Traditional: 03-01
Themed: 10-02

Projectile Motion

Describing Vectors

What is a projectile? How is this unit different?

- A projectile is “a moving object whose motion is only affected by gravity”
  - Sound more like freefall or terminal velocity to you?
- Very different because two dimensions instead of one (not linear any more!)
- First we’ll need rules on describing directions:

Describing Vector Direction

- Two ways of specifying vector direction
  1. Relative to horizon
  2. Mapping method
- You need to be able to recognize both
- You should be able to use both, but if you must be good at one, Mapping Method is more useful – know it

Vector Descriptions - Horizon Method

- Assume: Archer at right shoots her arrow at 75 m/s
- Horizon method says:

Speed + degrees above/below horizon

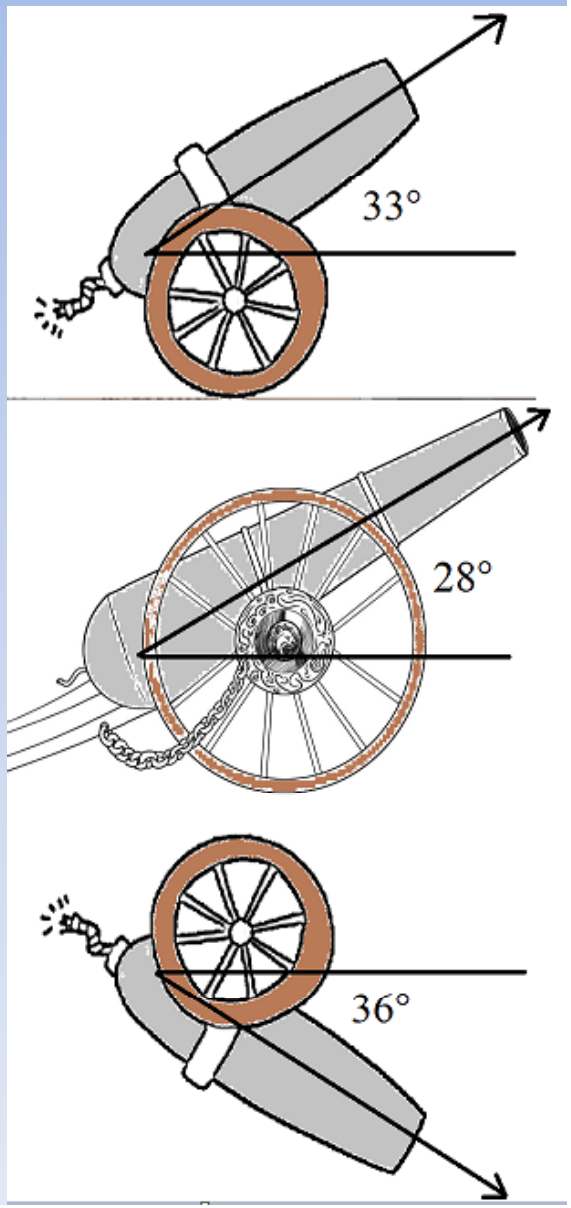
In this case:

V = 75 m/s 37° above horizon

Archer above is the women's world record holder for distance, April Moon

Vector Descriptions - Horizon Method

- Vectors are drawn with arrows, or northeast would be identical to southwest!
- Apply this method to find initial velocities at right
- Why do we call it, “initial”? Why would it change?

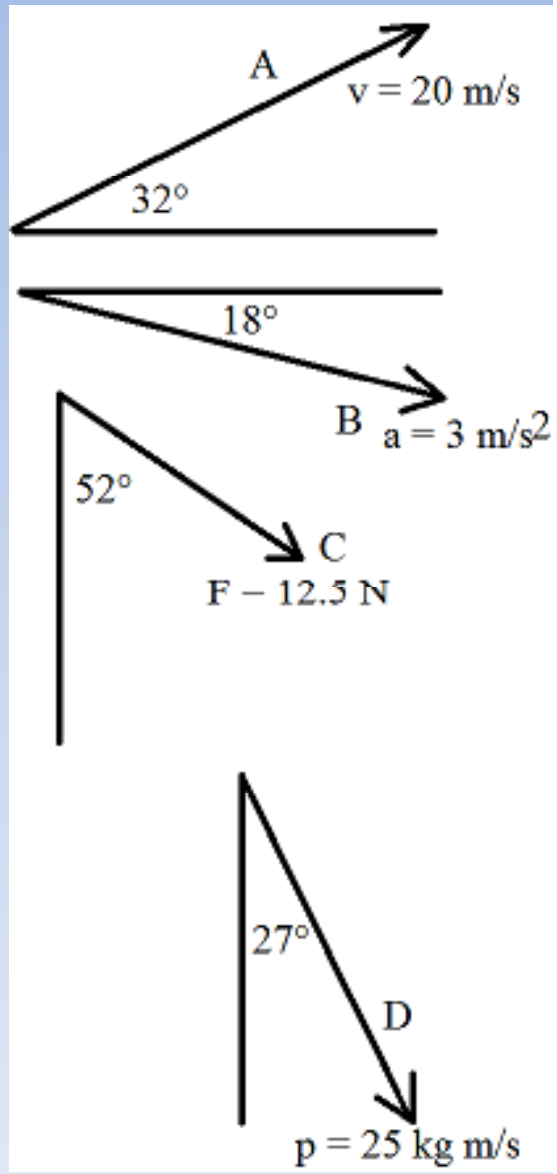


Vector Descriptions – Mapping Method

- Mapping method says:

Speed + degrees direction 1 of direction 2

- Directions are N, E, S, W
- Example: 30° N of E describes: East-pointing arrow rotated by 30° toward North
- Complete vector might be: 3.5 m/s 30° N of E
- Try the examples at right including "2nd method" (complementary angle)



Scales/Scaling

- Product of a vector and scalar is a vector
  - Example: doubling your velocity is multiplying velocity vector by scalar (2), result is a vector!
- Used to represent something very big or very small
  - Maps
  - Amoebas
- Pick a scale by ratio of actual size to room you have to represent it
  - Example: You have 10 cm width on paper and USA is 3000 miles wide: Your scale is 300 miles = 1 cm

Nifty (TNEOM)…2-d Version

- Notice we now have y AND x?
- Y will mean vertical from now on and X horizontal
- Good news: We have no new equations! None!
- Bad news: YOUR equations still say X, you will need to know when they mean Y
- Good news: We only have ONE equation for X (so all the rest must mean Y!)

Y direction (where velocity is changing)

Equation	a	*t*	v_i	v_f	Δy
$v_f = v_i + at$	√	√	√	√	☹
$\Delta y = \frac{(v_i + v_f)}{2} t$	☹	√	√	√	√
$\Delta y = v_i t + \frac{1}{2} a t^2$	√	√	√	☹	√
$v_f^2 = v_i^2 + 2a\Delta y$	√	☹	√	√	√

X direction (where velocity is not changing): $\Delta x = v_x t$

Nifty (TNEOM)…2-d Version

- Time (t) is the common link between X and Y directions
- There is a vi and vf in Y, but not in X…can anyone clever figure out why?
- Patterns are exactly the same: Each equation only involves 4 of the 5 variables
- Huge concept: X and Y are independent!
  - you can examine one independently of the other
- Bad news: Table (below) not yours on test; look at packet eqn. list & find equivalent eqns. for all 4 below

Y direction (where velocity is changing)

Equation	a	*t*	v_i	v_f	Δy
$v_f = v_i + at$	√	√	√	√	☹
$\Delta y = \frac{(v_i + v_f)}{2} t$	☹	√	√	√	√
$\Delta y = v_i t + \frac{1}{2} a t^2$	√	√	√	☹	√
$v_f^2 = v_i^2 + 2a\Delta y$	√	☹	√	√	√

X direction (where velocity is not changing): $\Delta x = v_x t$

Horizontal Projectiles

- Vi = zero….'nuff said?
- Combine this concept with independence of X and Y to solve this:

If a bullet is dropped from 2 m high and a bullet is fired at 300 m/s from 2 m high, which will strike the ground first?

- What's happening in the Y direction in both cases (list all five variables and solve for time)
  - What does the physics tell you will happen?