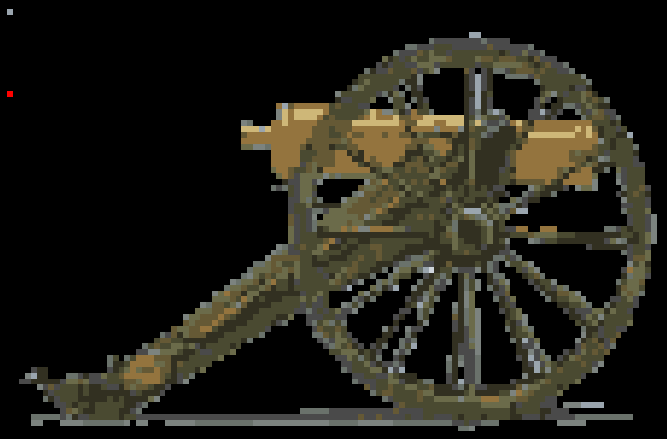
Kinematics in Two Dimensions; Vectors



AP Physics

Chapter 3

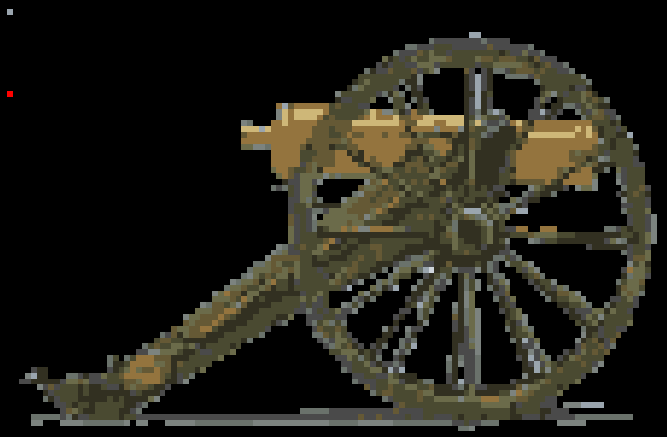
Standard

IA2a

Students should be able to add, subtract, and resolve displacement and velocity vectors

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors



AP Physics

Section 3-1 Vectors and Scalars

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

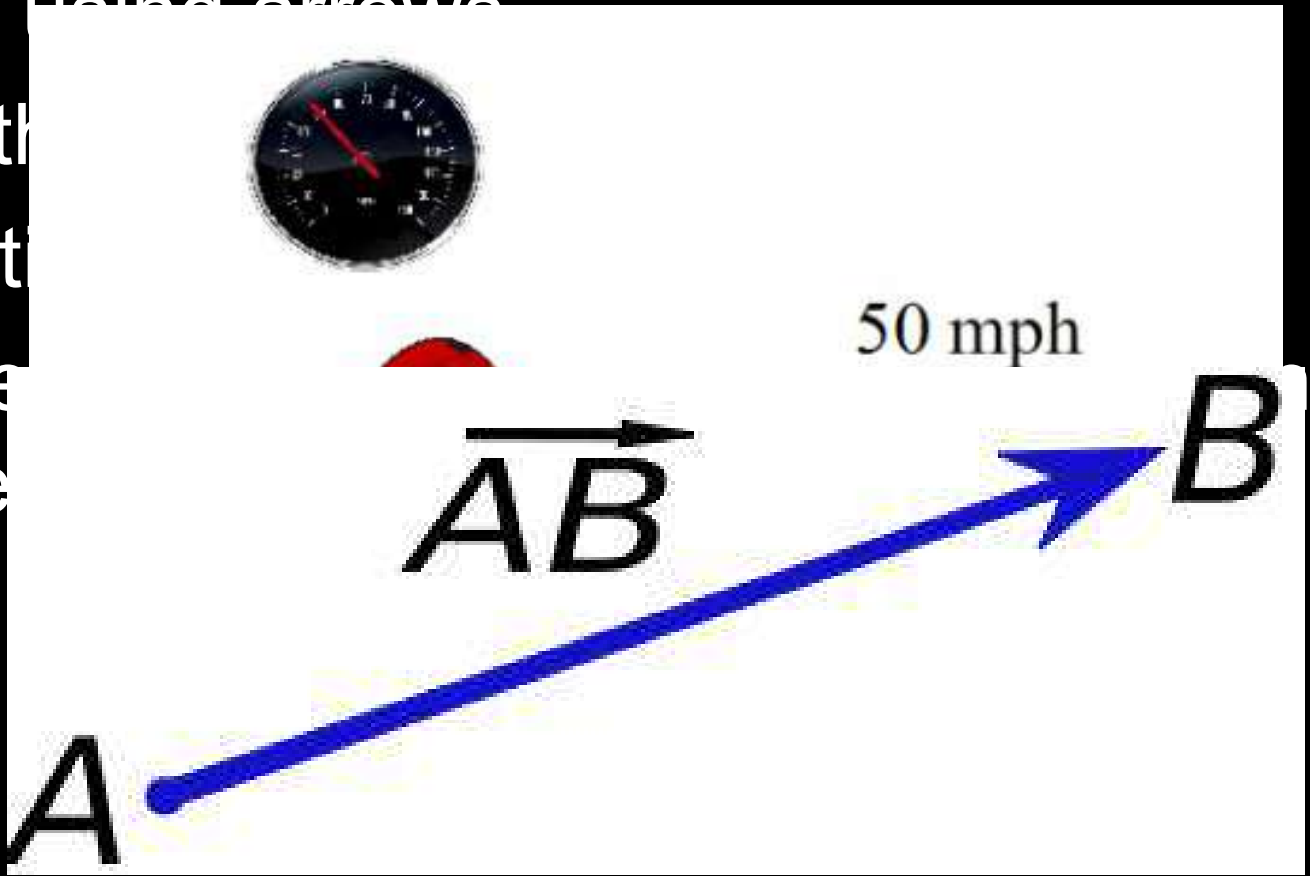
Vectors – magnitude and direction

Draw using arrows

Length

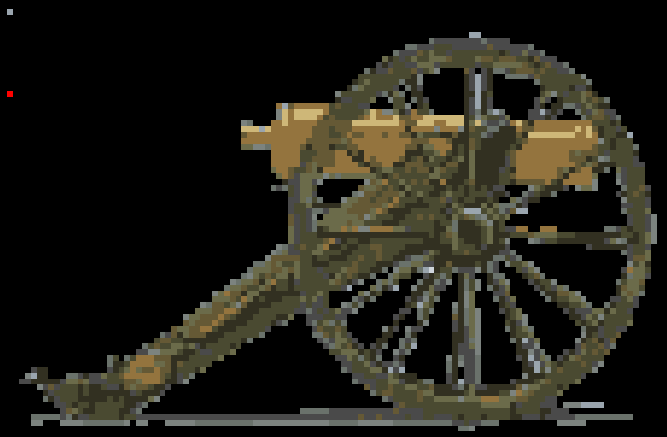
Direct

Repre arrow of the



Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors



AP Physics

Section 3-2 Addition of Vectors-Graphical Method

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

Used for estimating results

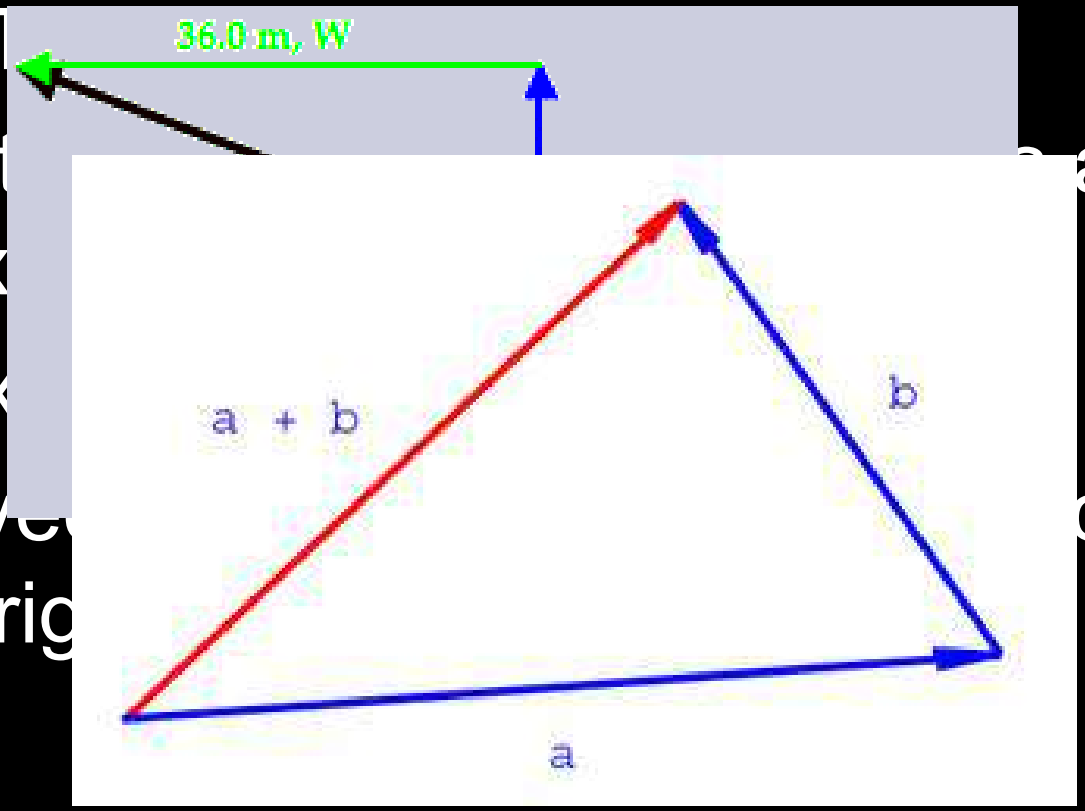
To verify validity of calculated results

Head to T

Draw first angle from x ax

Draw nex

After all ve ctor from start of orig



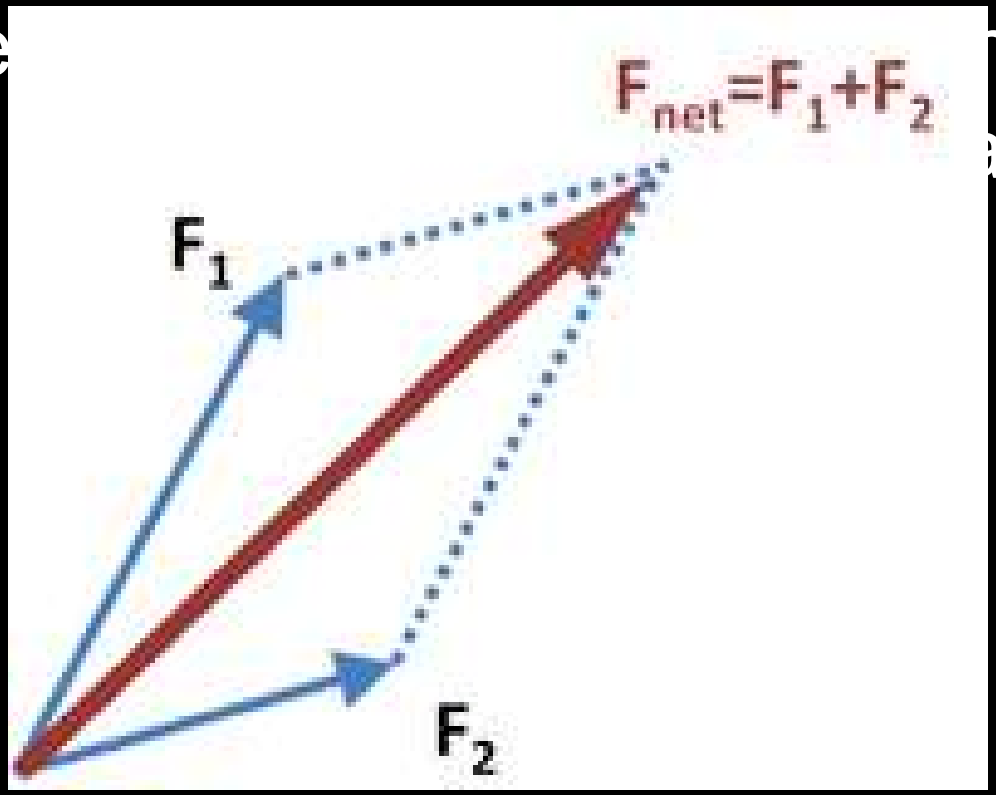
Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

Parallelogram method

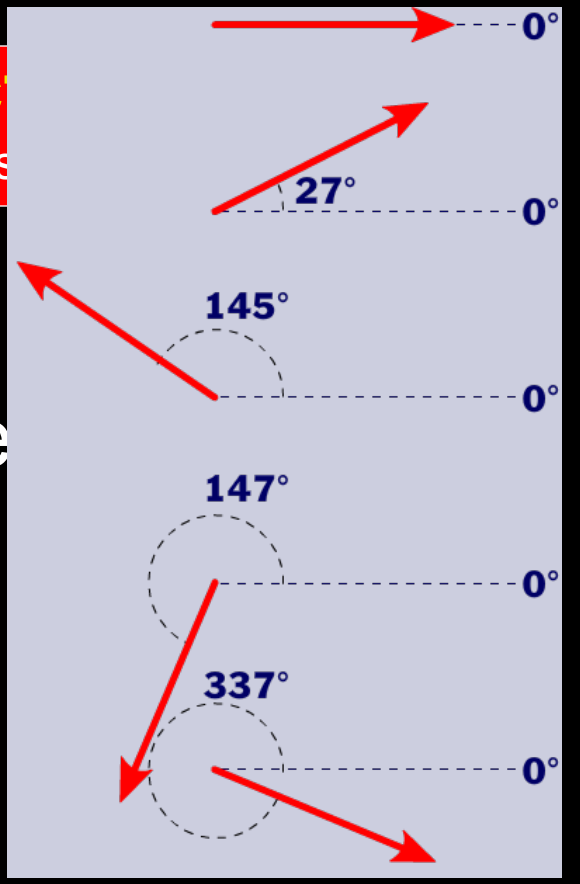
Construct a parallelogram using the two vectors to be added.

Draw a ve ng at the same orig adding



Kinematics in Two Dimensions; Vec

add, subtract, and resolve displacement and velocity vectors

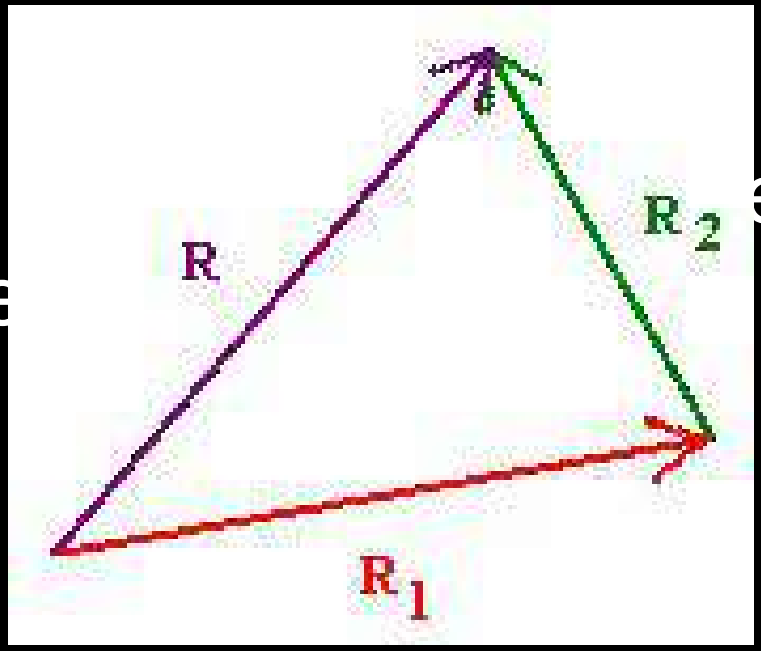


Note

Resultant Vector – the sum of the

Label the vectors with a symbol

The Resultant Vector is labeled



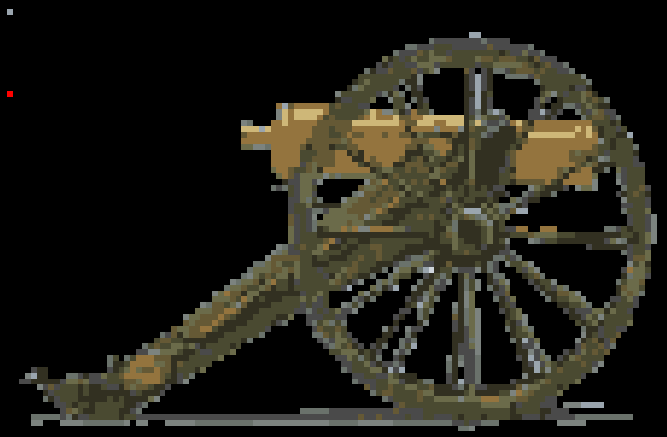
Always give ector (angle from positive

Practice Drawing Vectors

add, subtract, and resolve displacement and velocity vectors

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors



AP Physics

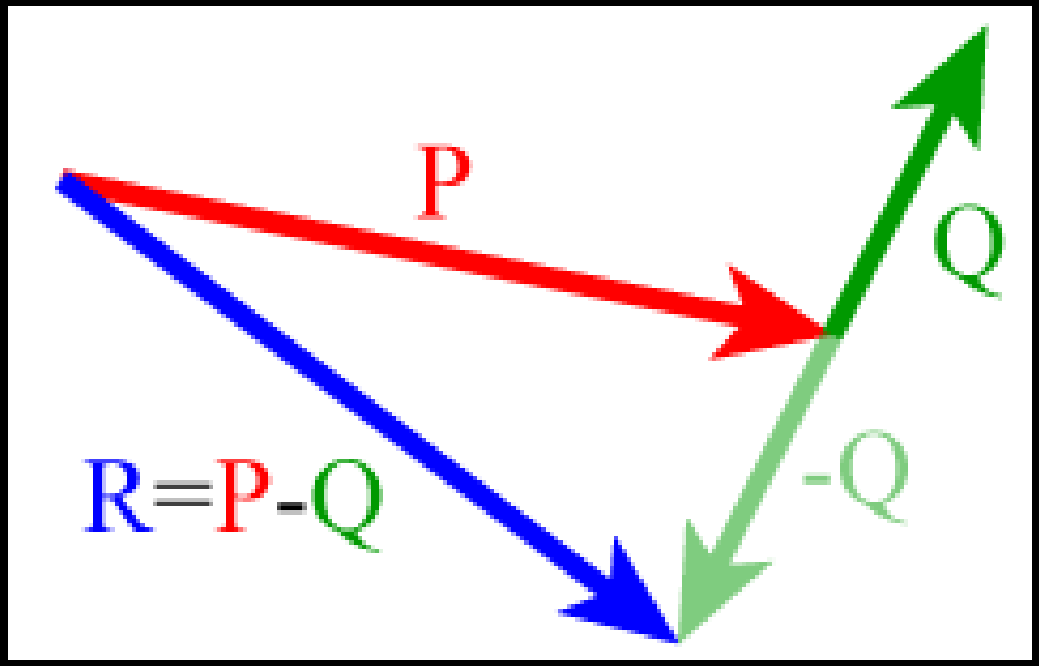
Section 3-3 Subtraction of Vectors and Multiplication of a Vector by a Scalar

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

To subtract a vector you add the negative of that vector

The negative of a vector has the same magnitude, but opposite (180^{o} difference) direction

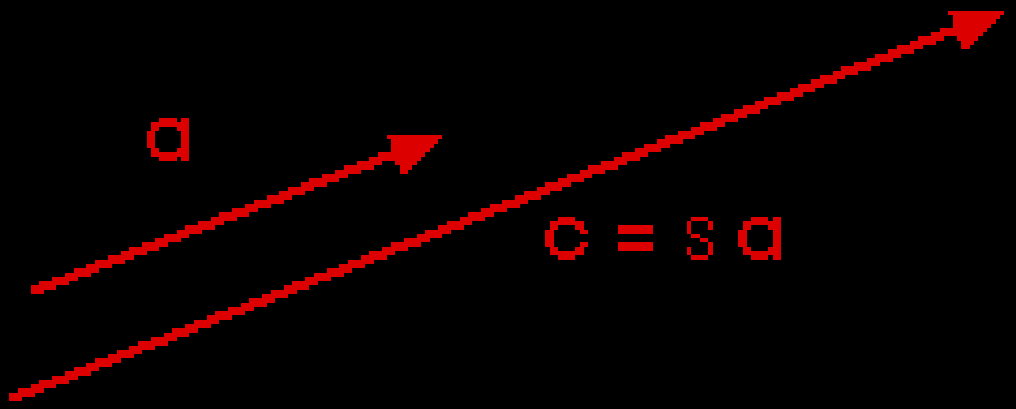


Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

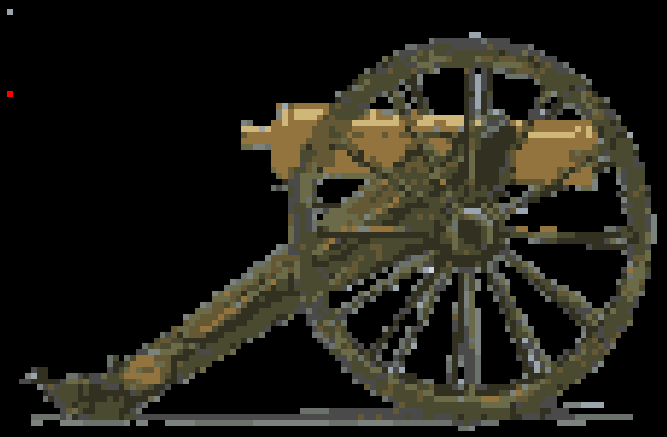
To multiply by a scalar, the magnitude is multiplied, the direction stays the same.

If multiplied by a negative scalar, the direction is opposite.



Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors



AP Physics

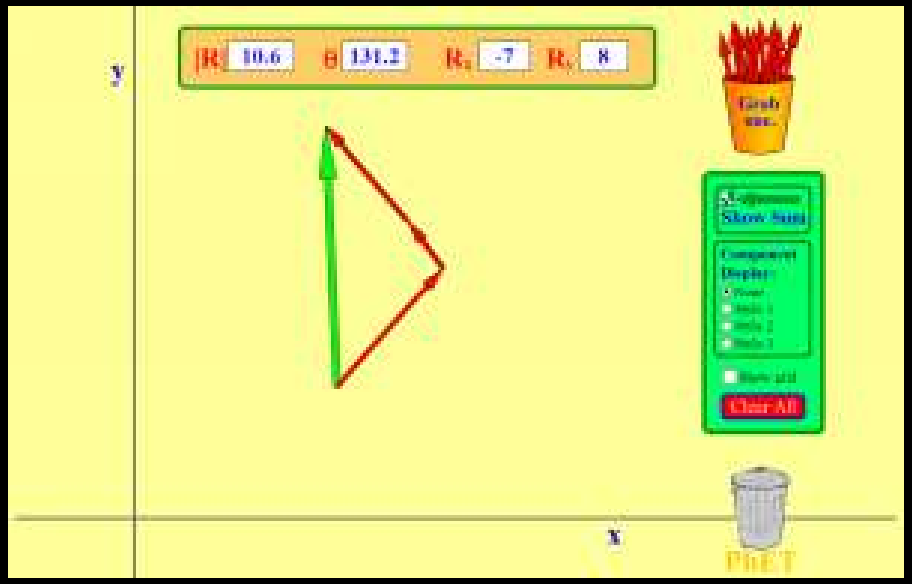
Section 3-4 Adding Vectors by Components

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

First resolve the vector into its components

The length in the x axis, and the length in the y axis



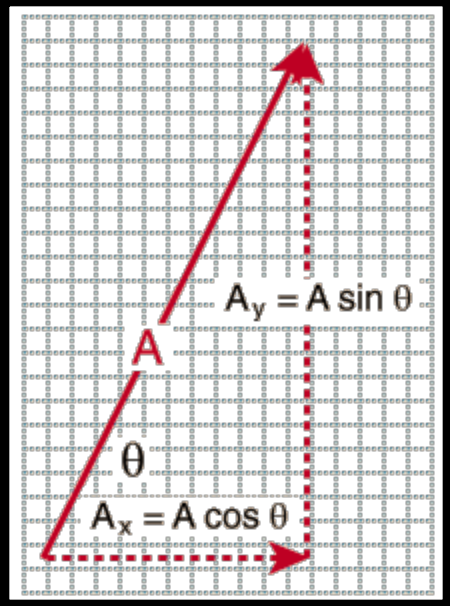
Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

Using trig, we can solve for the sides of a right triangle

One side is on the x-axis, one on the y-axis

The vector becomes the hypotenuse

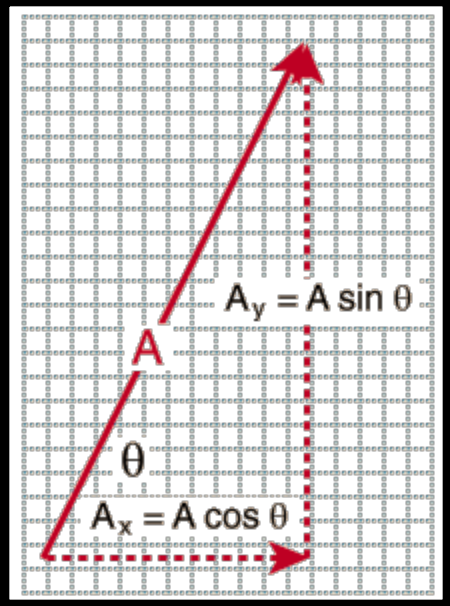


Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

If the vector is named $\vec{A}$

Using the equation for the adjacent side we solve for the x component of the vector



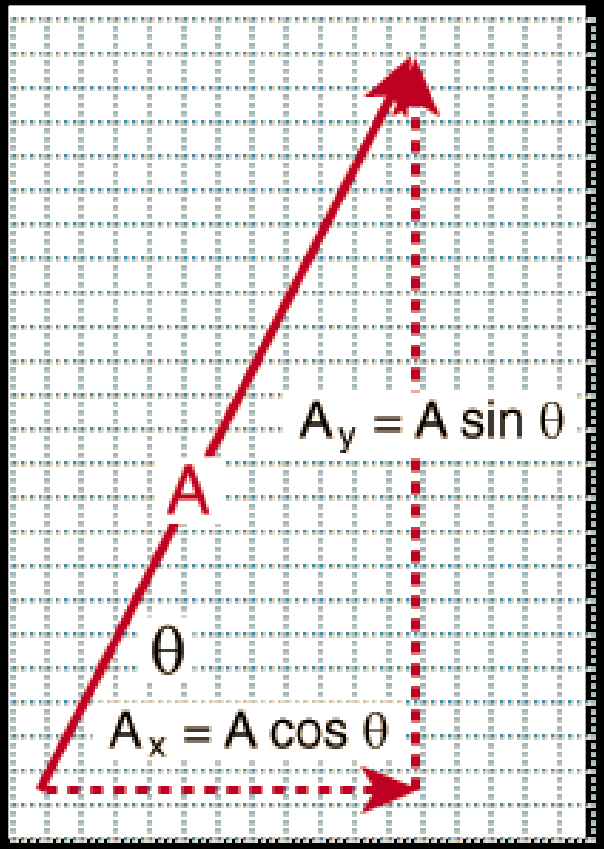
Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

$$\cos\theta = \frac{adjacent}{hypotenuse}$$

$$\cos\theta = \frac{A_x}{A}$$

$$A_x = A\cos\theta$$

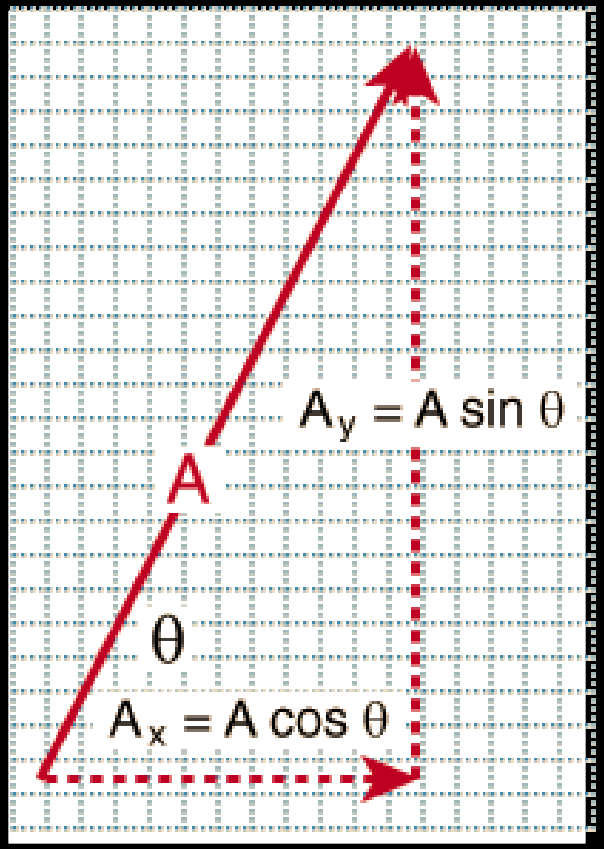


Same logic for y component

$$\sin\theta = \frac{opposite}{hypotenuse}$$

$$\sin\theta = \frac{Ay}{A}$$

$$A_y = A\sin\theta$$



Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

Each vector is resolved into it's components

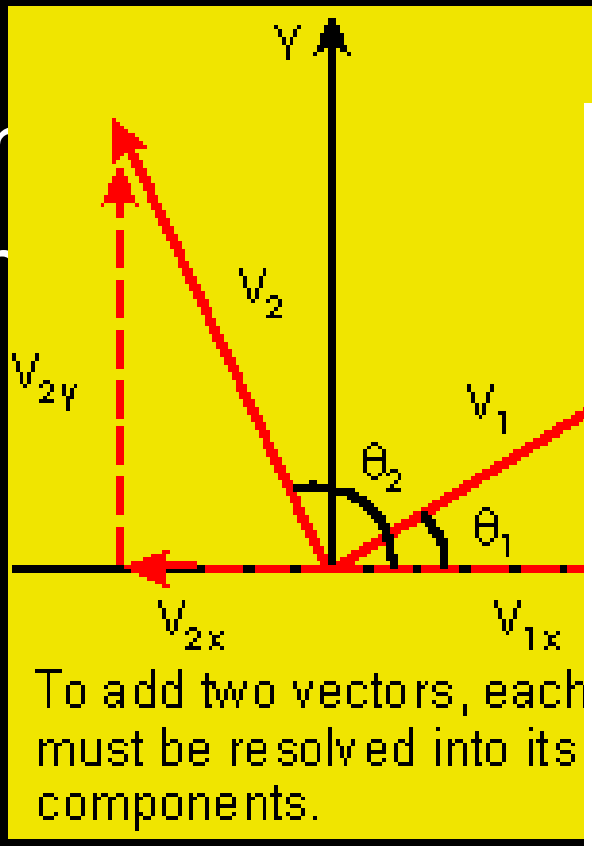
You must be consistent with your x/y axis

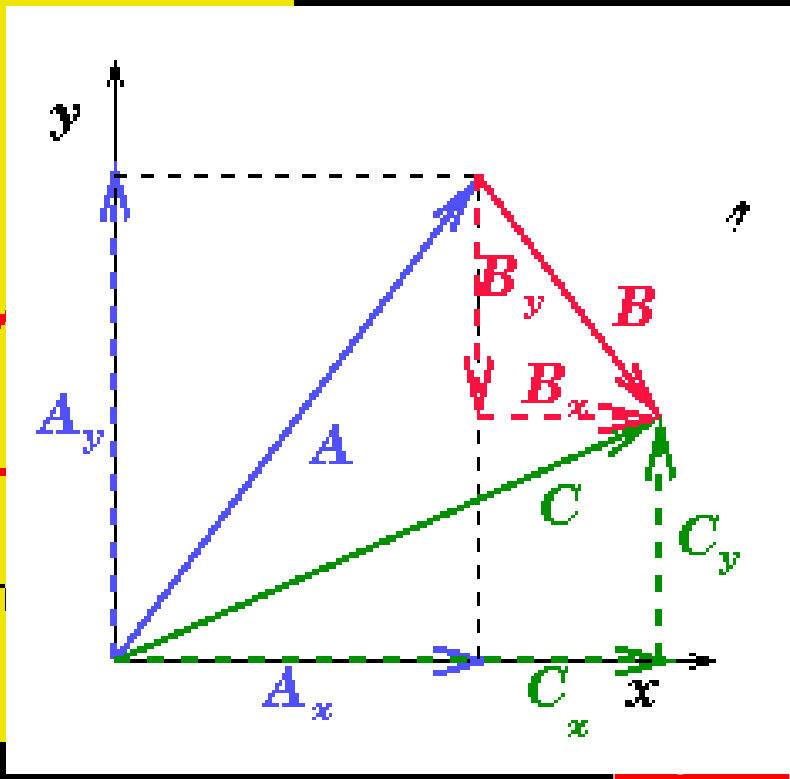
Now we add n the x

with each oth

Then all of th

in the y with

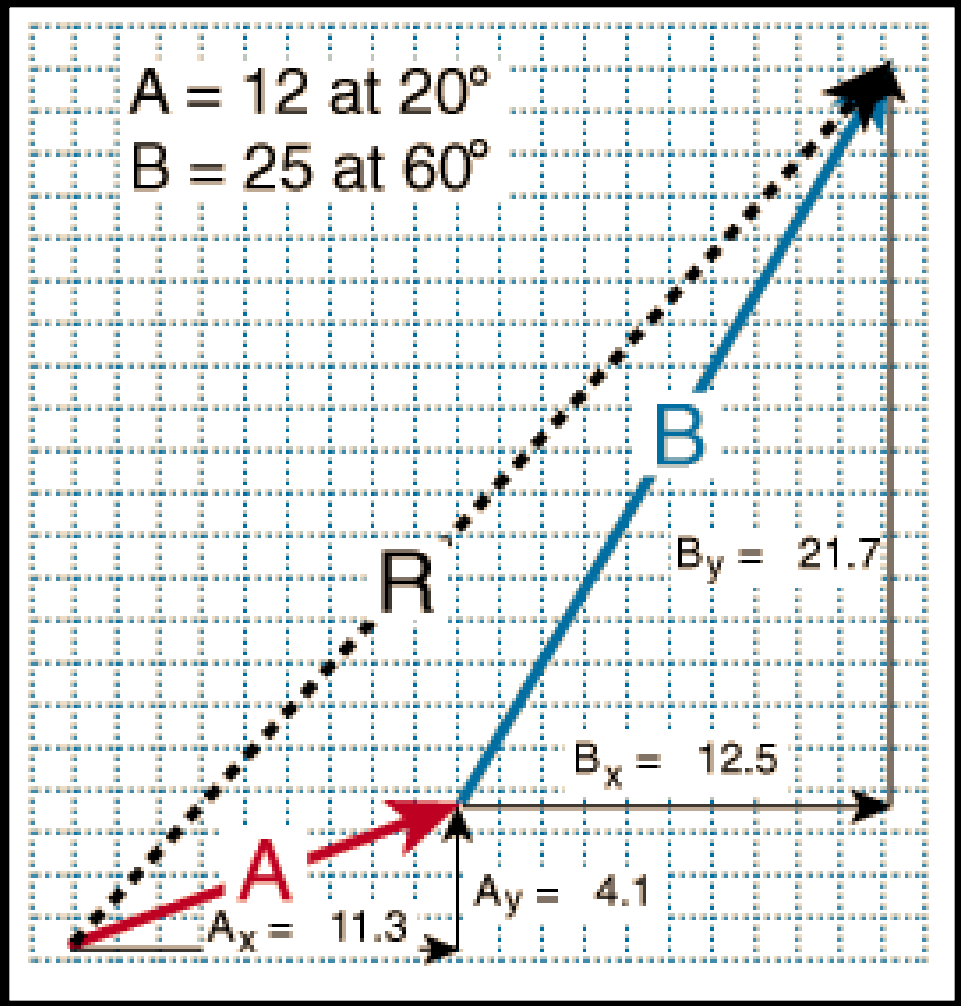




Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

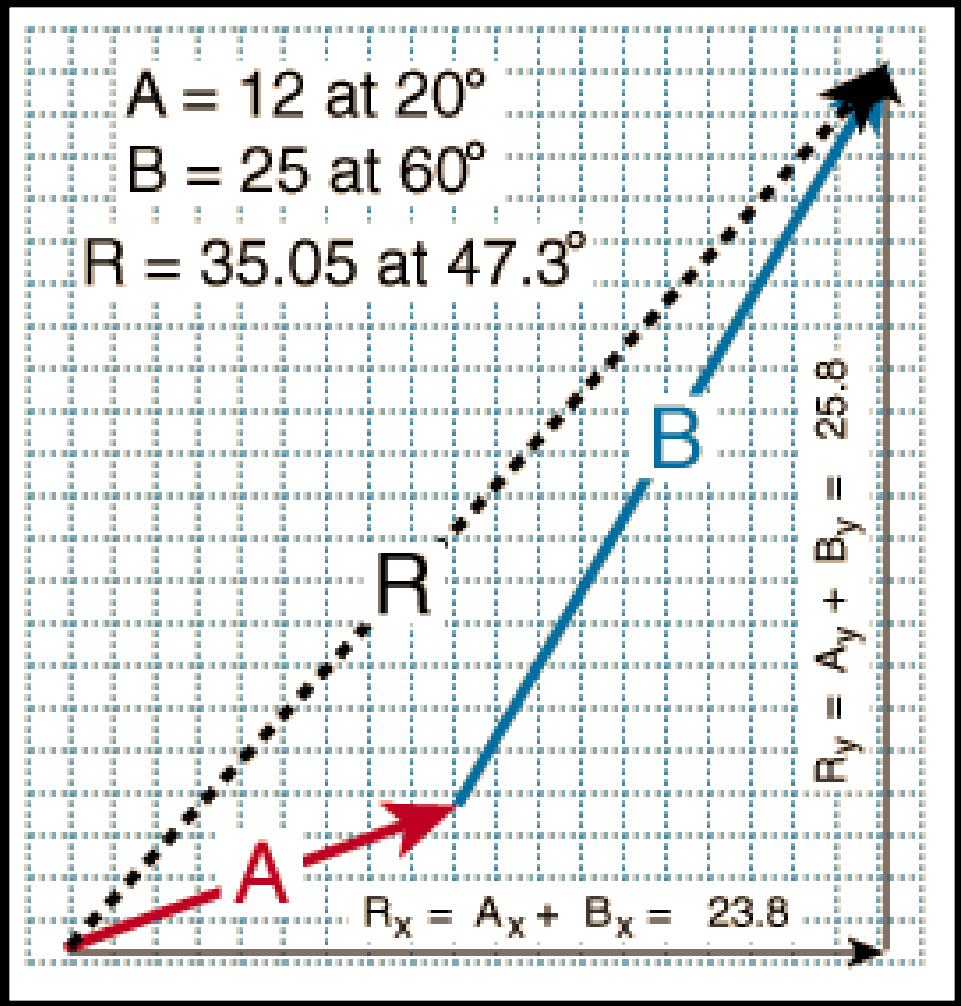
We are calculating the total change in the x and the y



Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

We then know the components of the resultant vector



Practice Resolving Vectors

add, subtract, and resolve displacement and velocity vectors

A-8

A flashy hog of dubious lineage runs at 45 m/s and an angle of 37° to the x axis. What is the x-component of his velocity? What is the y-component?

The equation for the components of the resultant

$$R_x = A_x + B_x$$

$$R_y = A_y + B_y$$

Kinematics in Two Dimensions; Vectors

add, subtract, and resolve displacement and velocity vectors

Now we will use the Pythagorean theorem to calculate the magnitude of the Resultant vector

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

$$R^2 = R_x^2 + R_y^2$$

$$R = \sqrt{R_x^2 + R_y^2}$$

The direction is given as an angle from the positive x-axis, calculate using tangent function

$$\tan\theta = \frac{opposite}{adjacent}$$

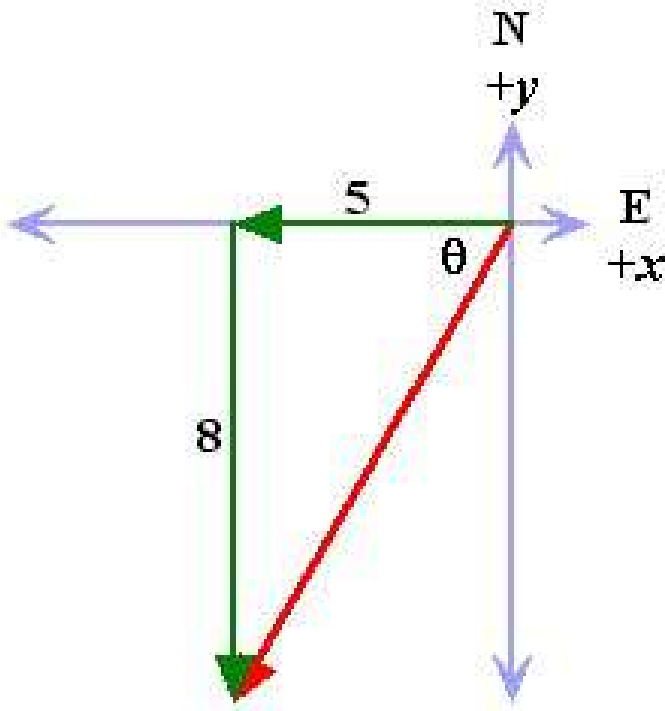
$$\tan\theta = \frac{R_y}{R_x}$$

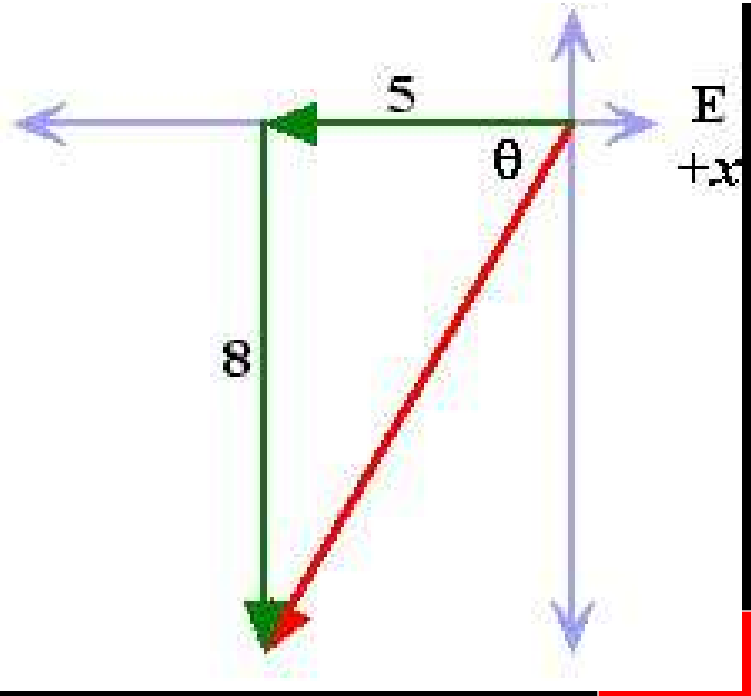
$$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$$

Kinematics in Two Dimensions; V

add, subtract, and resolve displacement and velocity ve

- The only time you have to think component is negative
- The angle you calculate will be from the negative x-axis
- In that case, add 180° to you that it is measured from the
- Unless otherwise noted, all a given from the positive x-axi counterclockwise being the



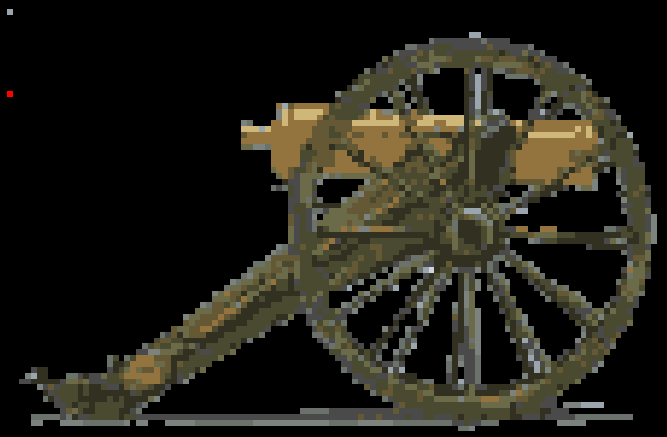


Practice Adding Vectors

add, subtract, and resolve displacement and velocity vectors

Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field



AP Physics

Section 3-5 Projectile Motion

Standard

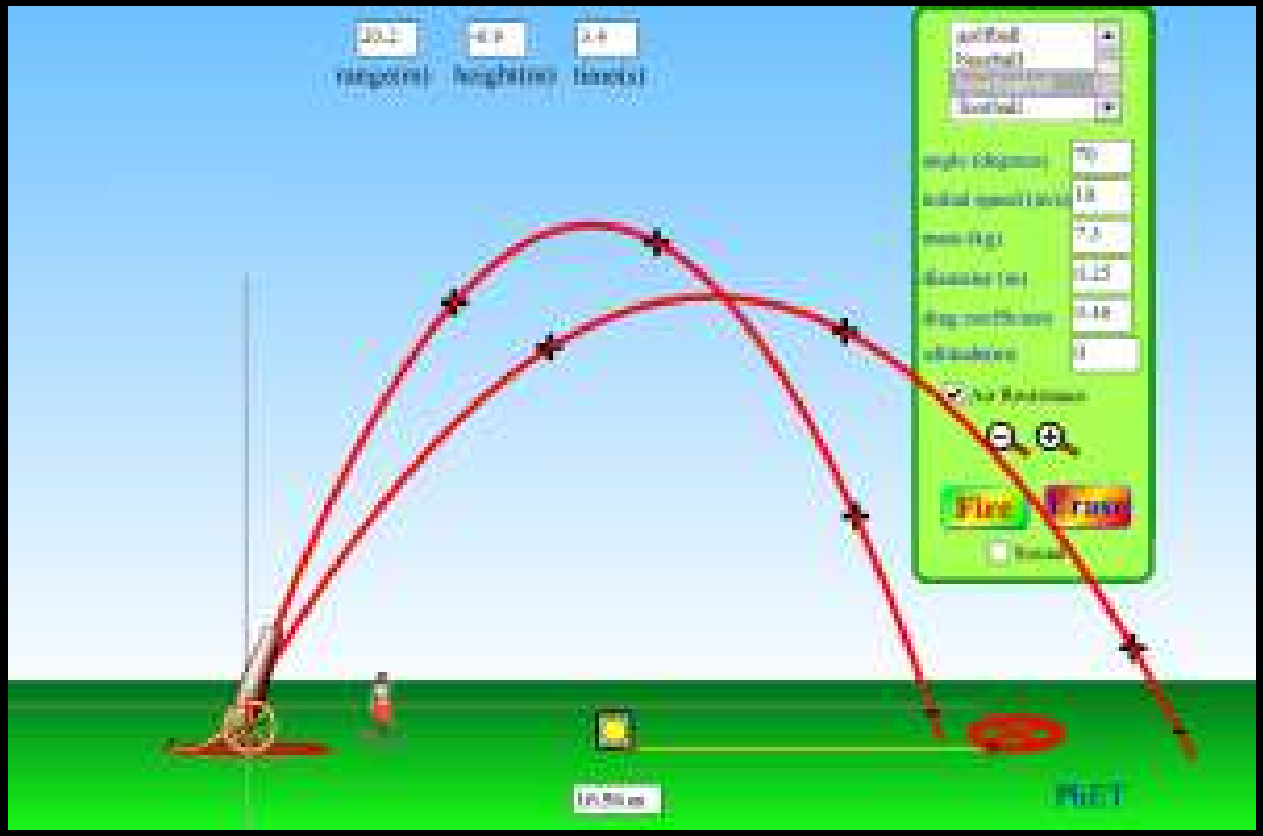
IA2c

Students should understand the motion of projectiles in a uniform gravitational field.

Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

Projectile – object moving through space under the influence of gravity

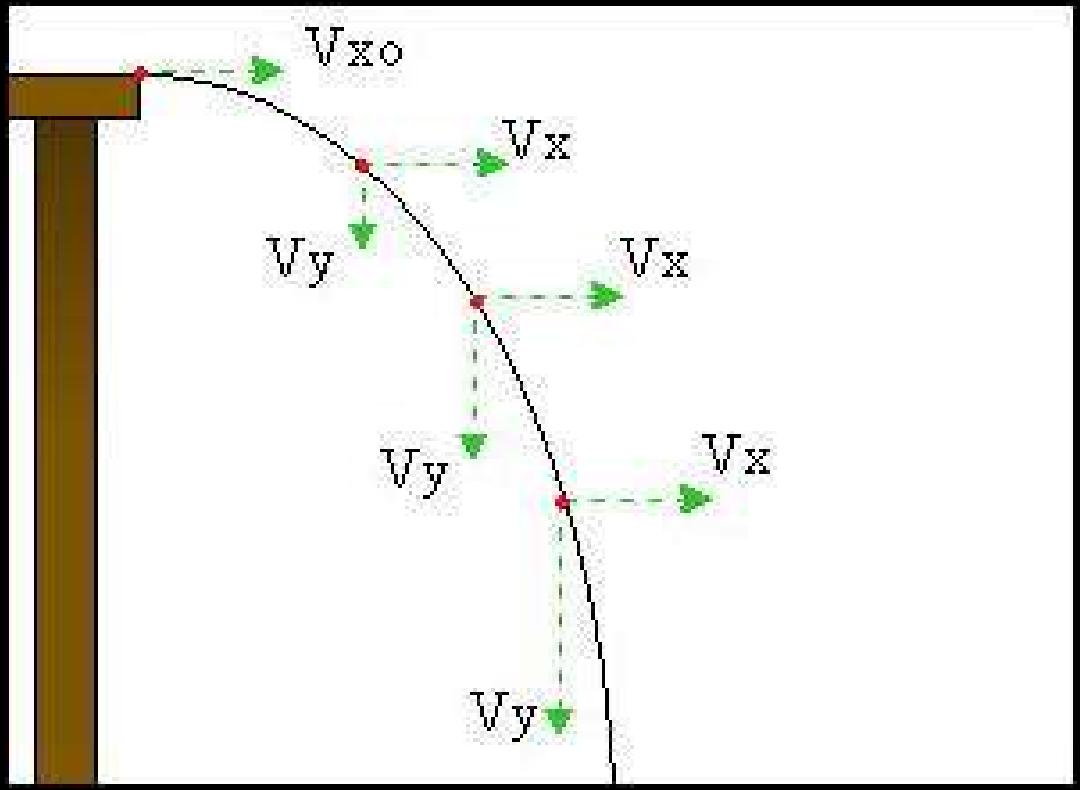


Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

We will deal with the projectile after it is launched and before it hits the ground

We will analyze horizontal and vertical components separately

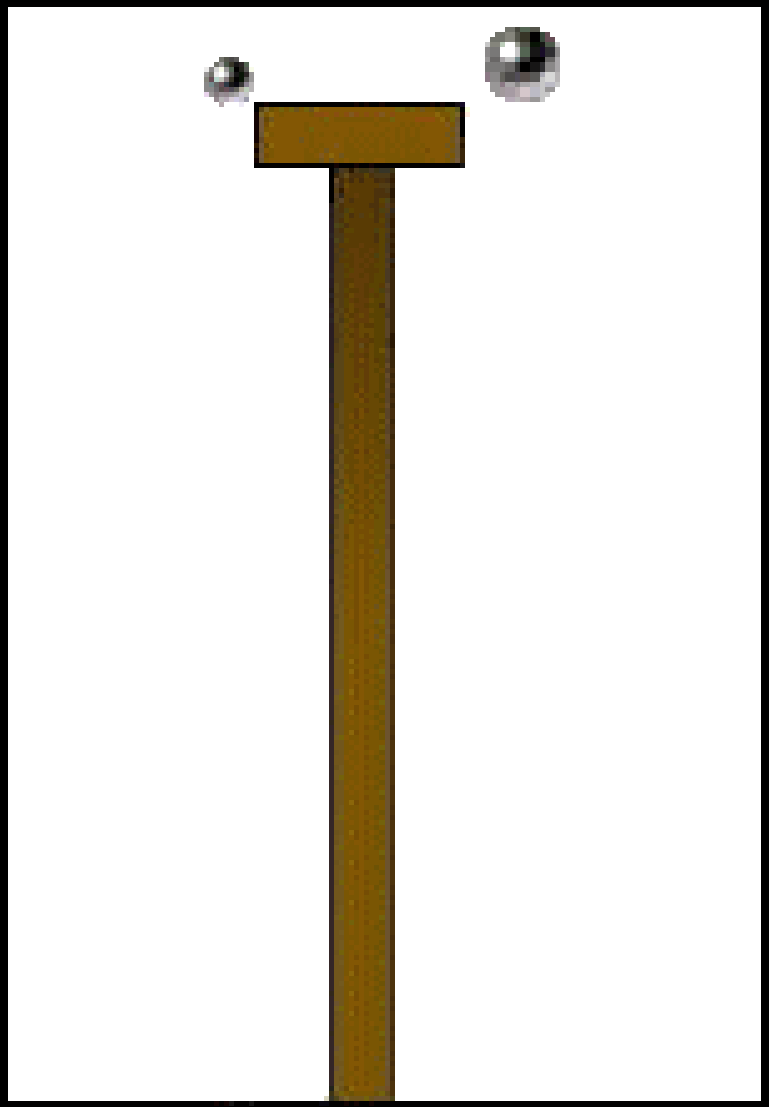


Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

In the y-axis the projectile accelerates at -9.80m/s^2

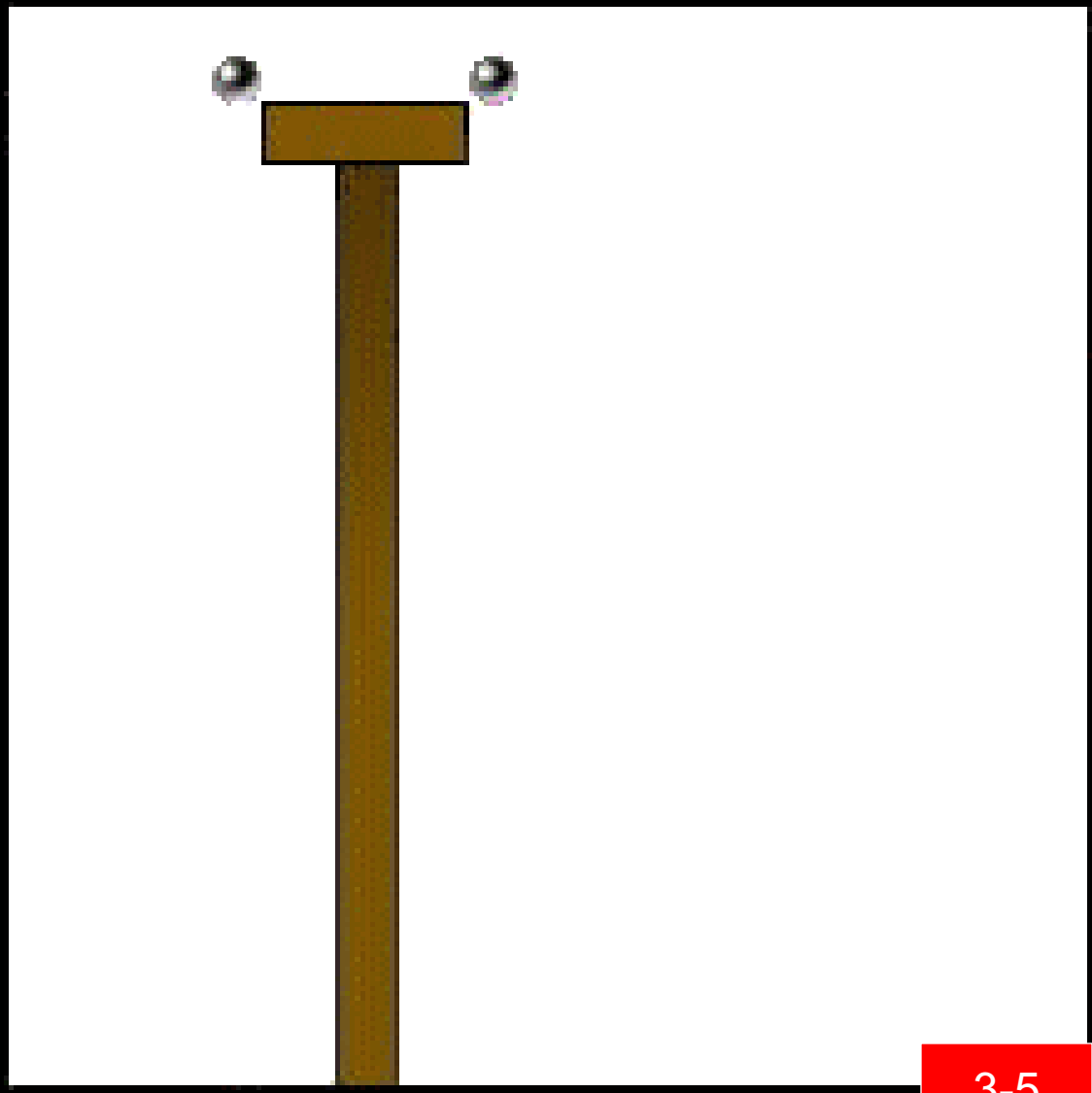
This is independent of the shape or mass of the object (we ignore air friction)



Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

It is also independent of any motion in the x-axis

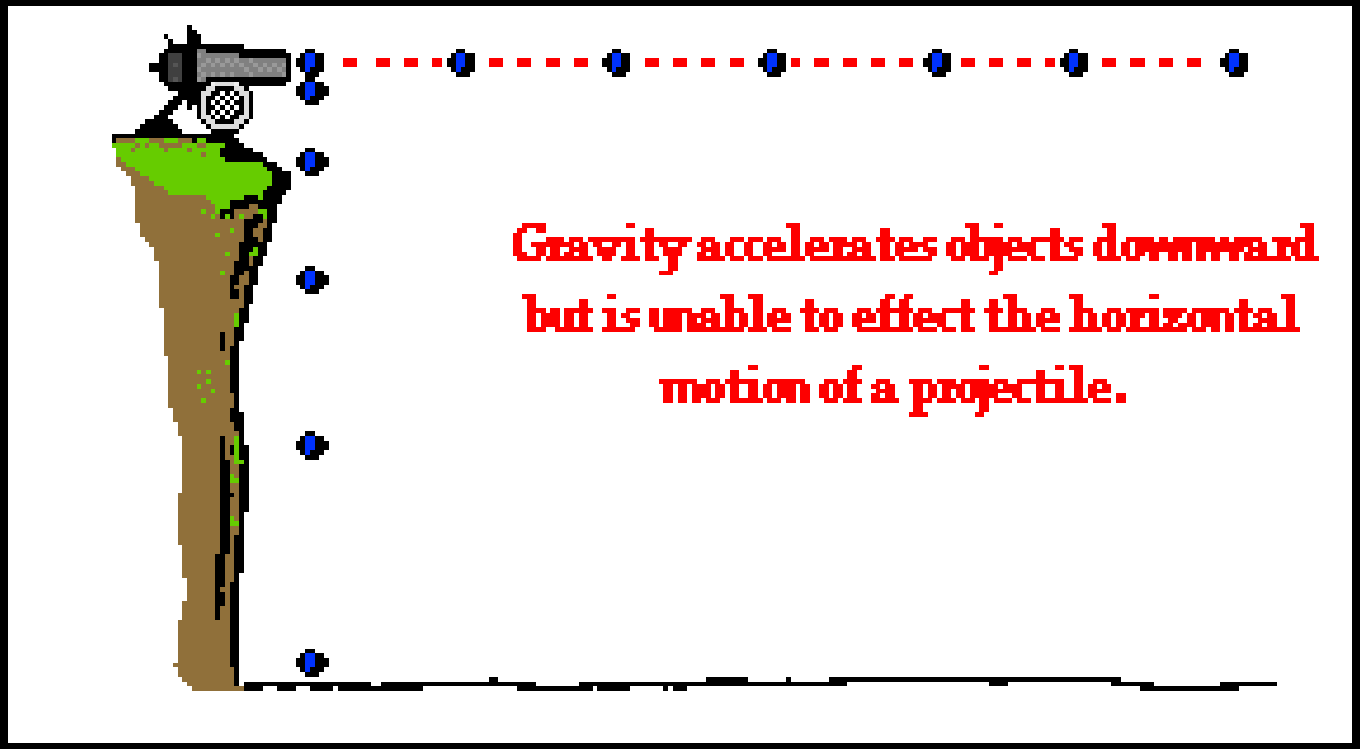


Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

We use all the equations for motion with constant acceleration in the y-axis

In the x axis, the projectile does not accelerate (if we ignore air friction)



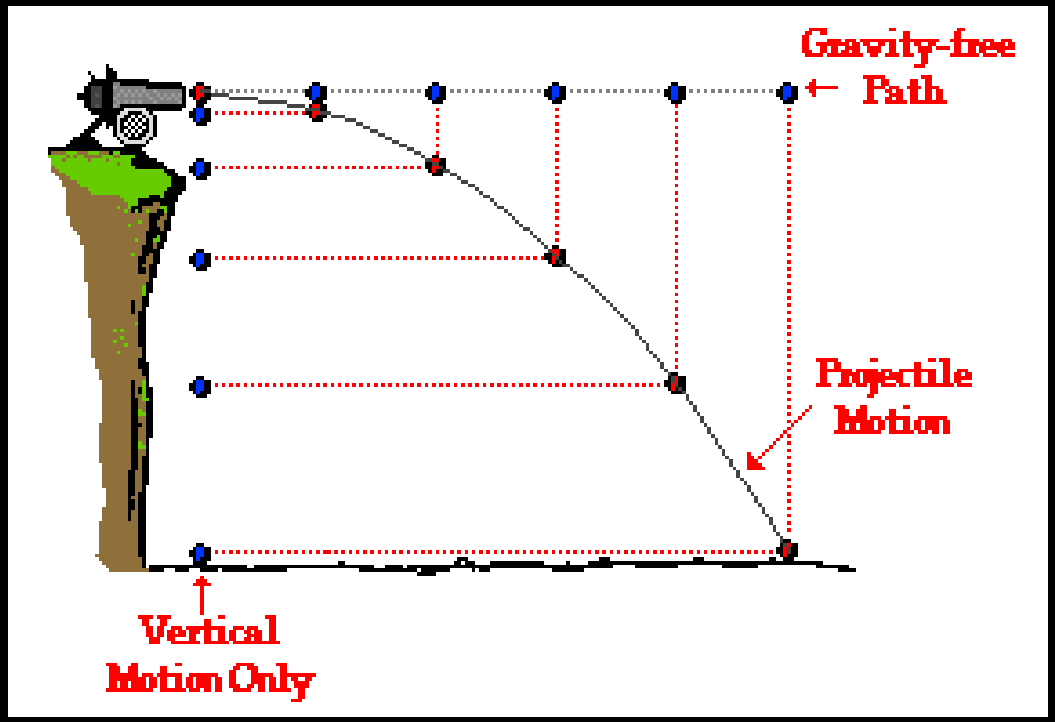
Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

The only motion equation for the x-axis is then

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

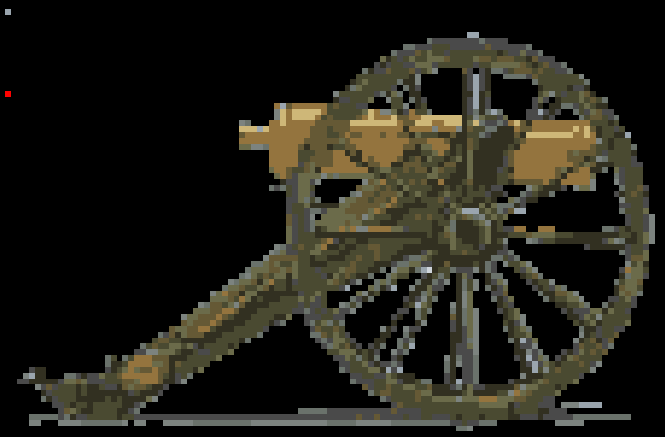
When we combine these actions we get an object moving as a projectile



Click for Simulation

Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field



AP Physics

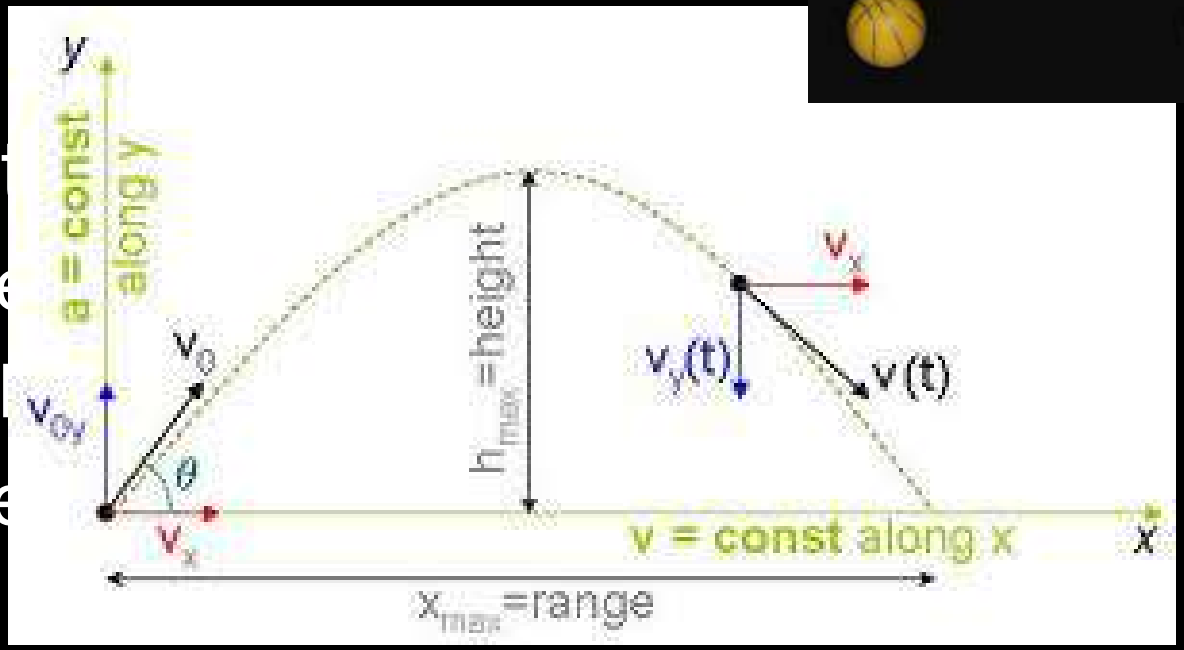
Section 3-6 Solving Problems Involving Projectile Motion

Kinematics in Two Dimensions; Vectors

understand the motion of projectiles in a uniform gravitational field

Steps in problem solving

1. Draw a diagram
2. Choose an origin and xy coordin
   system
3. Choose a t
   a. Only while
   b. Must be t
   c. This is the x
      and the y



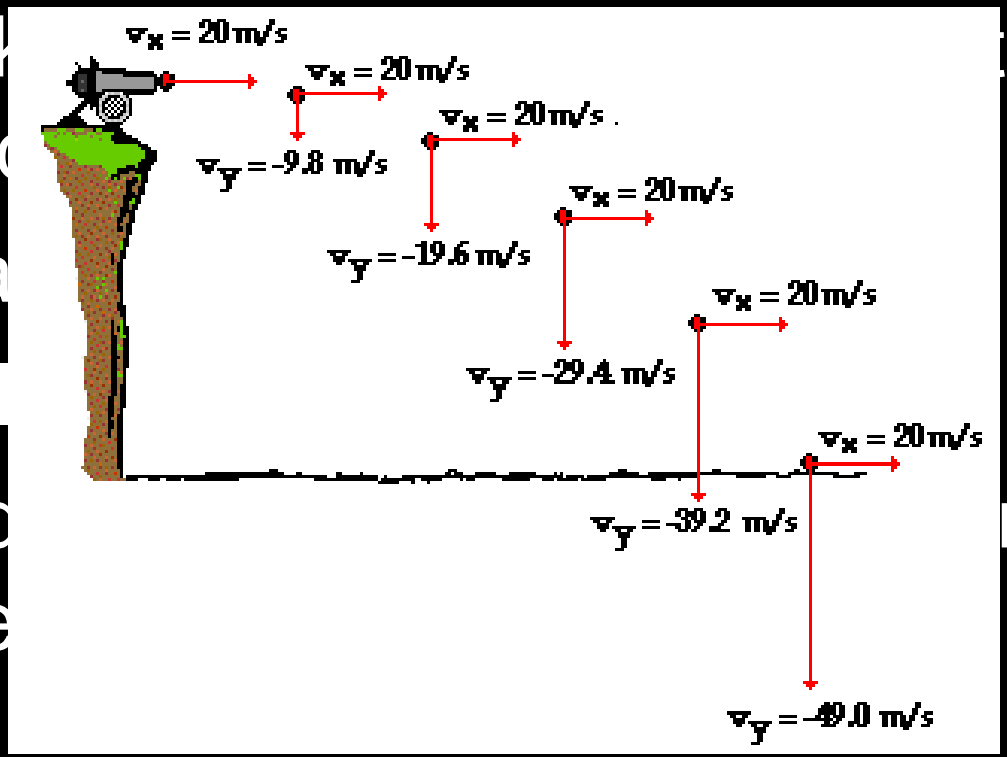
Kinematics in Two Dimens

understand the motion of projectiles in a ur

X-Axis	Y-Axis
t=	t=
V_x=	V_{y0}=
X=	Y=
	a=-9.80m/s^2
	V_y=

Steps in problem solving

4. Break given values i components
5. List the k tities in the x and
   a. Accelera
   b. No accel
6. Stop and roblem, visualize



Practice with Projectile Motion

understand the motion of projectiles in a uniform gravitational field

A-9

A highly trained attack squirrel jumps off a cliff that is 25 m tall (assume initial velocity of zero). Two Seconds later, the rest of his team jumps off. What must be their initial velocity so they all land at the same time?

Practice with Projectile Motion

understand the motion of projectiles in a uniform gravitational field

A-10

A cow accidentally dances off a cliff that is 350 m tall. If she leaves the cliff with a velocity of 120m/s @ 72^{o}, what is her final displacement when she hits the ground?

Practice with Projectile Motion

understand the motion of projectiles in a uniform gravitational field

A-11

A hamster dropkicks a walrus with an initial velocity of 312 m/s @ 62°.

A. What is the maximum height that the walrus reaches?

B. What is the velocity at this point?

C. What is the acceleration at this point?

Practice with Projectile Motion

understand the motion of projectiles in a uniform gravitational field

A-12

en
red
w at

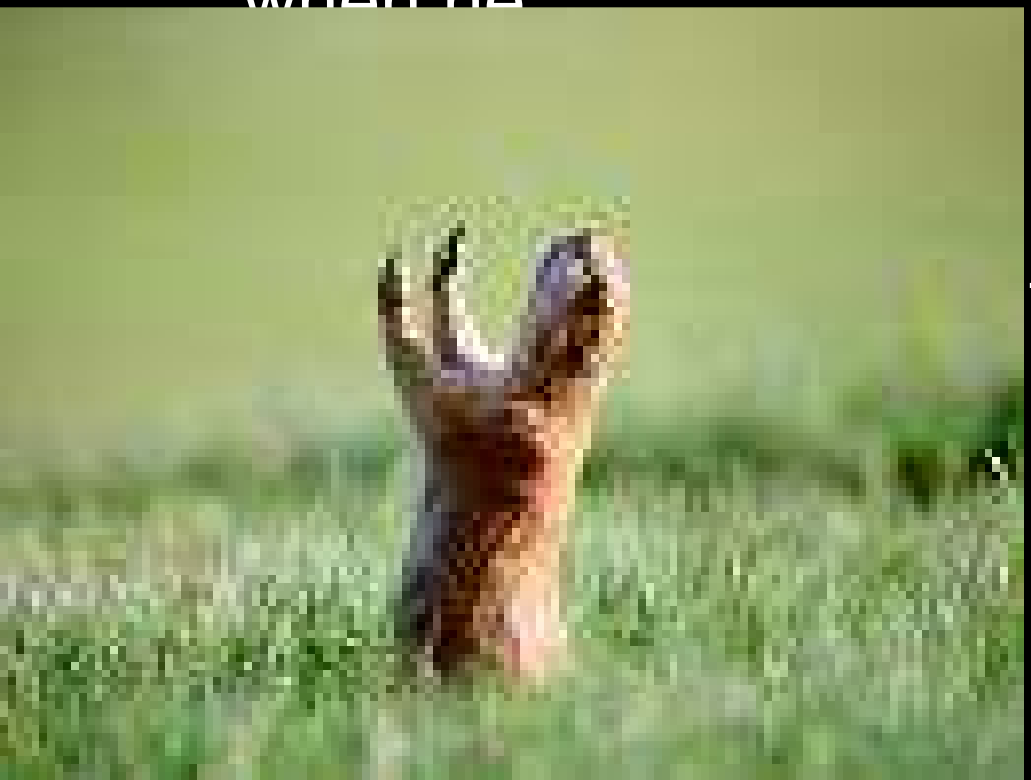
the mean dog next door. If the gun is held level 2.5 m above the ground and shoots a bullet with an initial velocity of 1000 m/s, how far will the bullet travel before it hits the ground?

Practice with Projectile Motion

understand the motion of projectiles in a uniform gravitational field

A-13

A gopher is out worshipping the sun god,
when a bird swoops down and grabs him.
The bird is climbing with a velocity of 55 m/s @ 62°
when he



time, with what velocity

Practice with Projectile Motion

understand the motion of projectiles in a uniform gravitational field

A-9

Test Day

Happy Dance

A-7

A cat jumps off a ski slope that is 14.5 m above the ground. If his launch velocity is 35 m/s @ 40^{o}

A. How long is he in the air
B. How far down range does he get
C. What is his velocity at the maximum height?

A-10

A dog is driving down the road at 45 m/s with his head out of the window.

If he shoots a large dog biscuit out of the right window with a velocity of 25 m/s and a height of 1.2 m, how far from the car will it land?

A-13

A very sad looking rabbit is thrown upward with an initial velocity of 200 m/s @ 72^{o}.

What is the maximum height he reaches?

What is his velocity at that maximum height?