a) What are the initial forward (x) and upward (y) components of velocity?
      [v_x = 22.1 m/s and vy = 15.5 m/s]
   b) what is the maximum height it will travel? **[12 m above]**
   c) How far will it go before it hits the ground? ie: what is the range of this throw?
      Hint: find the time of the trip using the vertical information. The horizontal velocity is considered constant since acceleration does not affect horizontal (x) velocity. Use the time to find the horizontal distance. **[69m]**