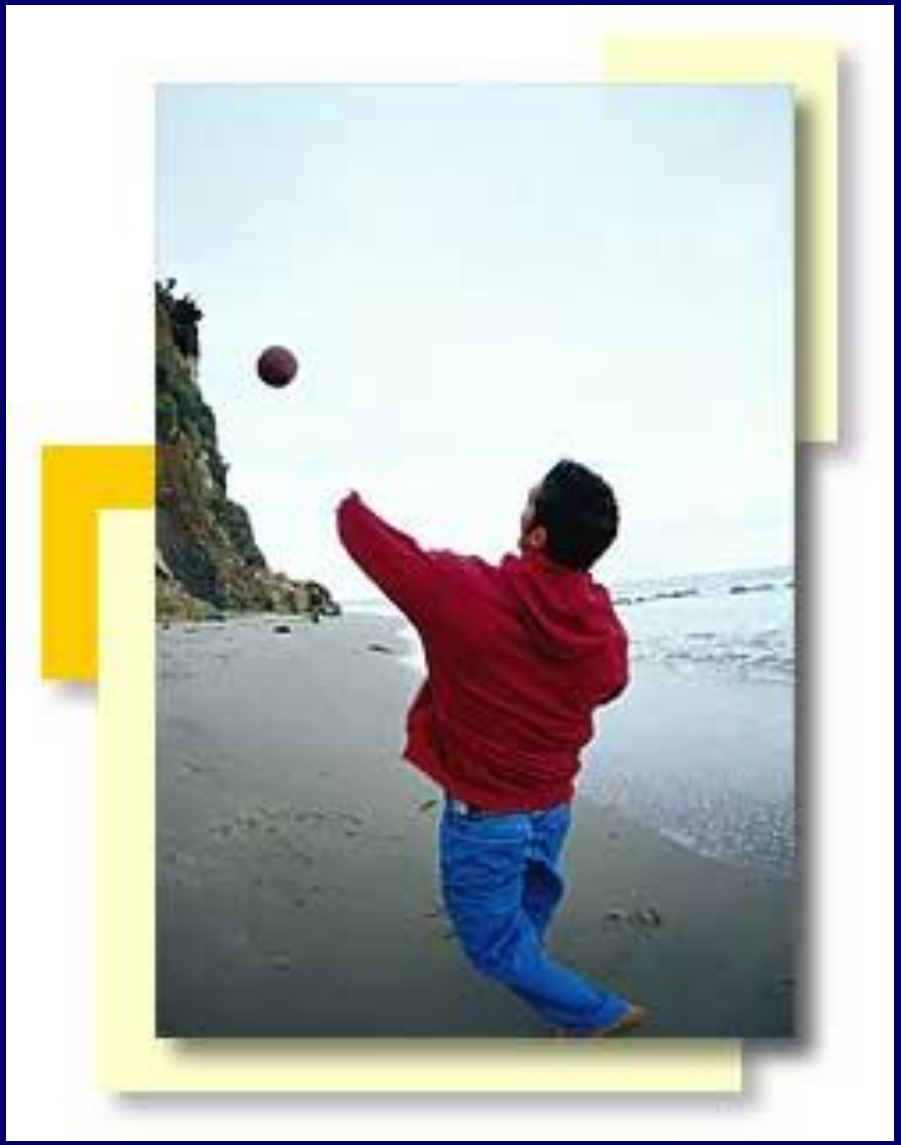
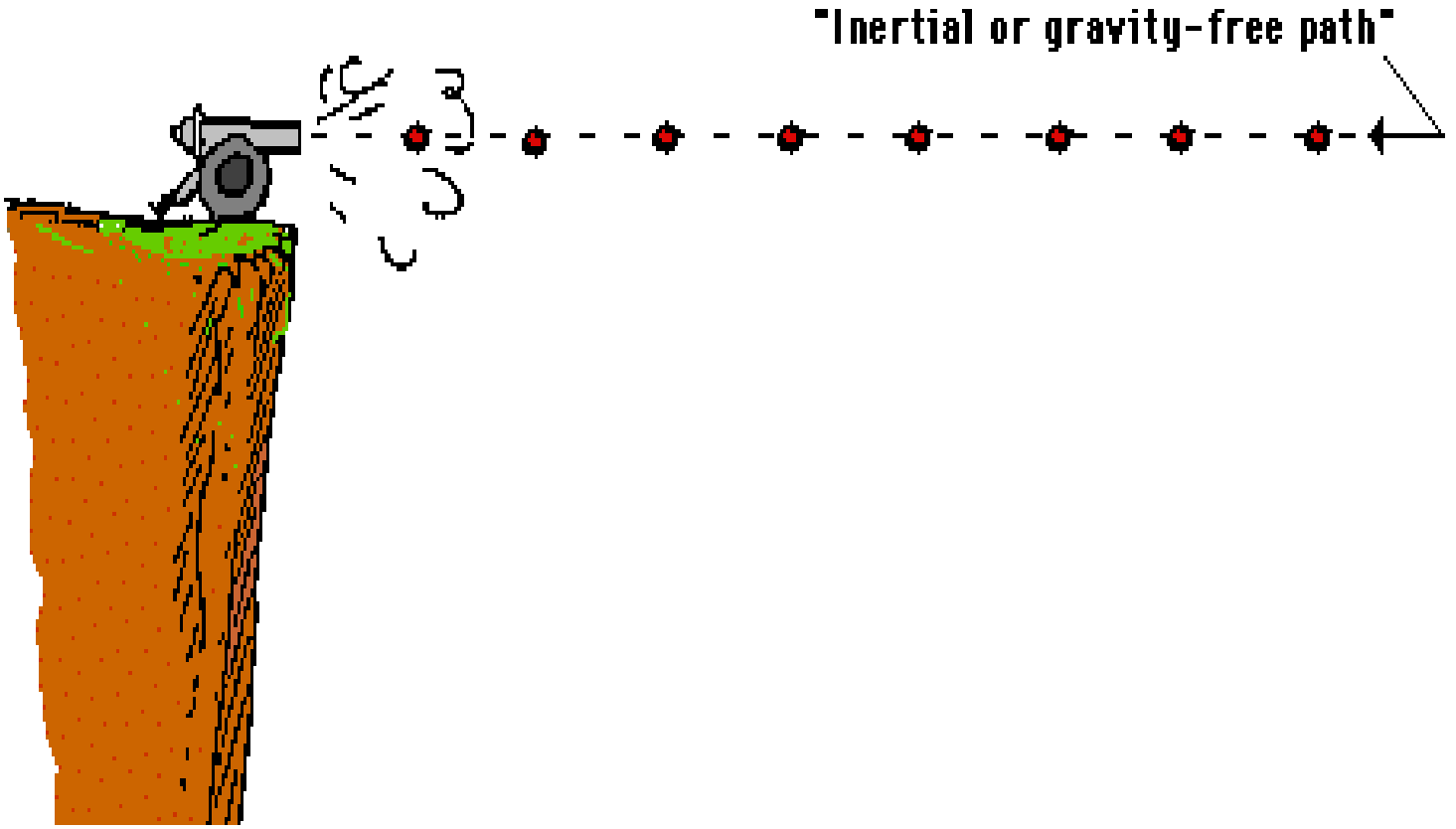
Chapter 6
Motion in Two Dimension



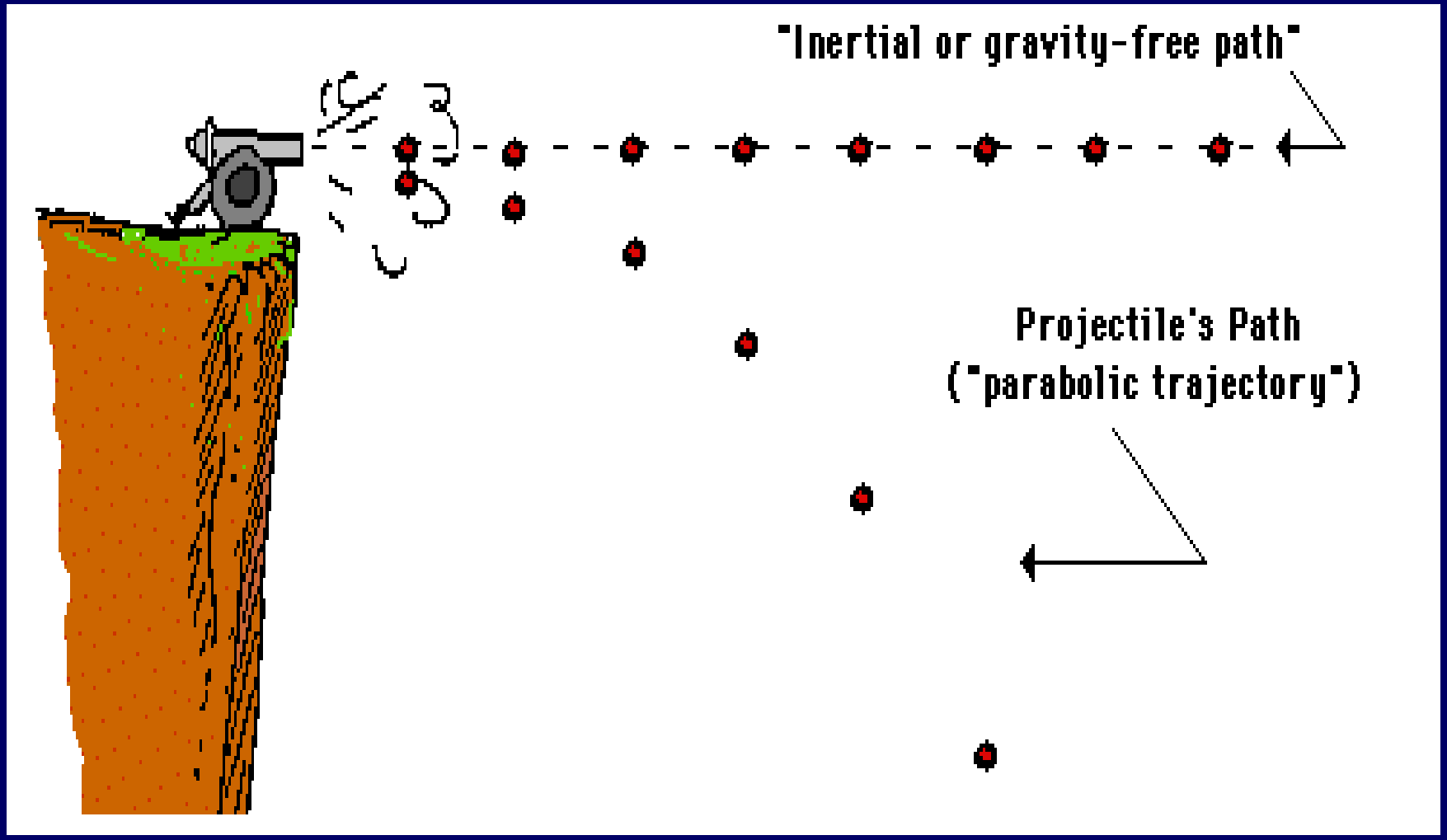
Projectiles
Ch 6.1

If Zero Gravity



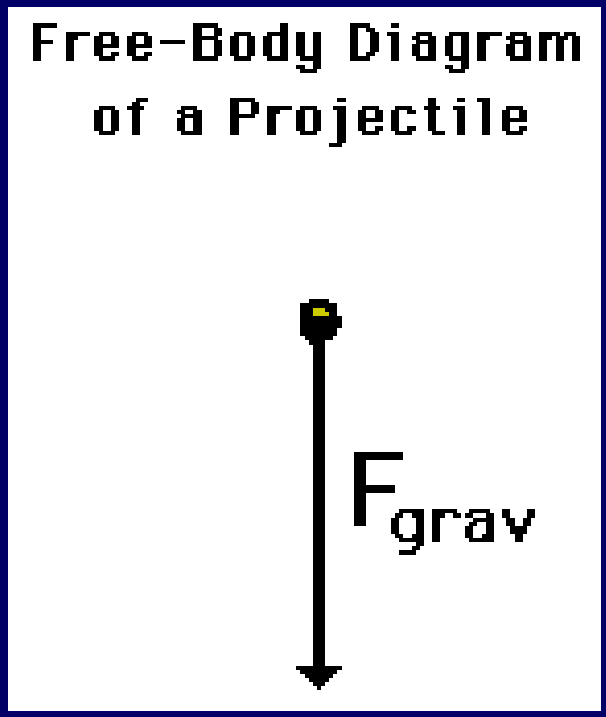
Without gravity, an object in motion will continue in motion with the same speed and in the same direction.

With Gravity



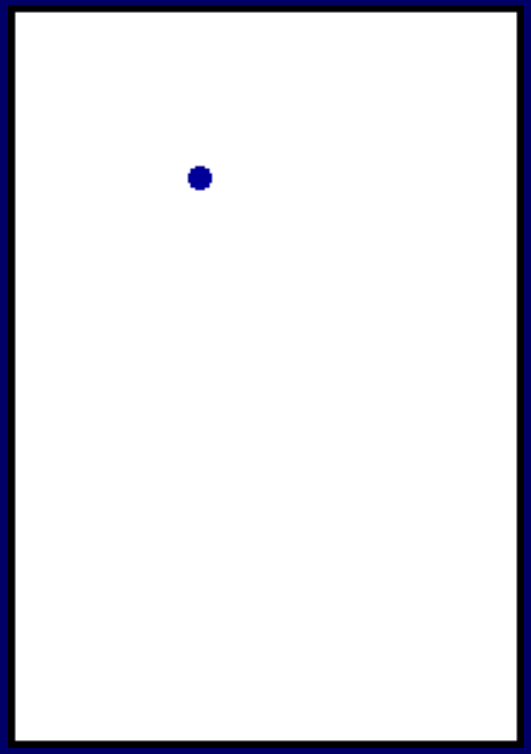
Projectile - An object that has _____.

- Gravity causes a projectile to _____
- Ignoring air/wind, there is ___ _____ so _____
- _____components of motion are _____ _____
- Meaning:_____ _____ _____ _____



Projectile

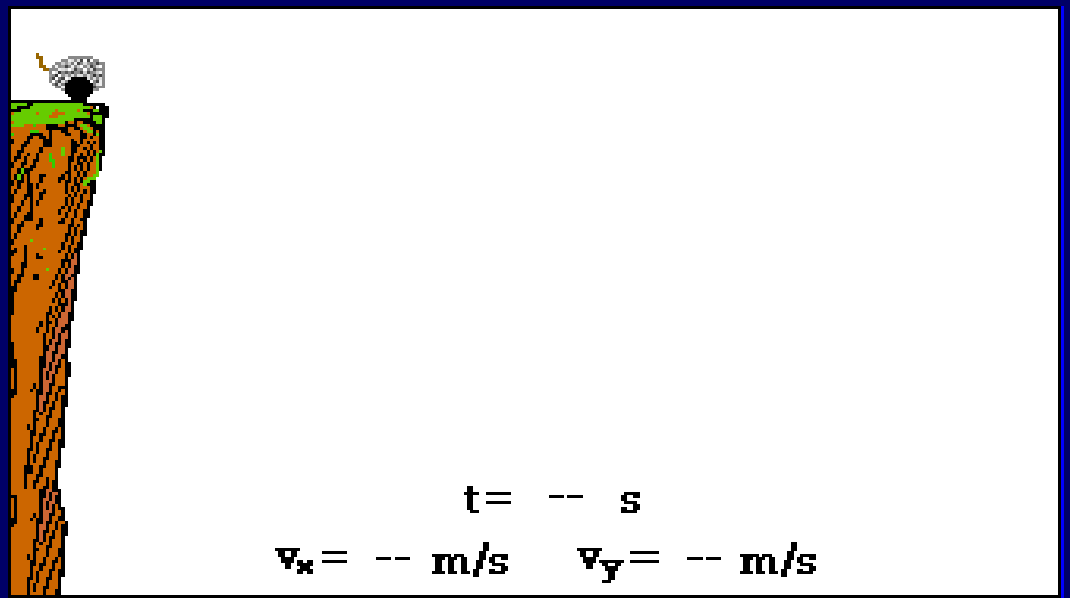
The result of a _____ acting upon a _____ _____ is to cause the object to deviate from its otherwise linear path – causing a _____ .



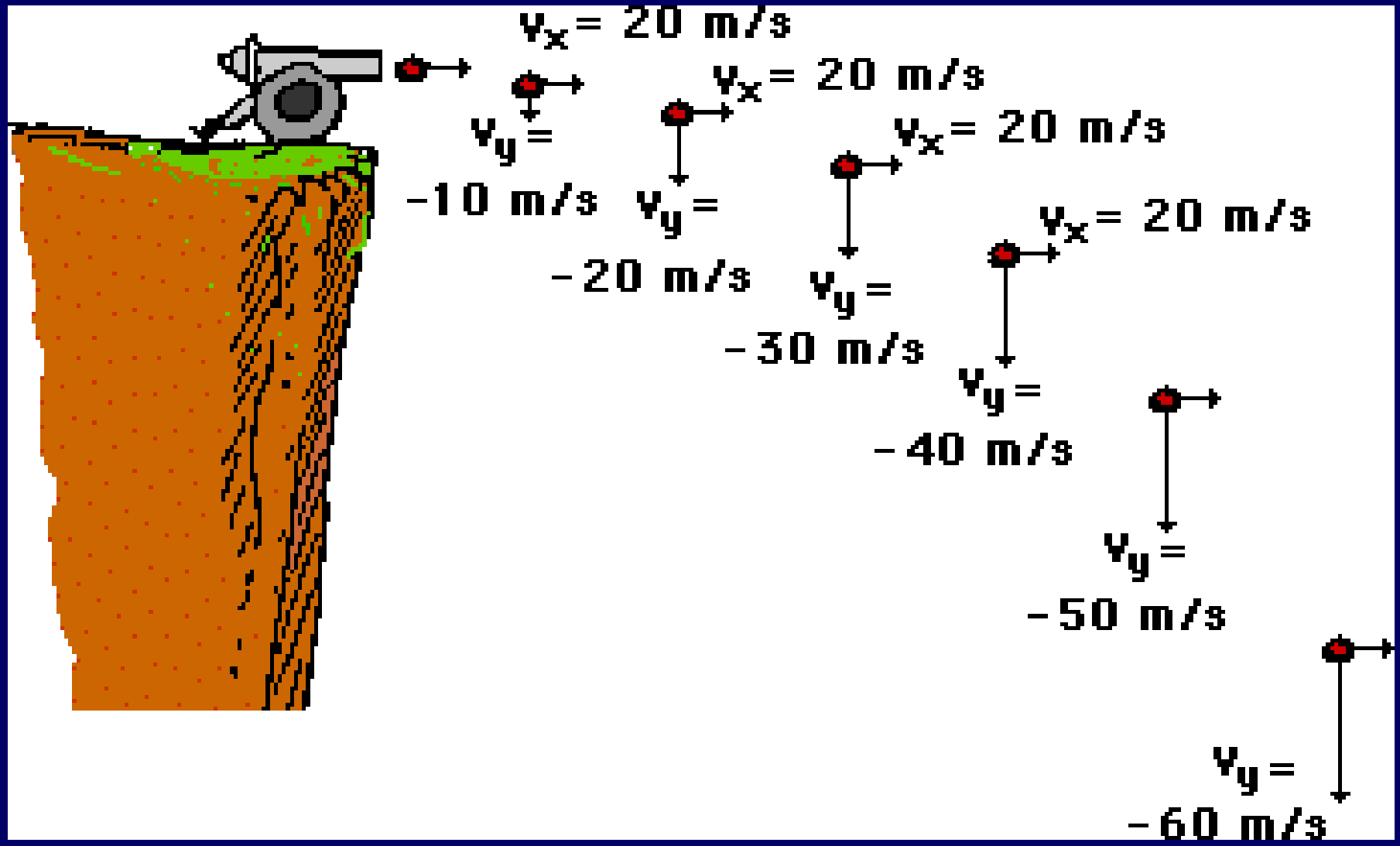
Object Propelled Horizontally Notes

Horizontally Launched Projectiles

- An object launched horizontally, neglecting air resistance, will initially _____ _____.
- No _____ component: _____.
- ____ is _____. ___ gets _____.

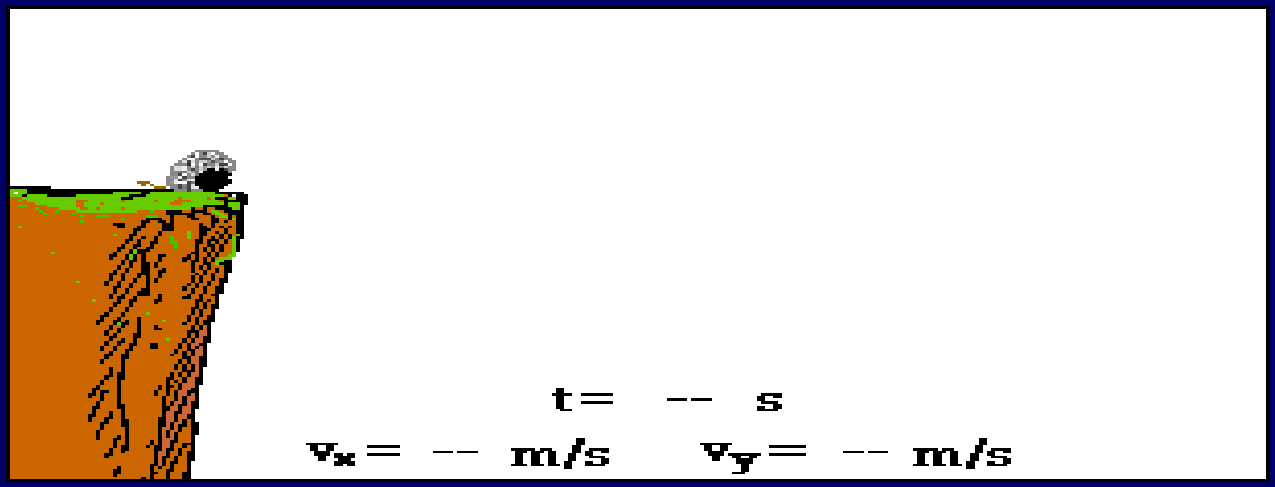


Horizontal velocity is constant
Vertical changes (acceleration)



Projectiles Launched at an angle

- Object follows a _____.
- Object undergoes a _____ on the _____AND the _____.
- Initial velocity will have both a _____ and _____ component.
- P.377

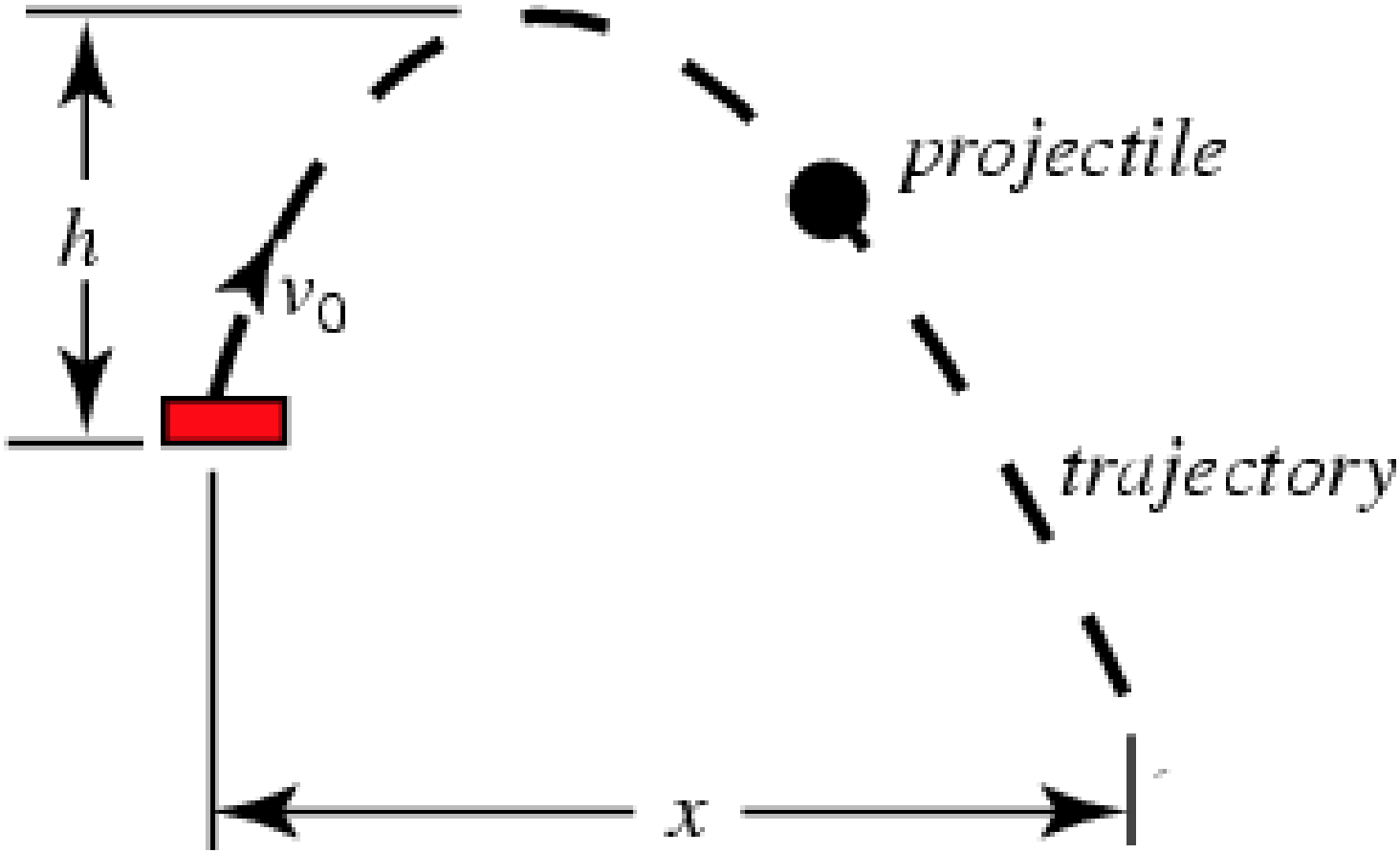


http://www.stmary.ws/highschool/physics/home/videos/Motion/projectileVideoBball.html

Projectile Components: Treat both separately!

	Horizontal Motion	**Vertical Motion**
Forces Present	None (neglect air)	The force of gravity acts downward
Acceleration	None	Downward at $-9.8\ m/s^2$
Velocity	Constant	Changing by 9.8 m/s each second

Terms

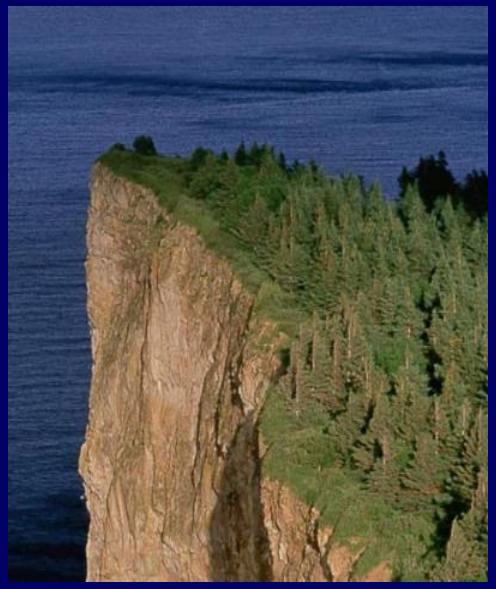


Horizontal displacement / Range

EX: A stone is thrown horizontally at 15 m/s from the top of a cliff 44 m high.

A. How far from the base of the cliff does the stone hit the ground?

B. How fast is it moving the instant before it hits the ground?



EX:

- Courtney kicks a soccer ball at rest on level ground giving it an initial velocity of 7.8 m/s at an angle of 32 degrees.
  - How long will the ball be in the air?
  - How high will the ball go?
  - What will be its range?

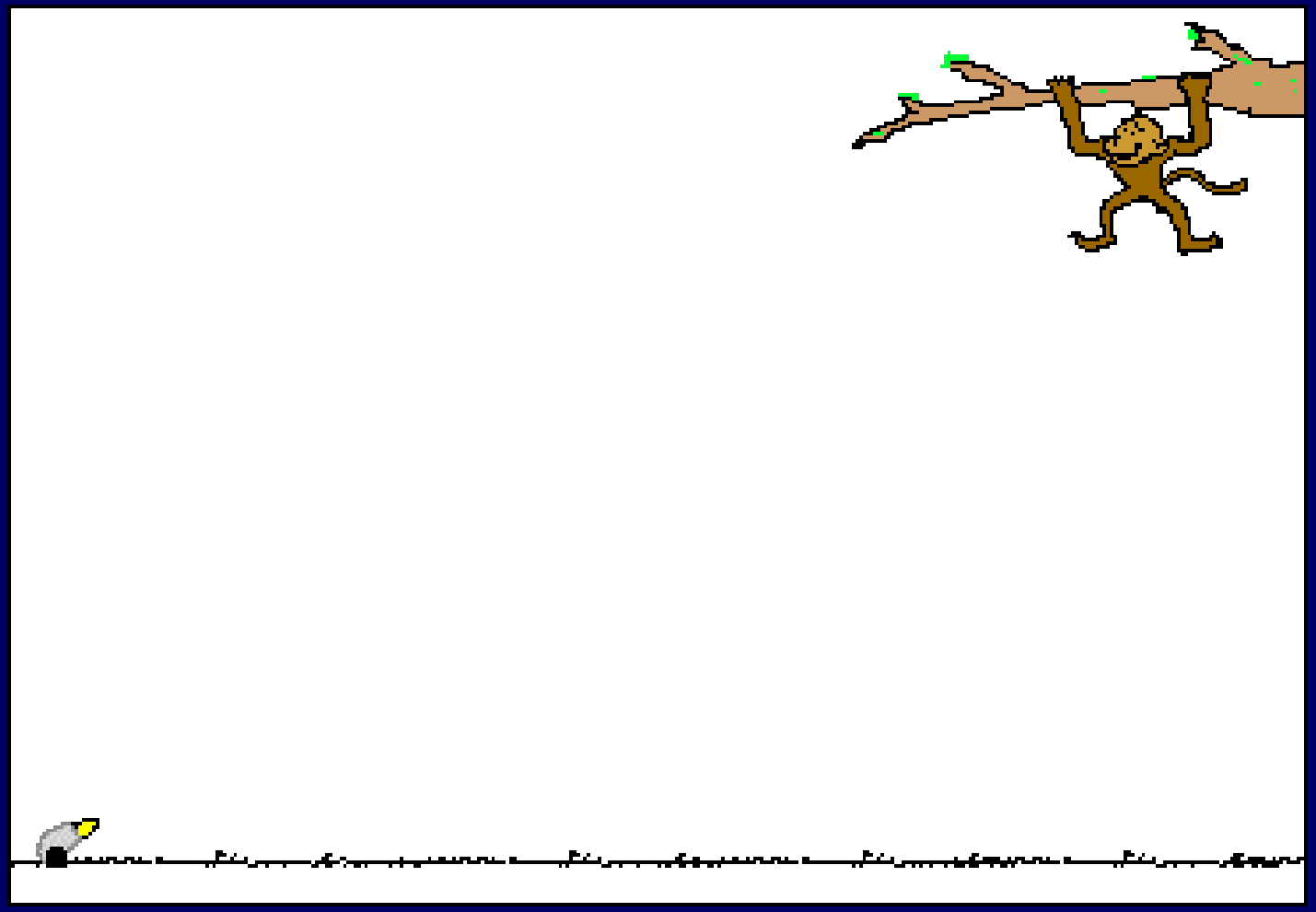
Football Kick

- Calculate:
- Vxi
- Vyi
- Vi
- Θ
- Ymax

http://www.youtube.com/watch?v=UwNi3iWbIPA

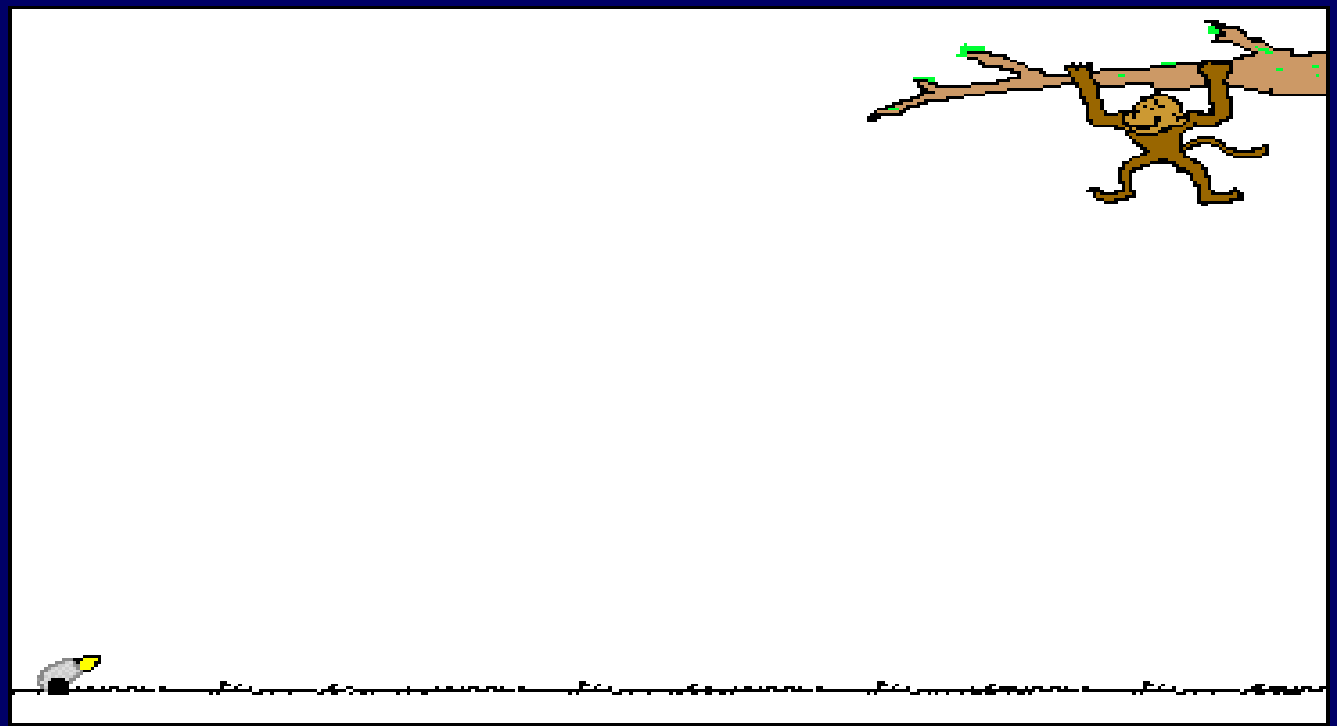
If Zero Gravity

- Consider a monkey gun shot at an angle



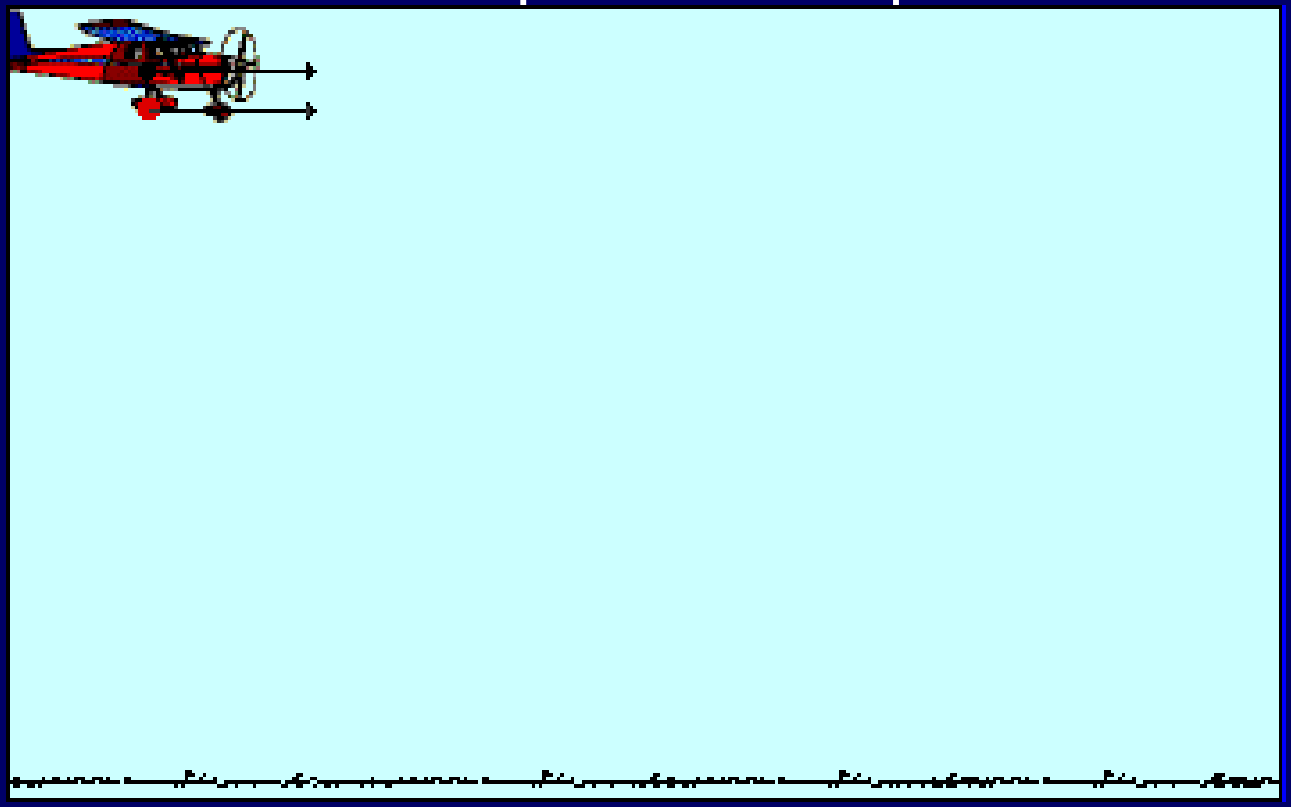
With Gravity

- Consider a monkey gun shot at an angle
- The sound will startle the monkey causing him to fall when the gun is fired.
- Where should you aim, in order to hit the monkey?
- http://dev.physicslab.org/Document.aspx?doctype=2&filename=Freefall_monkeyanimation.xml



The Plane and The Package

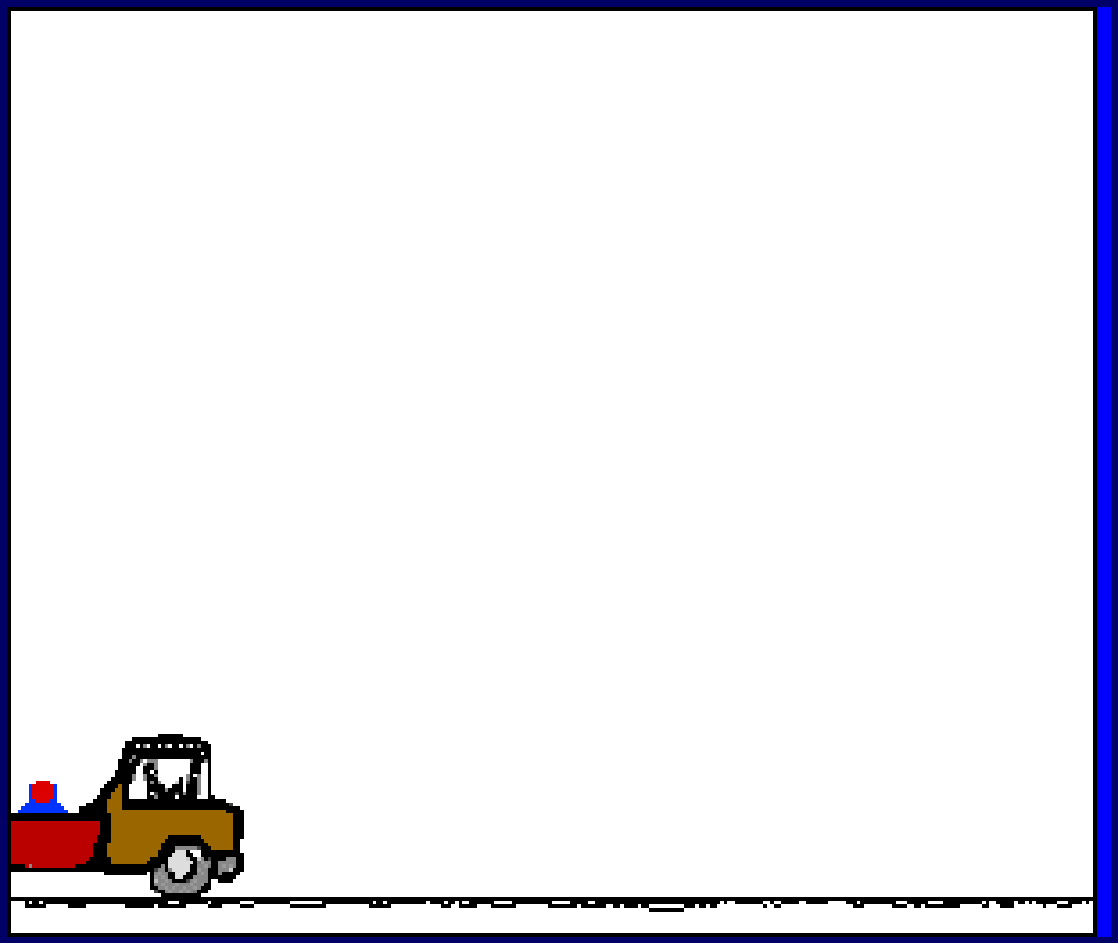
- Plane flying at a constant speed
- The plane drops a package.
- What will be the path of the package and where will it land with respect to the plane?



The Truck and The Ball

- Pickup truck moving with a constant speed.
- A ball is projected straight upwards by a launcher located in the bed of the truck.
- Neglect air resistance.
- What is the path of the ball to an outside observer?
- What will be the path of the ball and where will it be located with respect to the pickup truck?

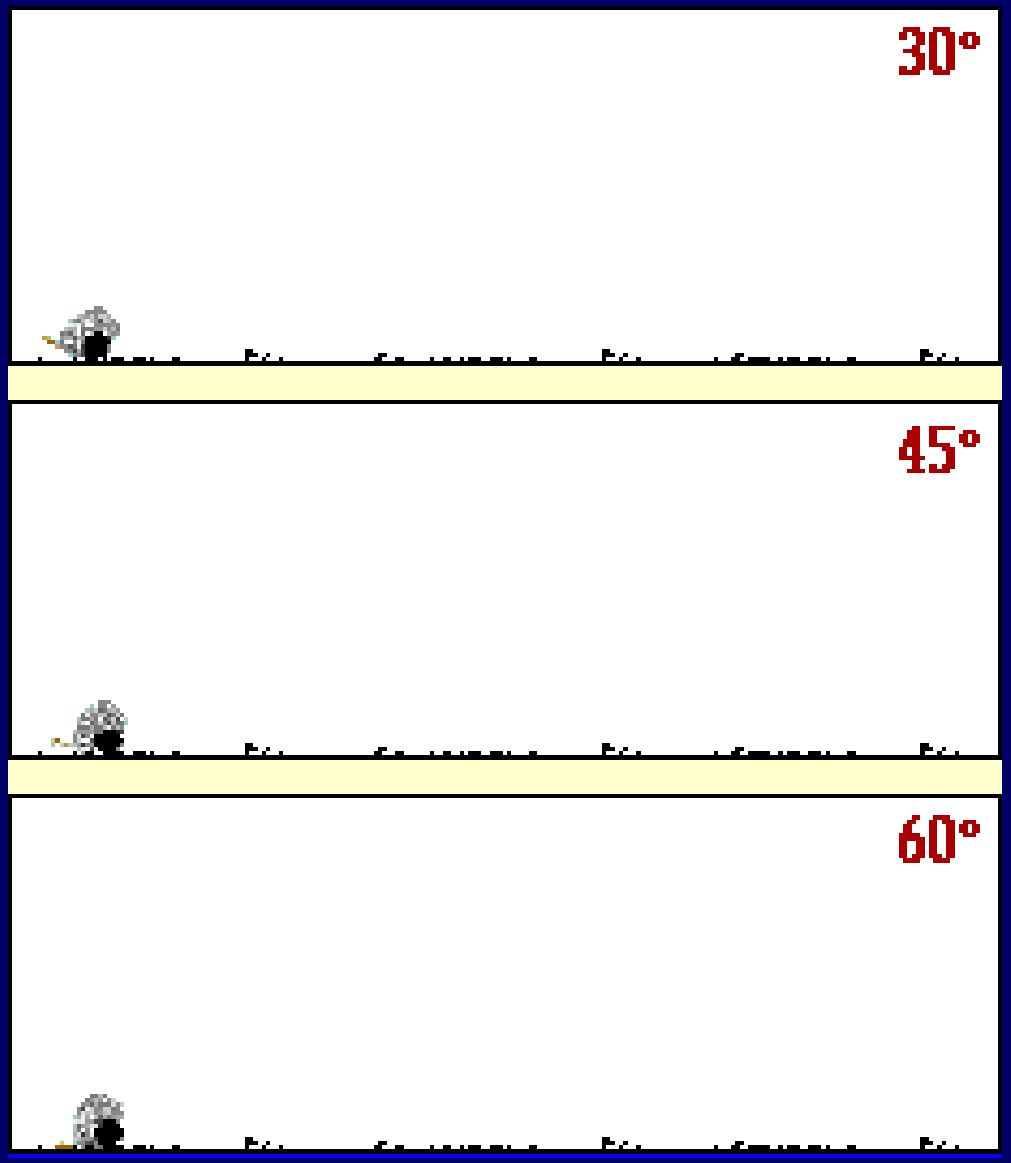
The Truck and The Ball



Maximum Range

- Cannonball launched at three different launch angles 30^{o}, 45^{o}, and 60^{o}.
- Launch speed is constant
- Neglect air resistance.
- Which cannonball will have the greatest range (horizontal distance)?
- Which cannonball go the highest?
- Which cannonball will reach the ground first?

Maximum Range



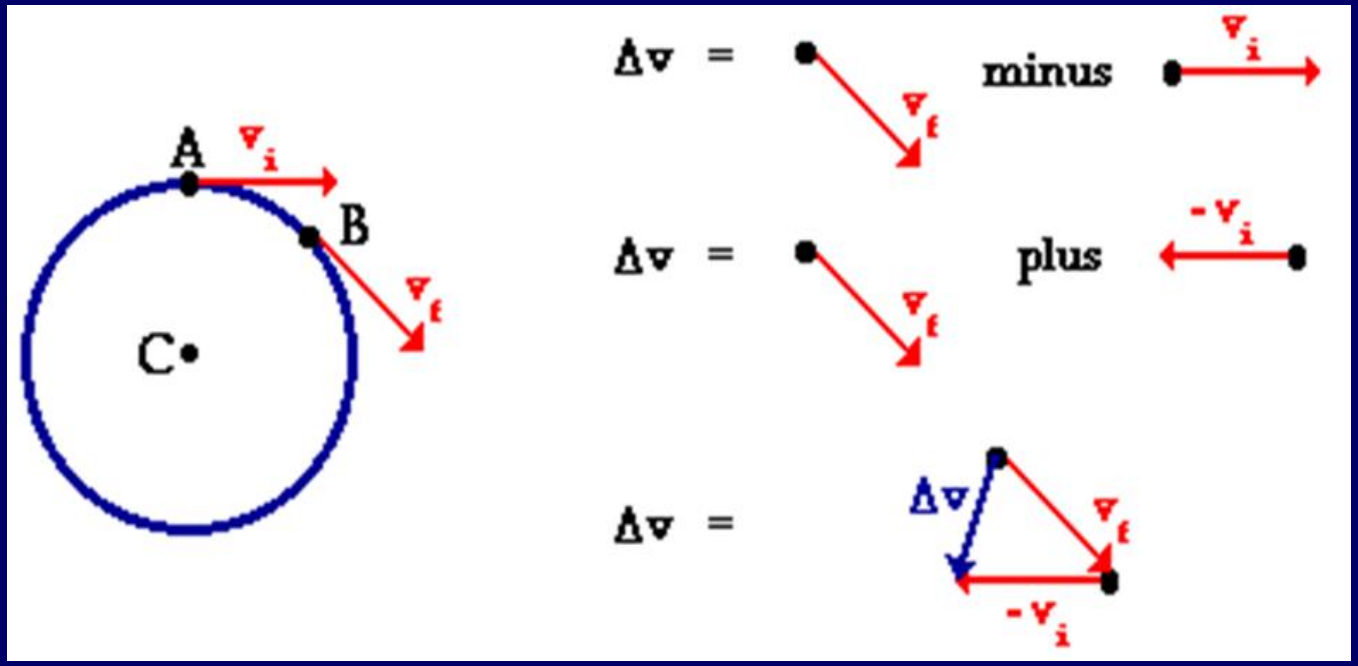
6.2 Uniform Circular Motion

- The movement of an object at a _____ around a _____ with a fixed _____
- ONLY _____ _____ _____

- EX: merry-go-round
- EX: Hammer throw

- Since _____ is changing, objects in UCM do have an _____.

- The _____of an object in uniform circular motion _____ points towards the _____ of the circle because _____ equals a _____.


A
B
C
v_i
v_f
Δv = minus
Δv = plus
Δv =
$-v_i$

Centripetal Acceleration Formulas

Period (T) – The _____ needed to make _____.

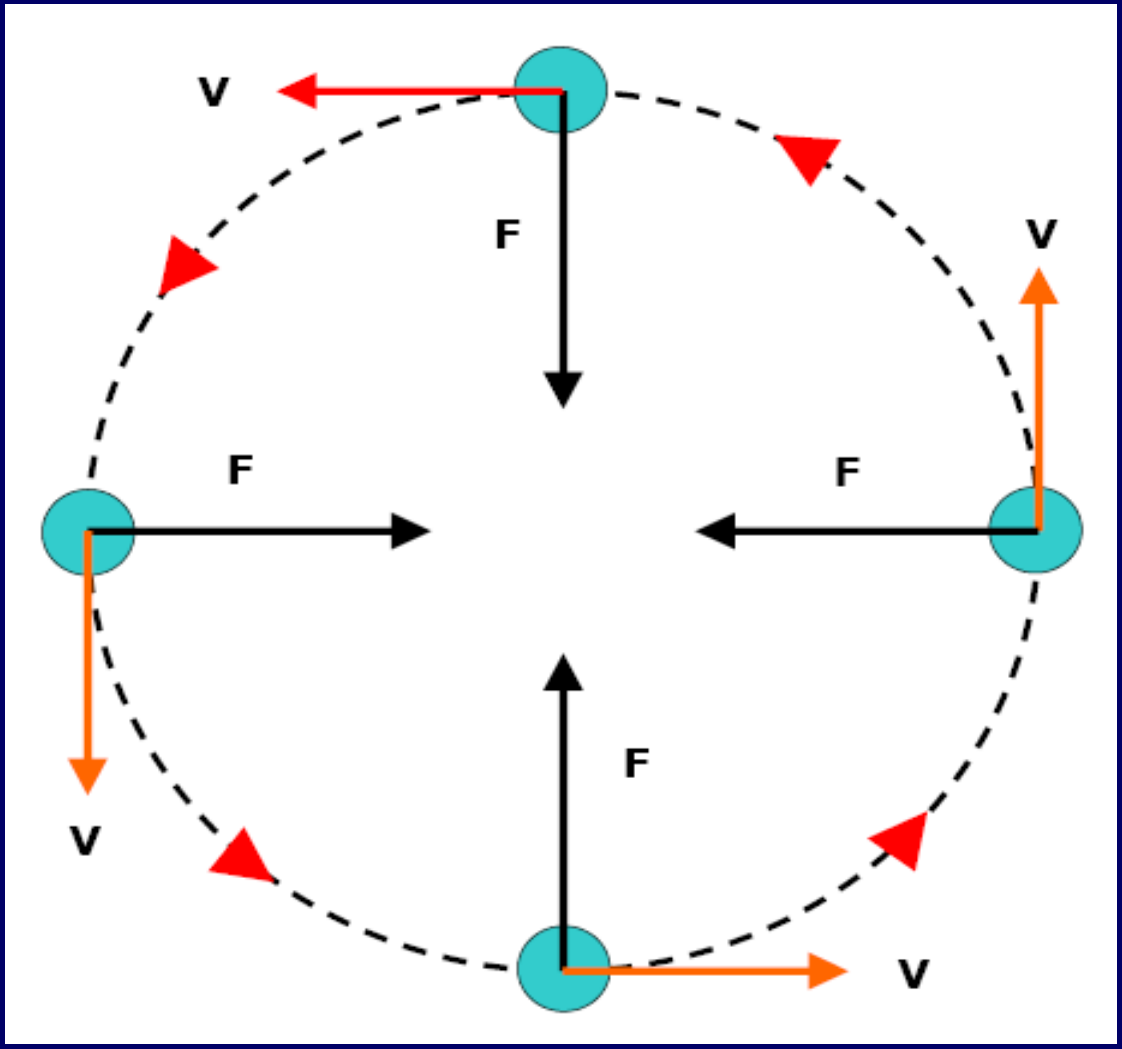
Remember: _____ Causes _____

- **Centripetal force**: the name for the _____ _____ that causes _____ acceleration.
- _____points towards the _____of the circle.

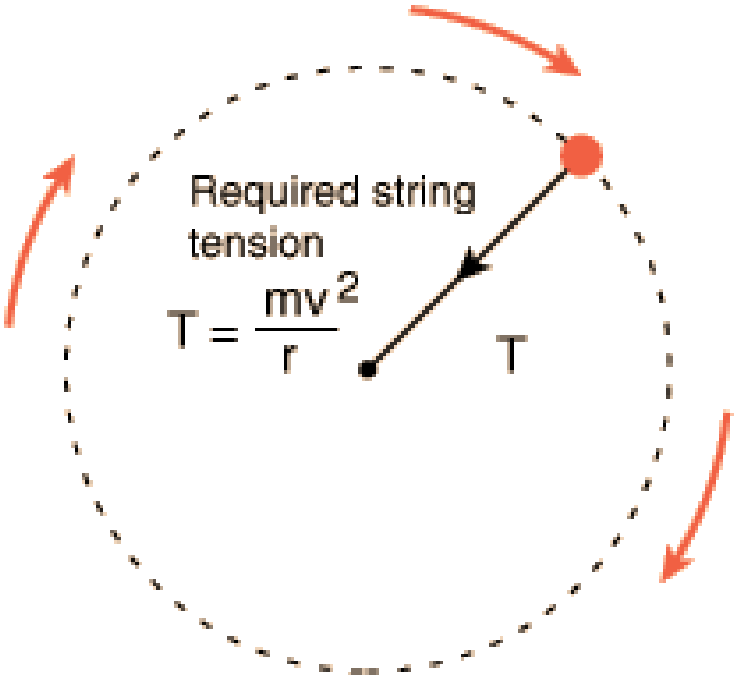
- EX: gravitational force that allows the earth to circle the sun
- EX: tension in the chain of the hammer
- EX: friction between the road and tires

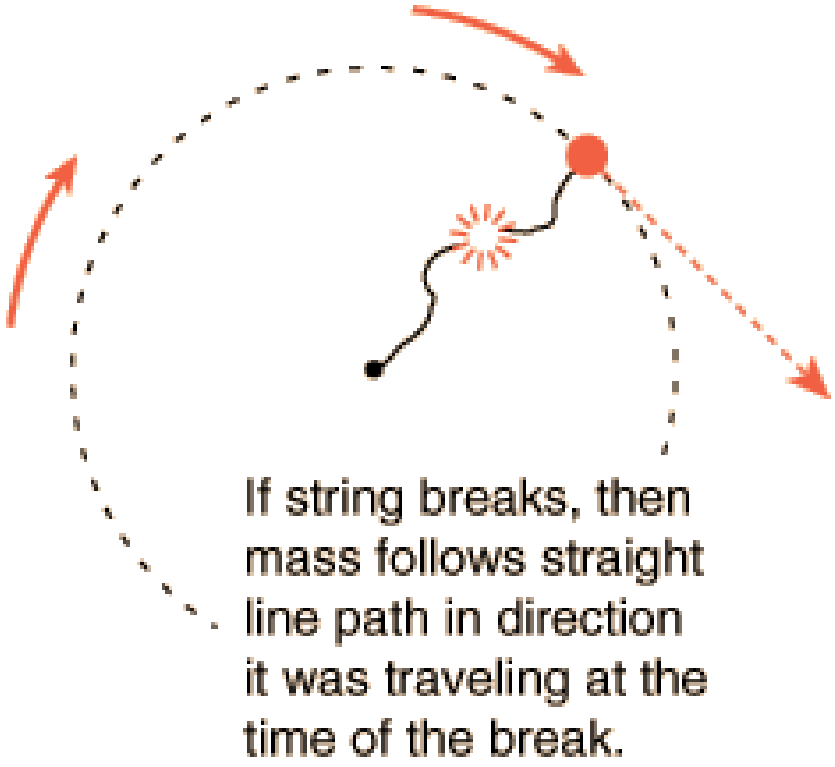
Centripetal Force Formula

Direction of vectors:



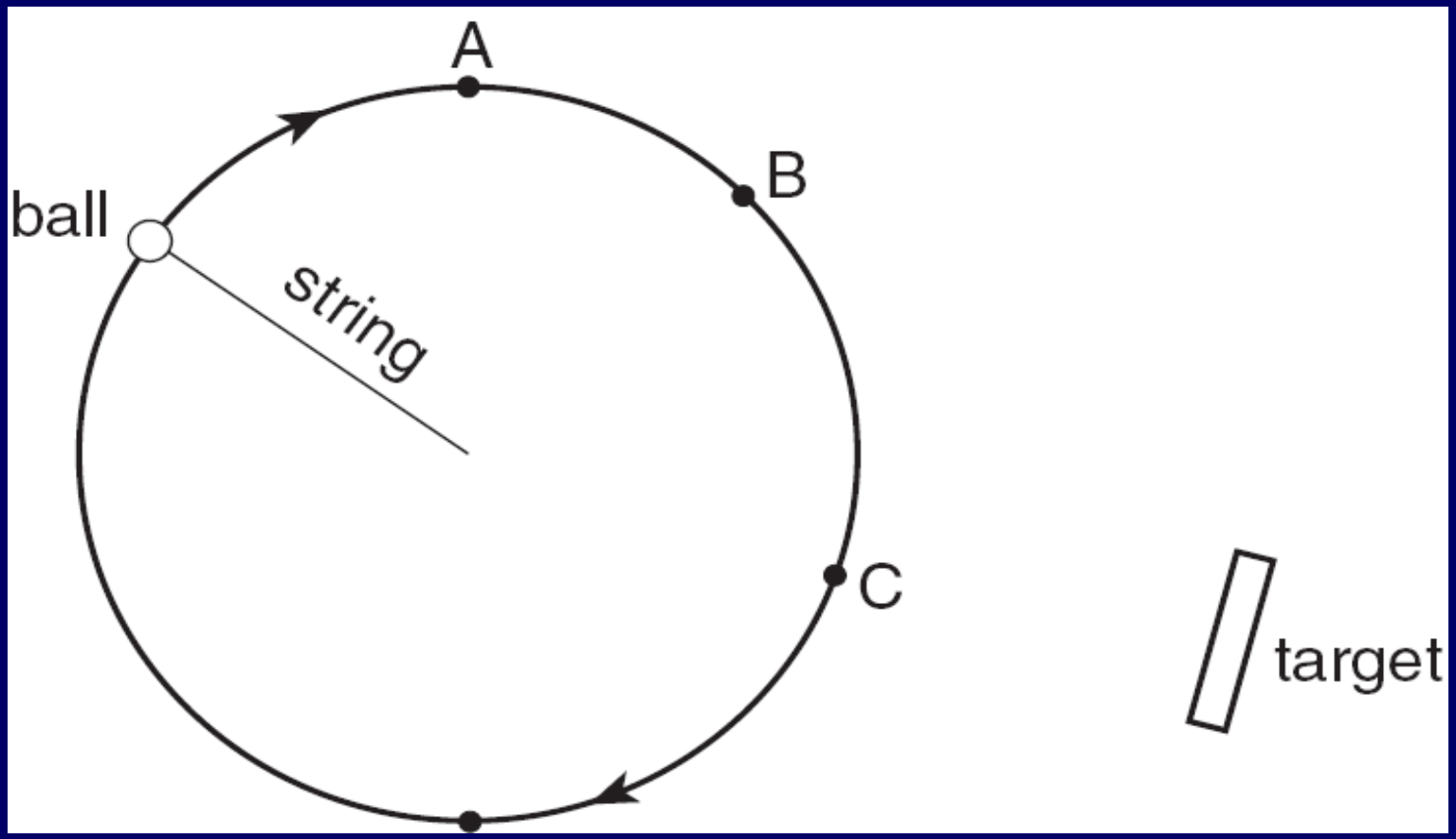
$$F_{centripetal} = m\frac{v^2}{r}$$





If string breaks, then mass follows straight line path in direction it was traveling at the time of the break.

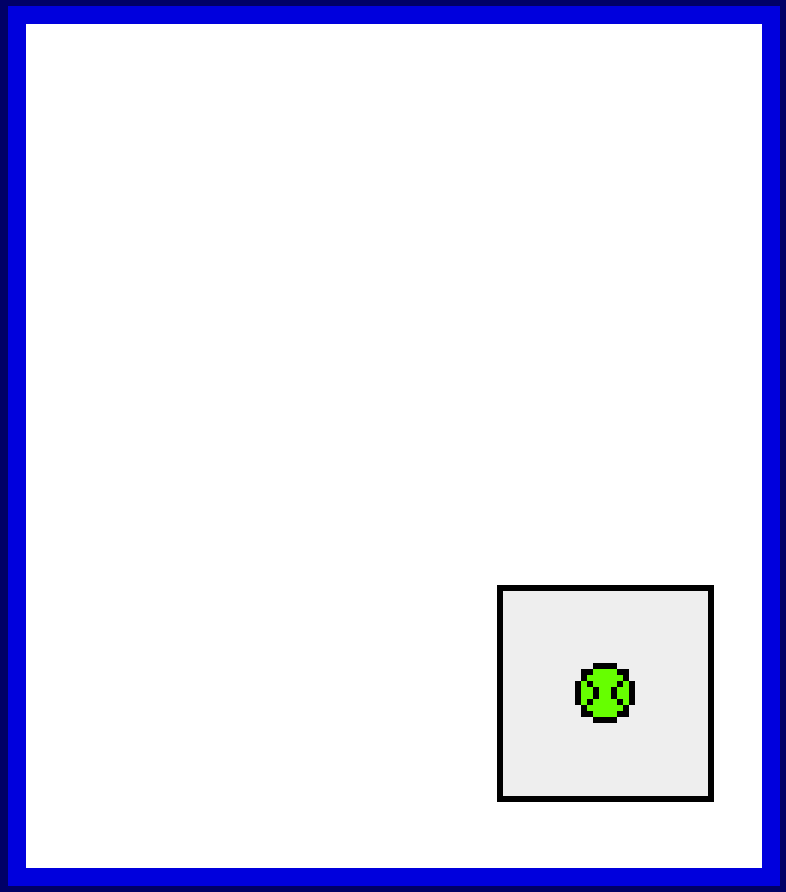
Where should you release the ball to hit the target?



Intro to Uniform Circular Motion

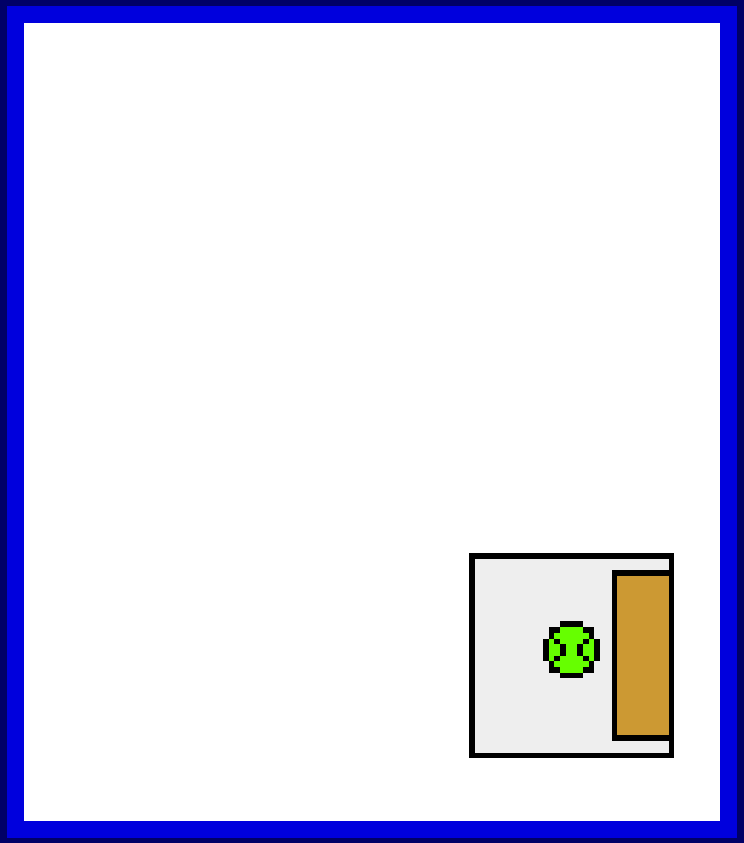
Without Centripetal Force

An object in motion (tennis ball) continues along a straight-line path.



With centripetal force

The object in motion will be accelerated and change its direction.



Example:

A 13 g rubber stopper is attached to a 0.93 m string. The stopper is swung in a horizontal circle, making one revolution in 1.18 s. Find the tension force exerted by the string on the stopper.

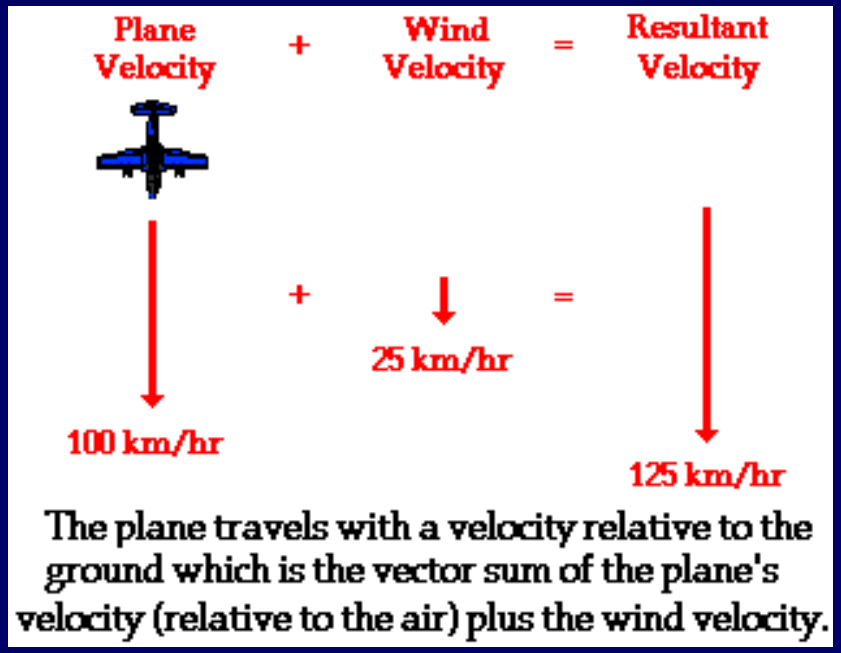
Relative Velocity

- The velocity of an object _____ from different _____.
  - What the velocity _____to be _____.
  - The _____ when using vector addition.

EX:

A boat's speedometer may read 20 mph but the river it is traveling with has a current of 5 mph. Therefore, to a person on the shore the boat appears to be traveling 25 mph.

Relative Velocity

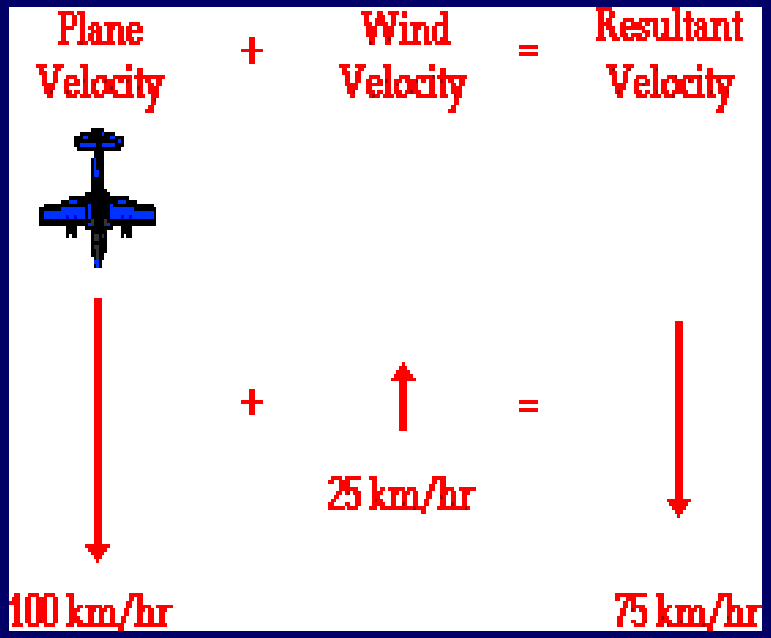


- Plane's speedometer reads 100 km/hr:

- Wind's velocity is 25 km/hr in the same direction as the plane's velocity:

- To an observer standing on the ground, the plane appears to be traveling at 125 km/hr:

Relative Velocity

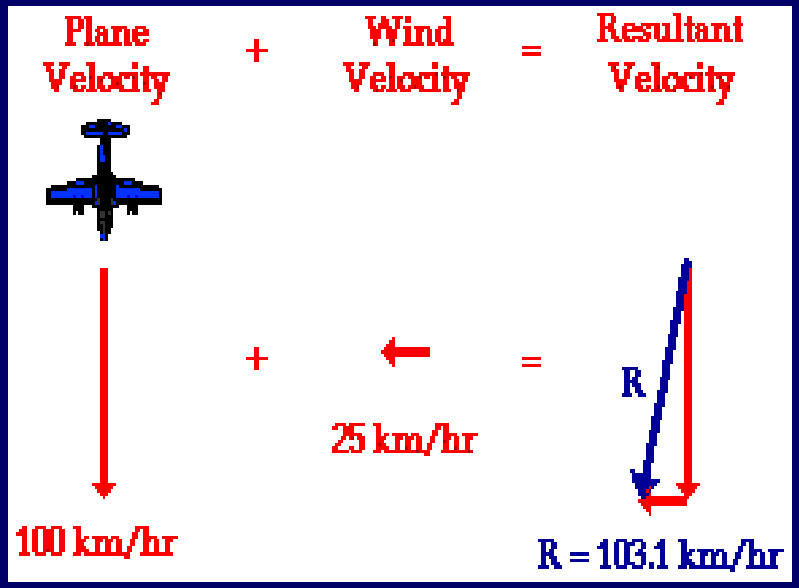


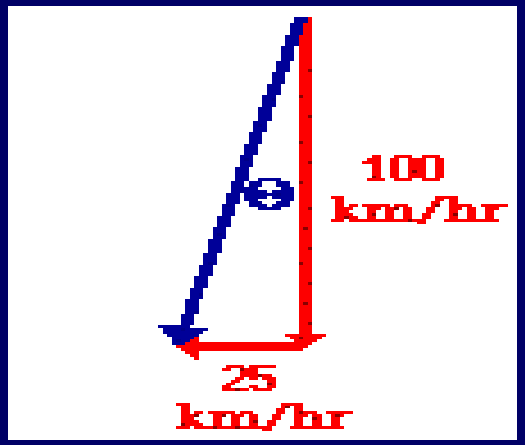
- Plane's speedometer reads 100 km/hr:

- Wind's velocity is 25 km/hr in the opposite direction as the plane's velocity:

- To an observer standing on the ground, the plane appears to be traveling at 75 km/hr:

Relative Velocity

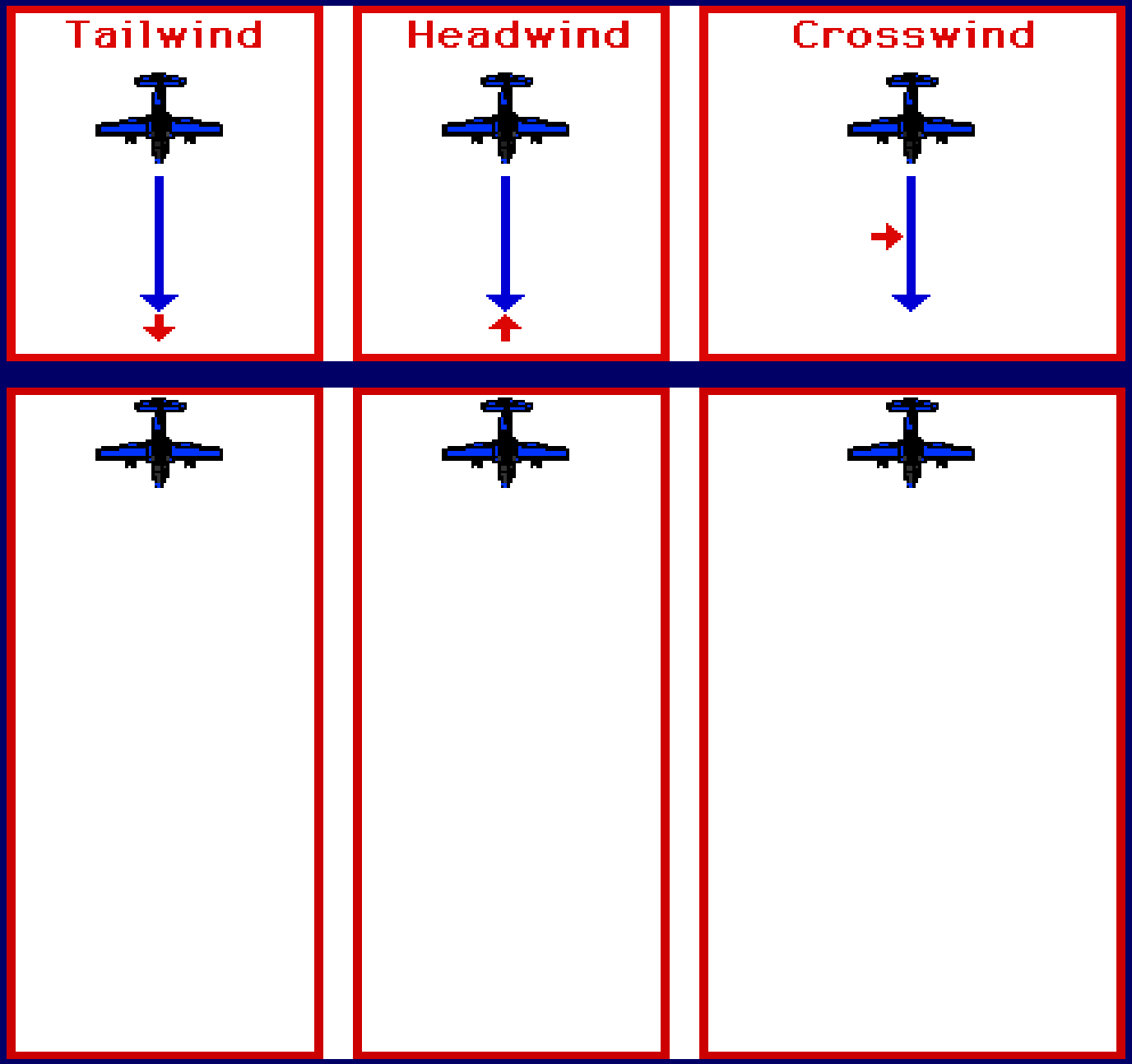




- Plane's speedometer reads 100 km/hr:

- The wind's velocity is 25 km/hr to the west:

- To an observer standing on the ground, the plane appears to be traveling at 103.1 km/hr, 14 degrees W of S:


Tailwind
Headwind
Crosswind

Examples:

1. You are in a school bus traveling at a velocity of 8 m/s. You walk at 3 m/s towards the front of the bus. How fast are you moving with respect to the street?
2. Now suppose that you walk 3 m/s towards the back of the bus. What is your relative velocity with res[ect to the street?

Examples:

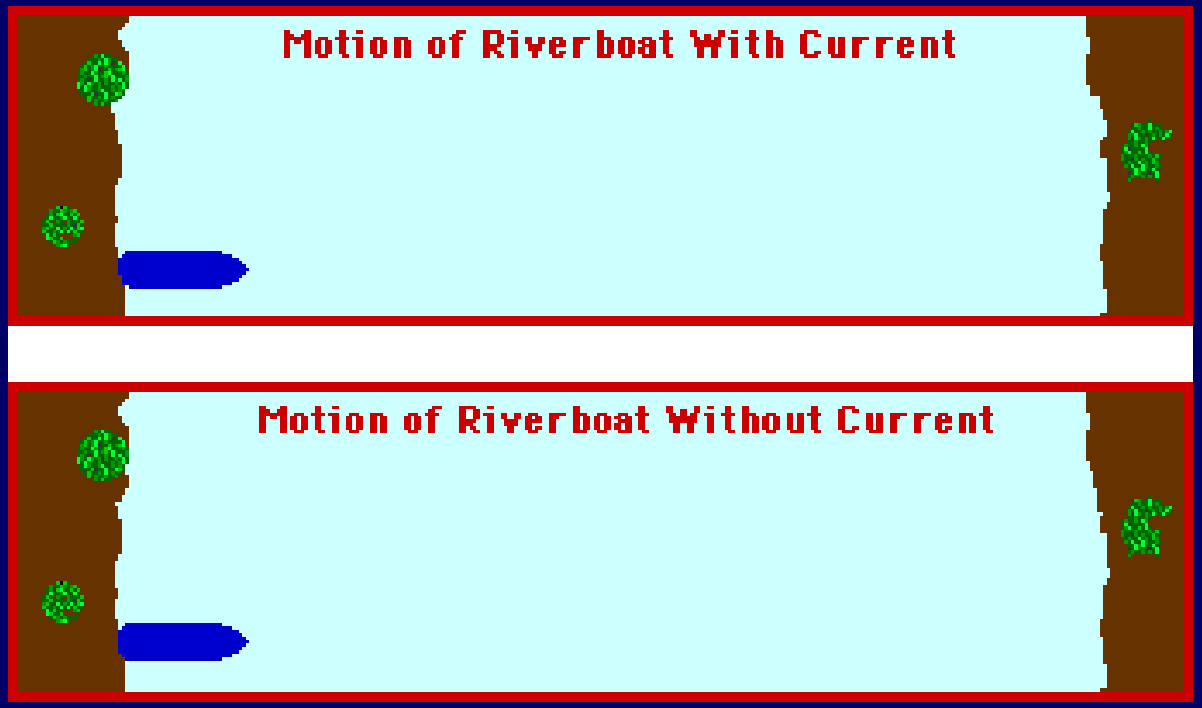
3. A boat moving at 5 m/s can travel across an 80 m calm pond and back in 32 s. Would it need the same time to travel 80 m downstream and 80 m upstream on a river with a current of 2 m/s?

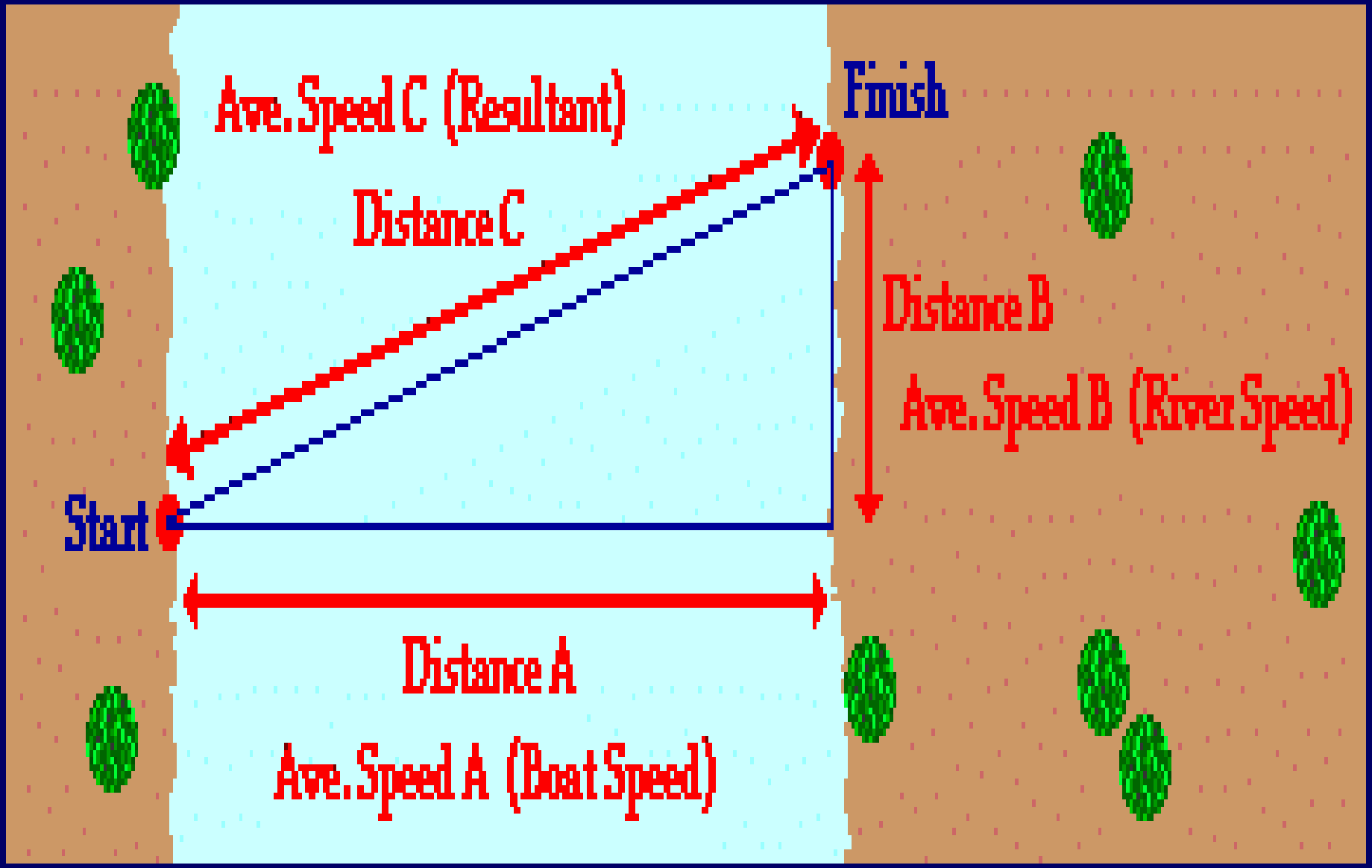
EX: Boat Problem

A motorboat heads due east at 16 m/s across a river that flows due north at 9.0 m/s. What is the resultant velocity of the boat with respect to the shore?

EX: Boat Problem Extension

- In which case (with or without a current) will the boat make it across the shore the quickest?




Ave. Speed C (Resultant)
Finish
Distance C
Distance B
Ave. Speed B (River Speed)
Start
Distance A
Ave. Speed A (Boat Speed)

EX: Boat Problem Cont.

- If the river is 136 m wide
  - How long does it take the motorboat to reach the other side?
  - How far does the boat drift downstream?

- **NOTE**:
  - Use the velocity that is in the same direction as our motion/distance.

To Travel Straight in a Moving Medium:

A _____ of your velocity must _____ the velocity of the _____.

Examples:

4. An airplane pilot wants to fly due south at 175 km/hr. However, there is a strong wind of 55 km/hr coming from the east. At what velocity (magnitude and direction) should the pilot fly his plane in order to achieve his desired flight path?

Example: Non-Right Triangle

1. A motorboat heads due northwest at 13 m/s with respect to the water across a river that flows due north at 5 m/s. What is the velocity (both magnitude and direction) of the motorboat with respect to the shore?