You’re riding on your bike at a constant speed when a squirrel lands in your lap! You freak out and throw the squirrel straight up in the air (from your point of view) while you and your bike continue to travel forward at a constant speed. If air resistance is neglected, where will the squirrel land?

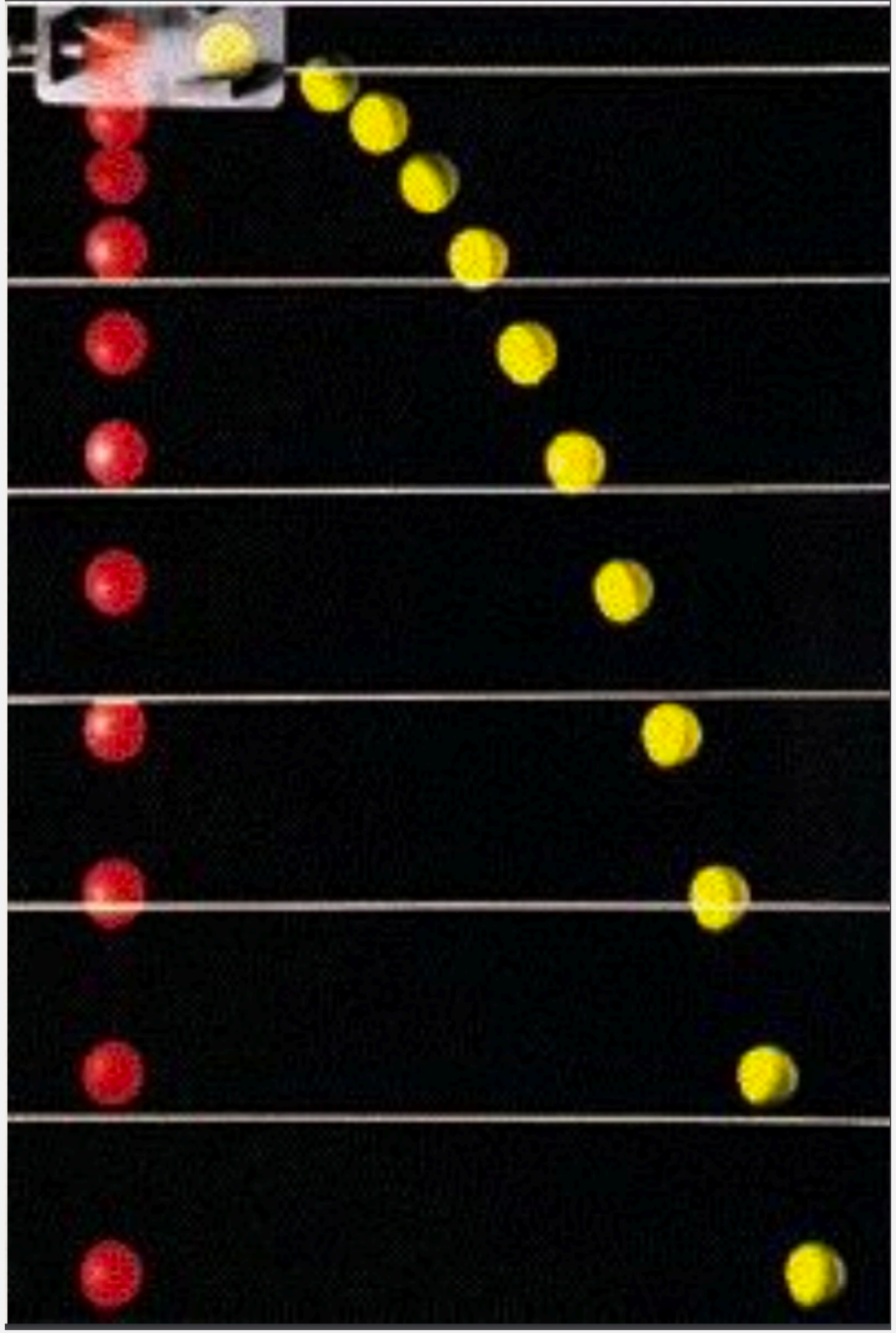
- A. In front of you
- B. Behind you
- C. Back in your lap

A COMMON MISCONCEPTION

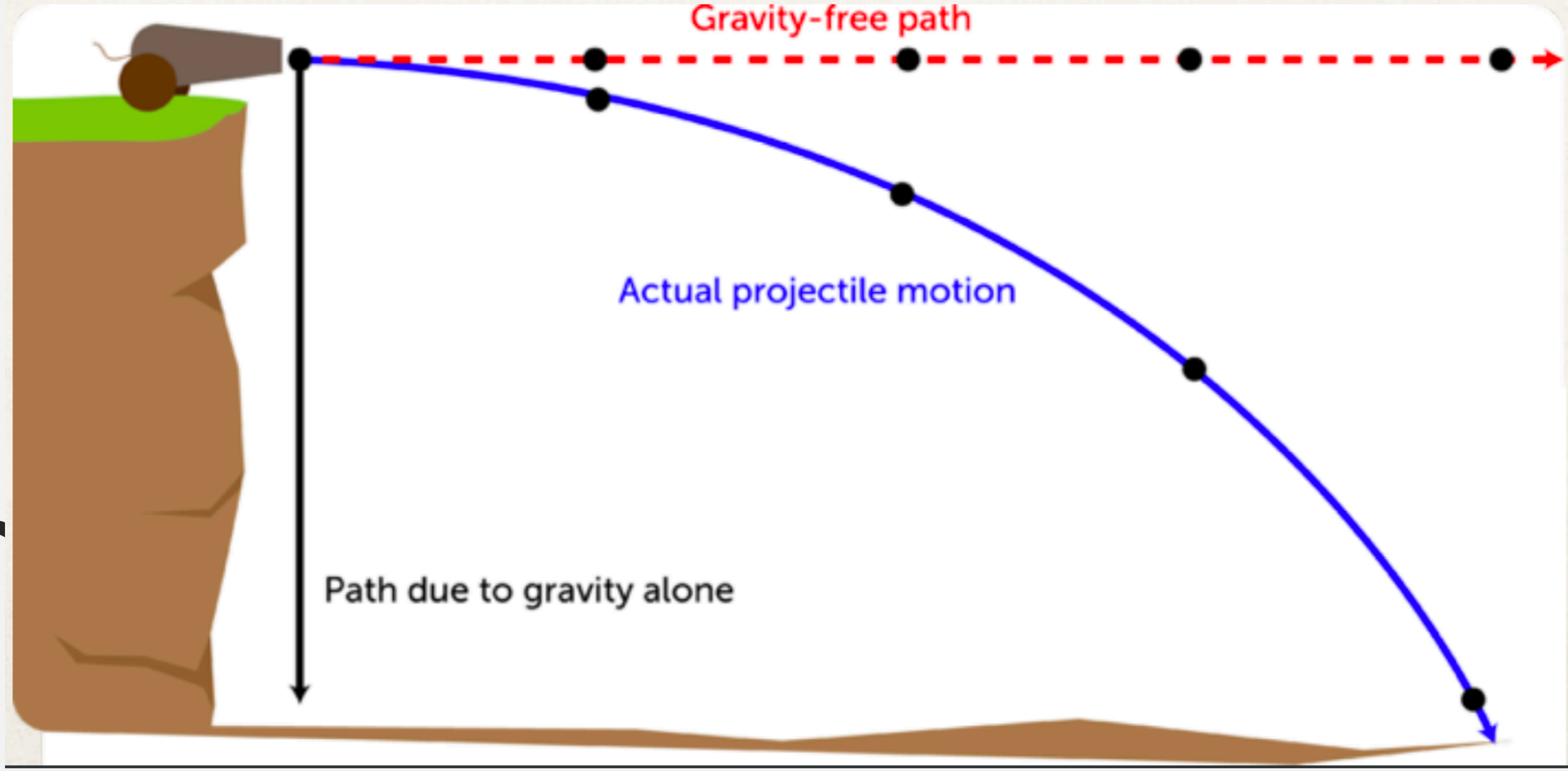
- "Acceleration increases and then decreases as an object is thrown upward and falls downward"
  - Just because an object is moving upward doesn't mean its acceleration is also upward
  - If an object's acceleration was upward, it would move faster and faster upwards!
  - The fact that projectiles move upward, slow until their highest point, then fall and speed up as they fall is due to gravity's constant downward acceleration

EXTENSION OF VECTOR INDEPENDENCE

- Horizontal and vertical components of velocity are independent of each other
- We are well familiar with free fall objects and calculations– but how else does this concept work?

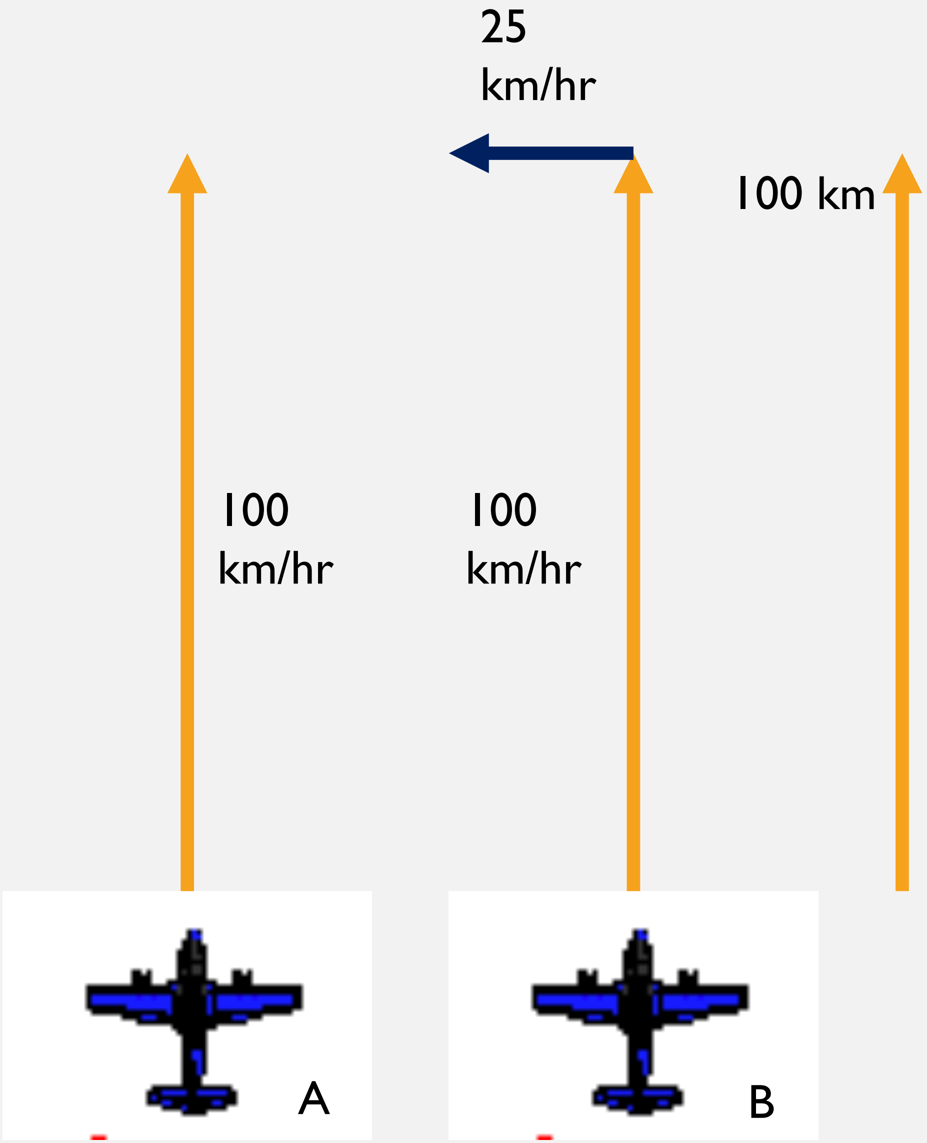


- They are independent because they are **perpendicular** to each other



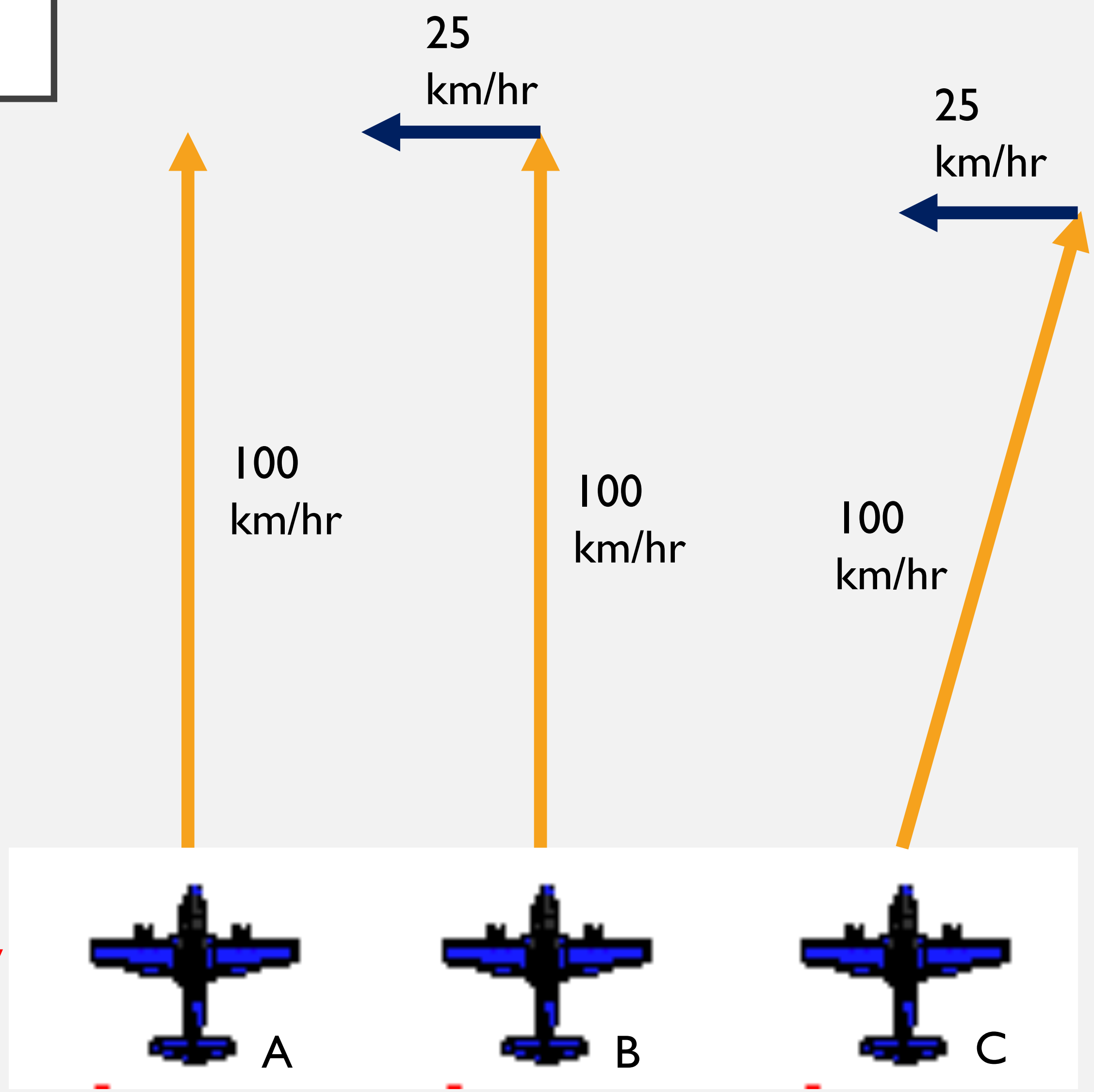
PLANE EXAMPLE

- Plane A flies due north at 100 km/hr. Plane B flies north at 100 km/hr and encounters a wind going west at 25 km/hr. Which plane travels 100 km north faster?
  - Both have the same vertical speed so they cover the distance in the same amount of time



PLANE EXAMPLE

- Plane C needs to go straight north so turns the plane against the wind. Compare the amount of time Plane C covers the 100 km north distance with A and B.
  - The vertical component of the motion of Plane C is now less than Plane A and B, so it takes longer to travel 100 km.



BOAT RACE!

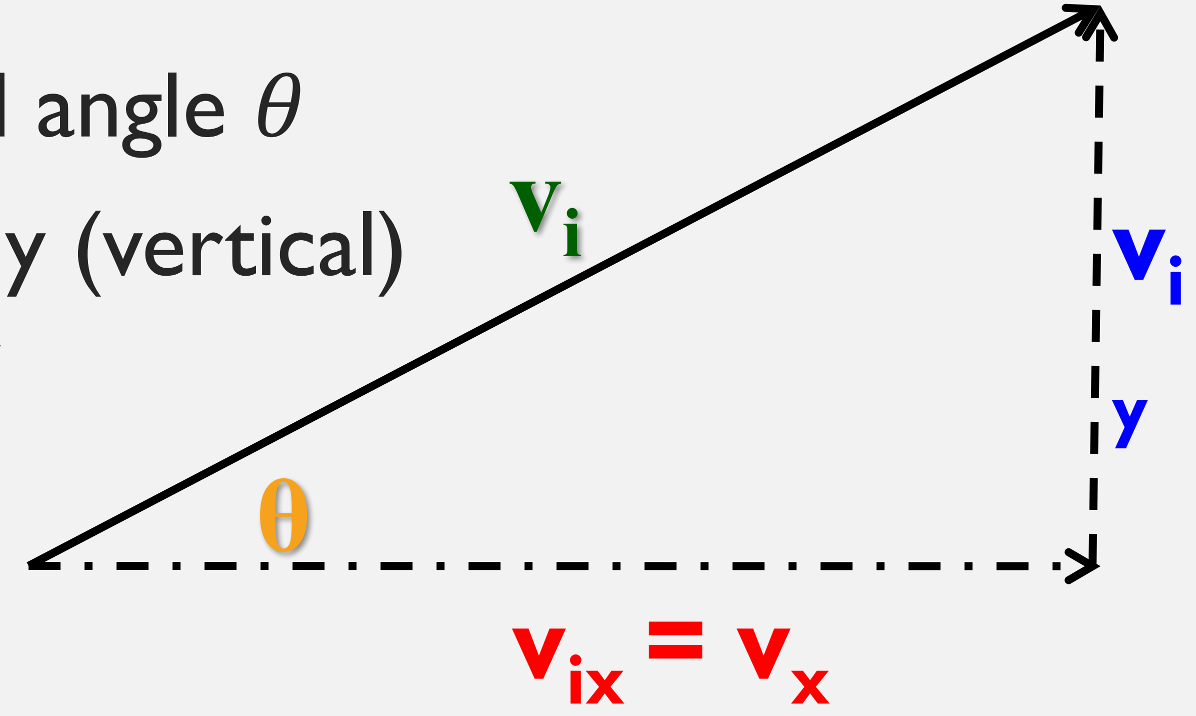
CALCULATIONS FOR LAUNCH ("FROM GROUND")

Given the initial velocity v_i and angle θ

A. Find the x (horizontal) and y (vertical) components of the velocity

$$v_y = v_i sin\theta$$

$$v_x = v_i cos\theta$$

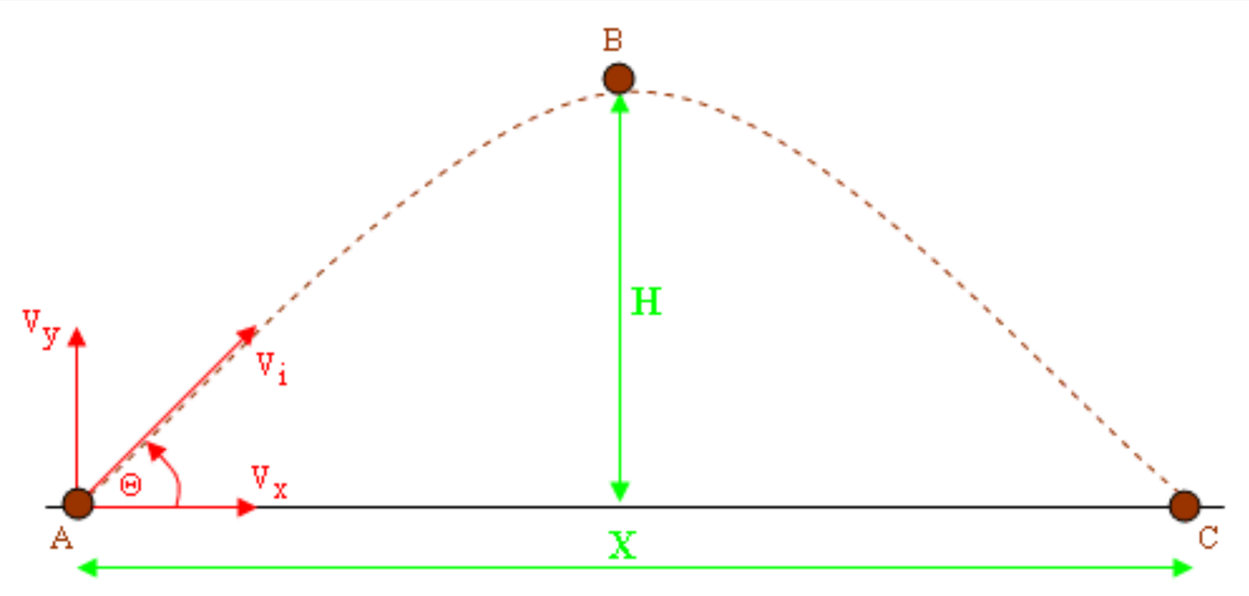


CALCULATIONS FOR LAUNCH ("FROM GROUND")

Given the initial velocity v_i and angle θ

B. Find time to get to top of path/maximum height

$$v_{fy} = v_{iy} + a\Delta t$$

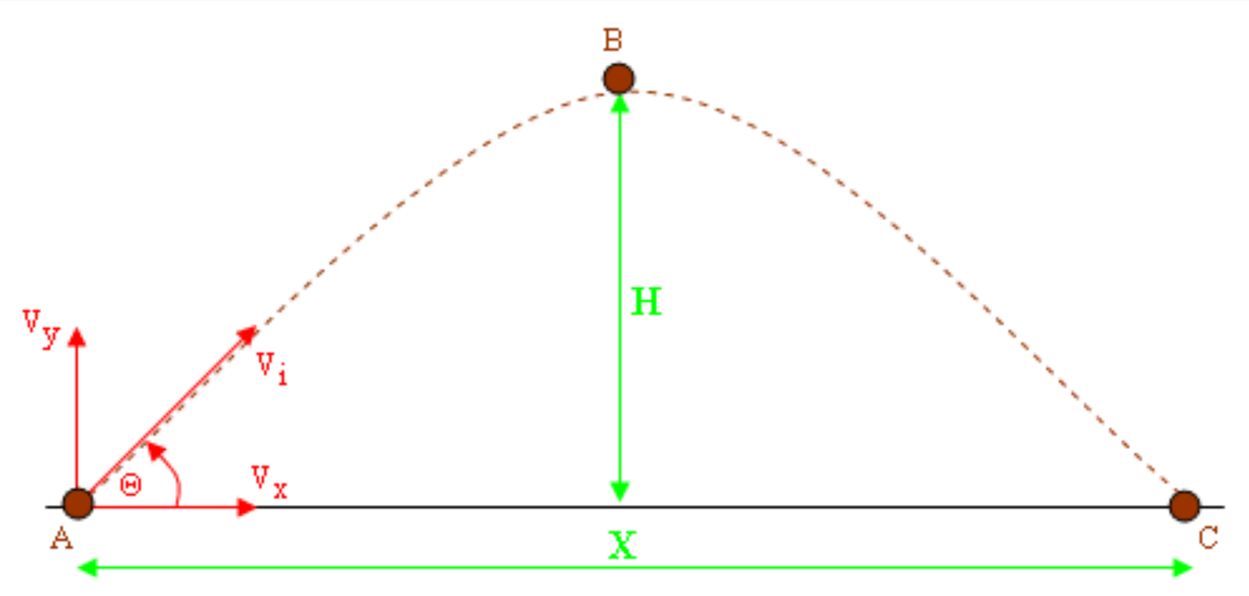


CALCULATIONS FOR LAUNCH ("FROM GROUND")

Given the initial velocity v_i and angle θ

C. Find the maximum height

$$\Delta y \quad = v_{iy}\Delta t + \frac{1}{2}a\Delta t^2$$



CALCULATIONS FOR LAUNCH ("FROM GROUND")

Given the initial velocity v_i and angle θ

D. Find the total distance traveled/horizontal distance/range

$$v_x = \frac{\Delta x}{\Delta t}$$