DEVIL PHYSICS

THE BADDEST CLASS ON CAMPUS

AP PHYSICS

LSN 3-4: ADDING VECTORS BY COMPONENTS

Questions From Reading Activity?

Big Idea(s):

- The interactions of an object with other objects can be described by forces.

Enduring Understanding(s):

- All forces share certain common characteristics when considered by observers in inertial reference frames.
- Classically, the acceleration of an object interacting with other objects can be predicted by using

$$\vec{a} = \frac{\vec{F}}{m}$$

Essential Knowledge(s):

- *Forces are described by vectors.*
  - Forces are detected by their influence on the motion of an object.
  - Forces have magnitude and direction.
- If an object of interest interacts with several other objects, *the net force is the vector sum of the individual forces*.

Learning Objective(s):

- The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.

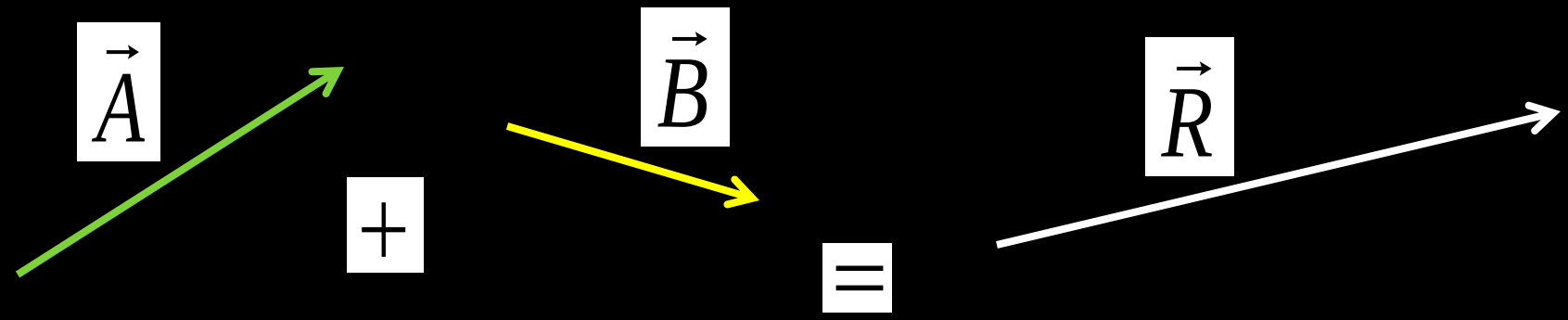
Learning Objective(s):

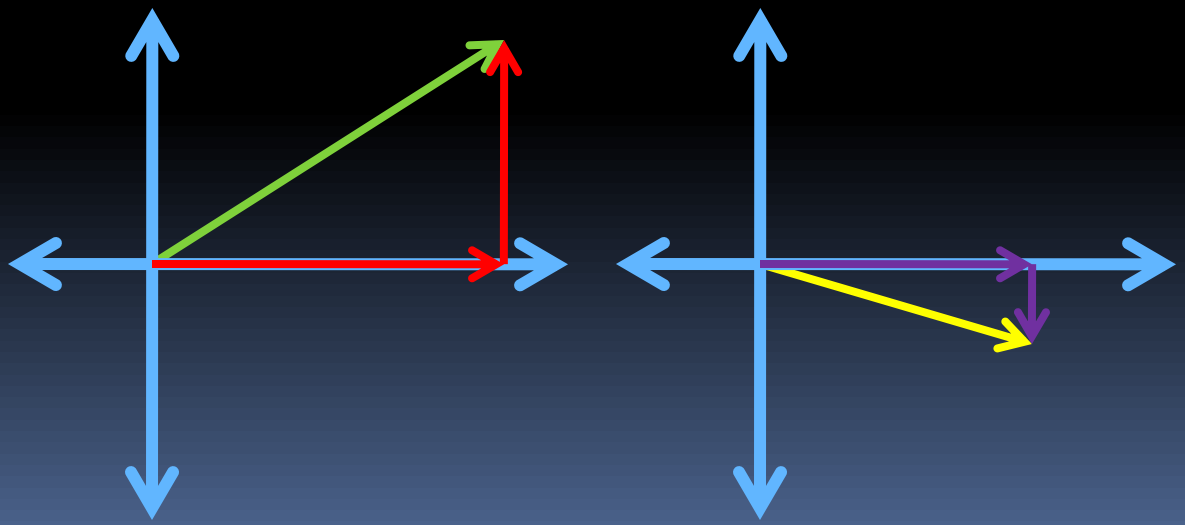
- The student is able to design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces.

Objectives

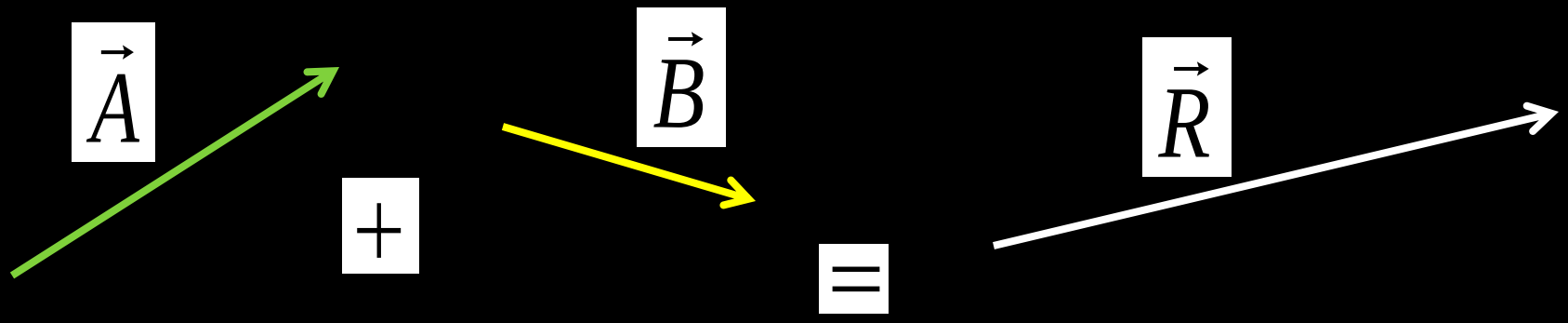
- Use trigonometry to find the x- and y-components of a given vector.
- Add two vectors by adding their components to find the components of the resultant.
- Use $\tan^{-1}$ to find the direction of the resultant and Pythagorean Theorem to find the magnitude.

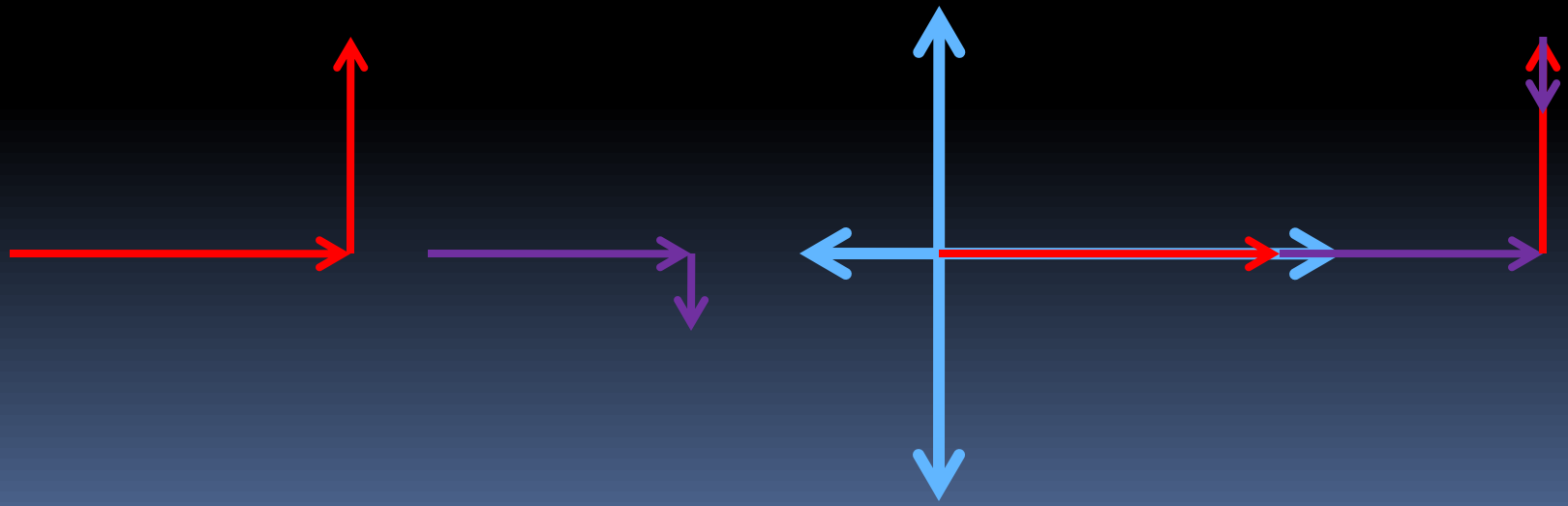
Adding Vectors Head-To-Tail by Components



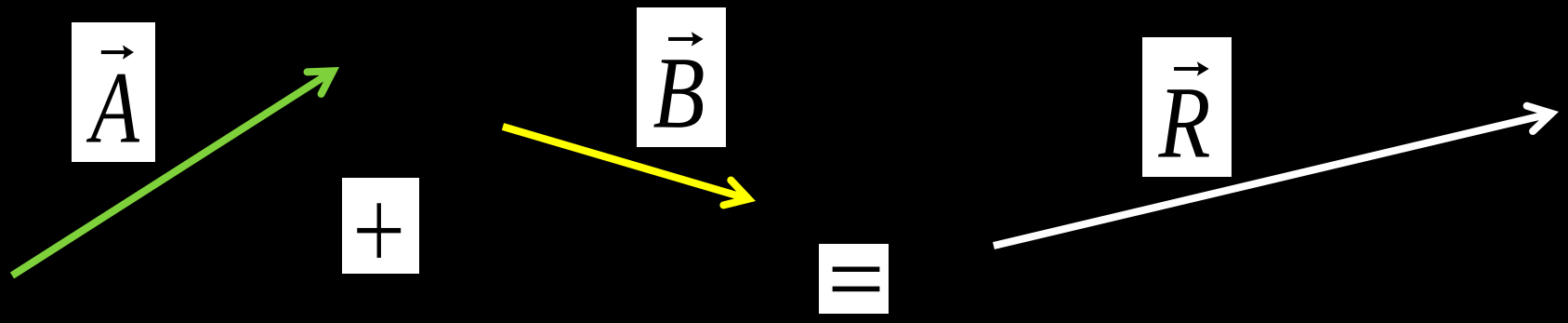


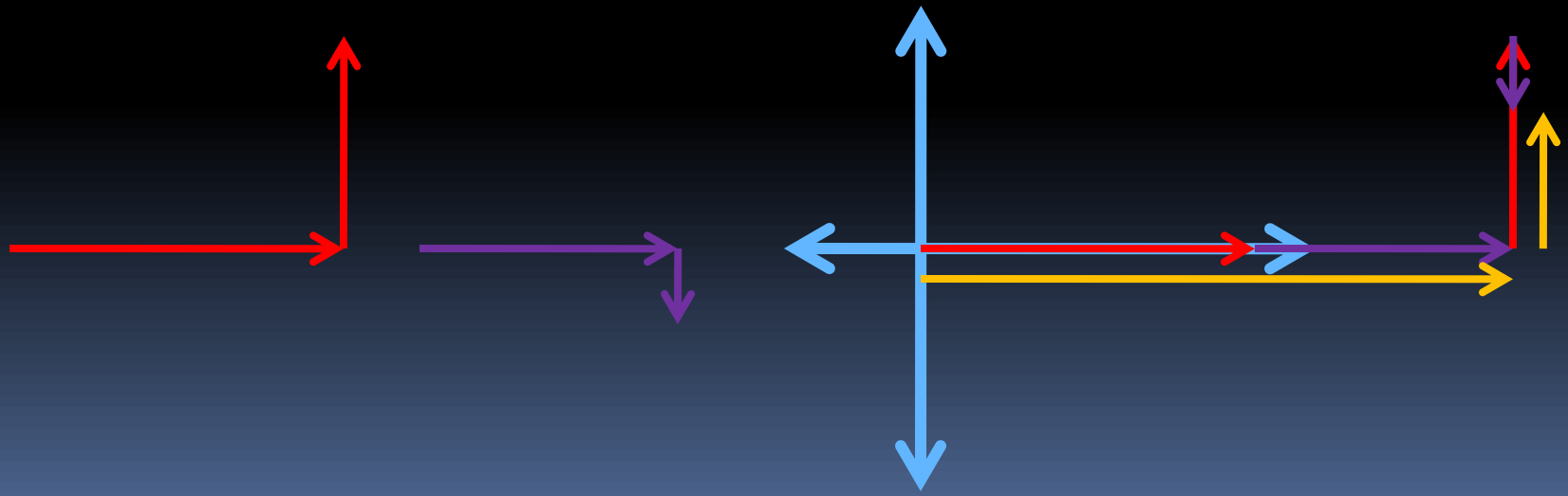
Adding Vectors Head-To-Tail by Components



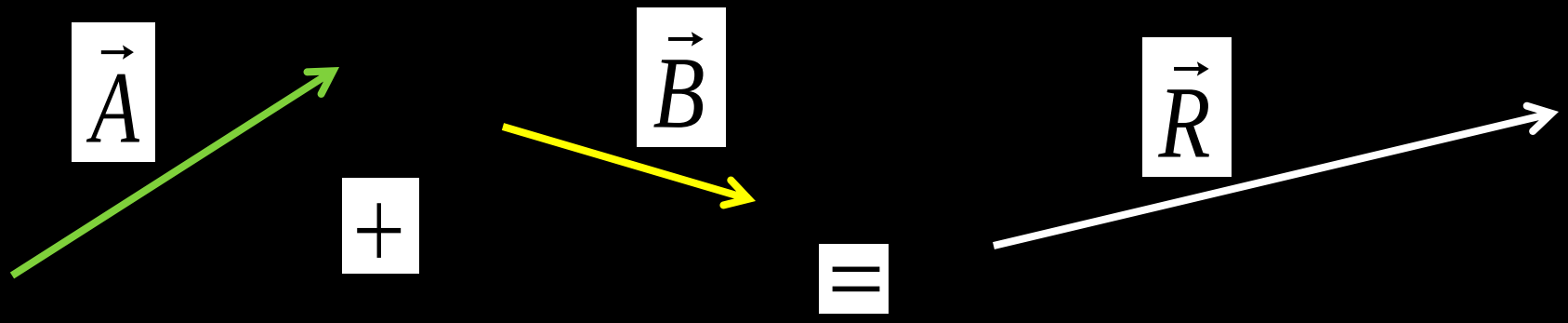


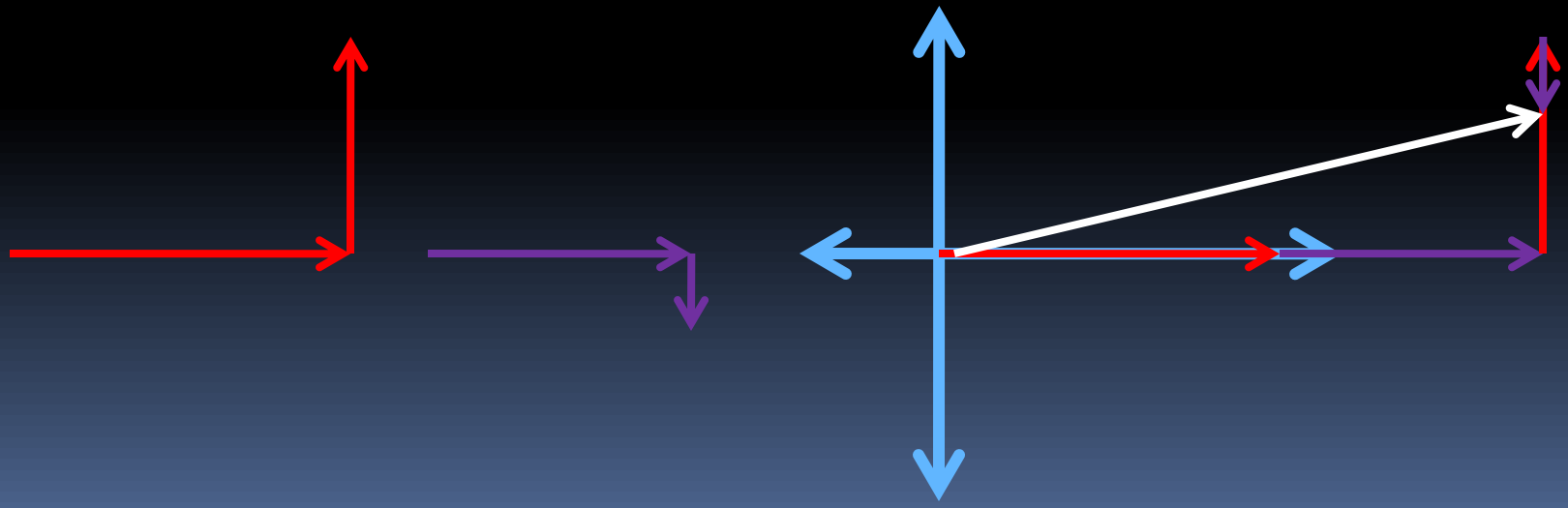
Adding Vectors Head-To-Tail by Components



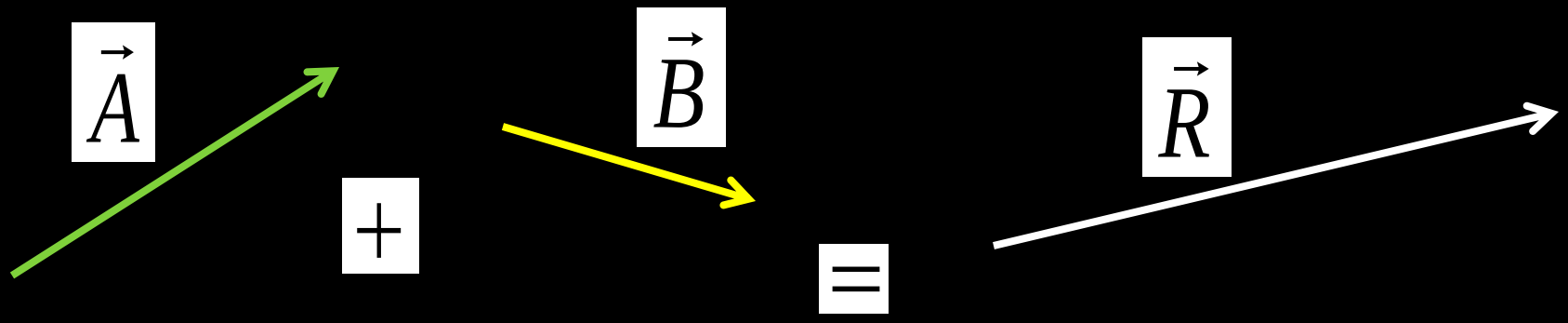


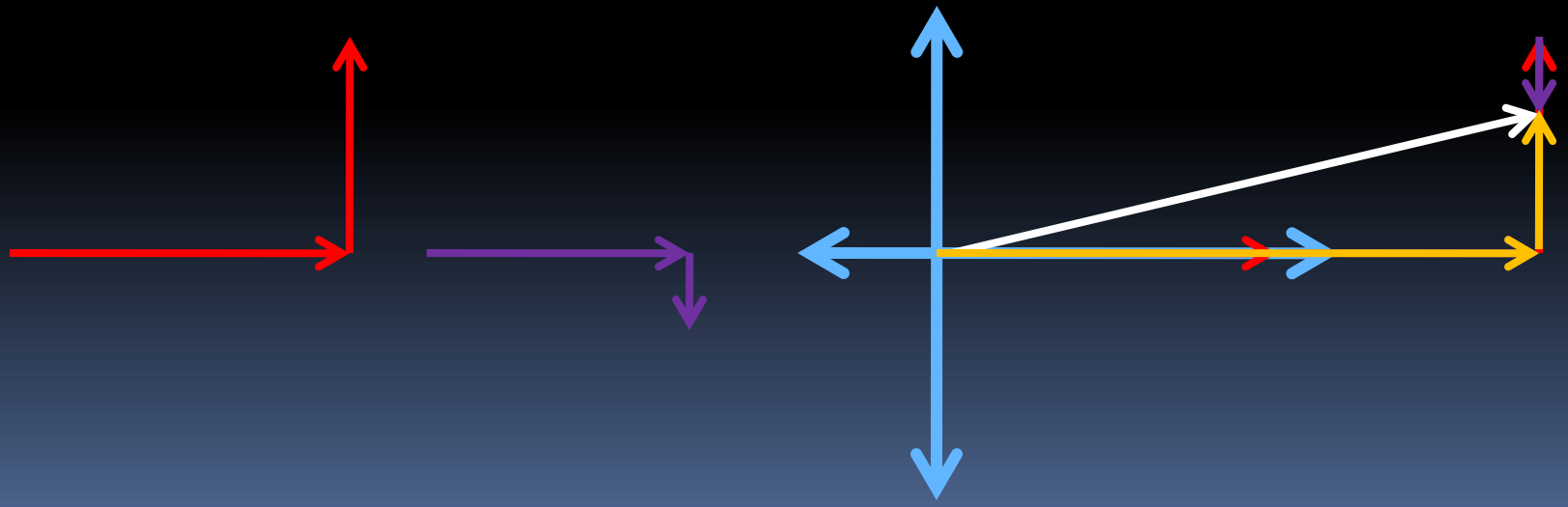
Adding Vectors Head-To-Tail by Components



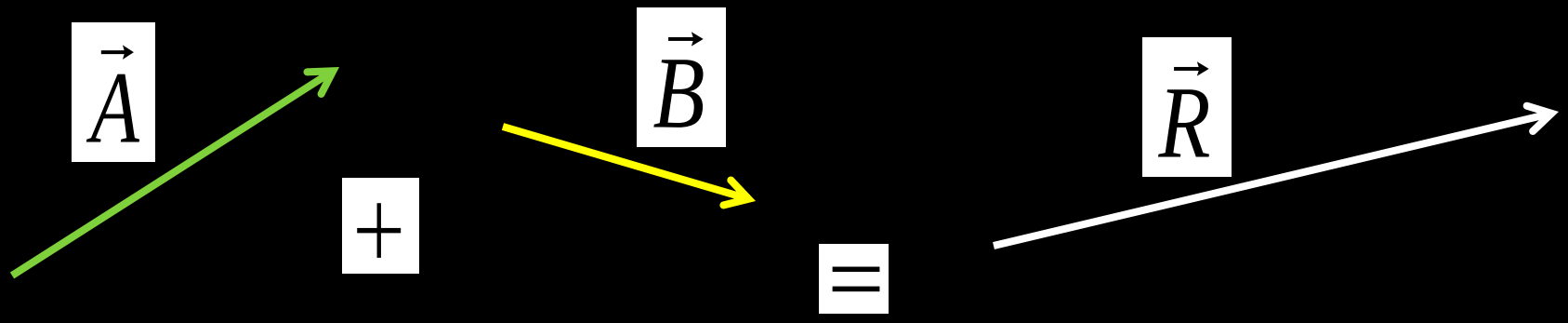


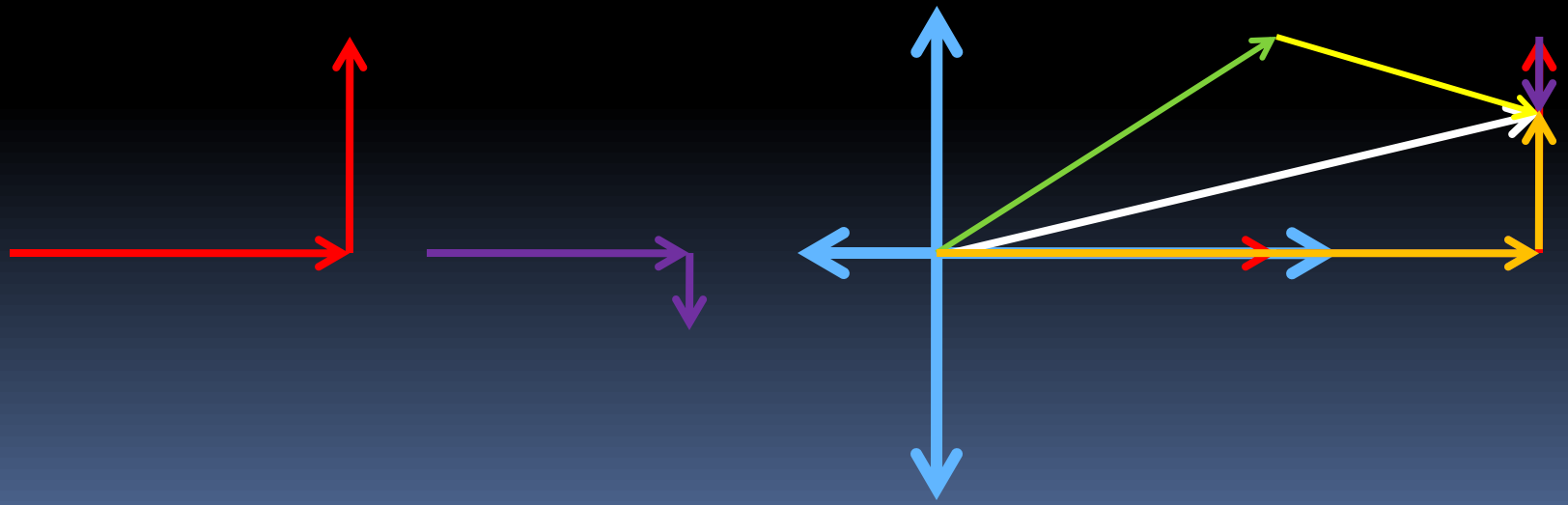
Adding Vectors Head-To-Tail by Components



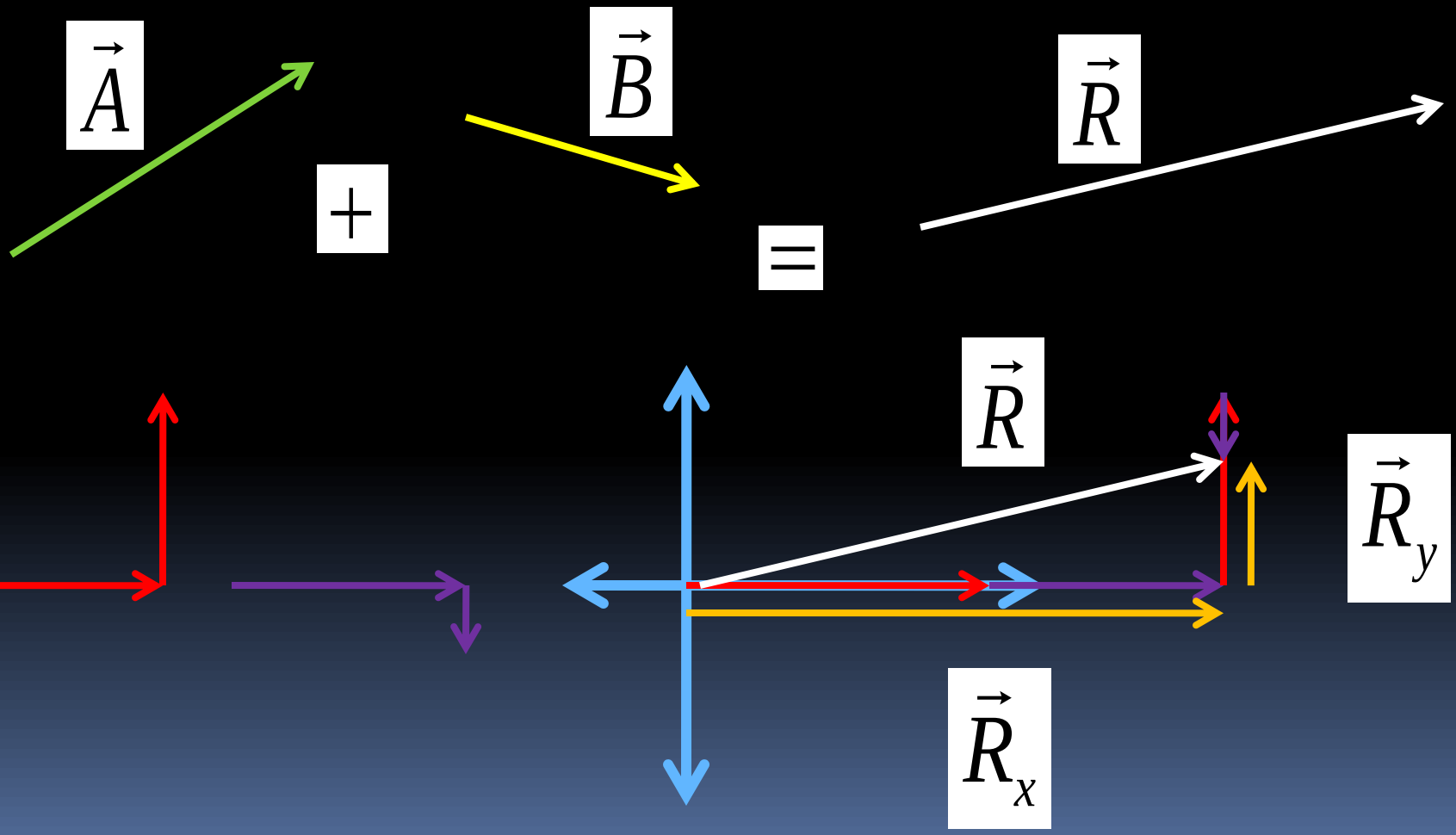


Adding Vectors Head-To-Tail by Components

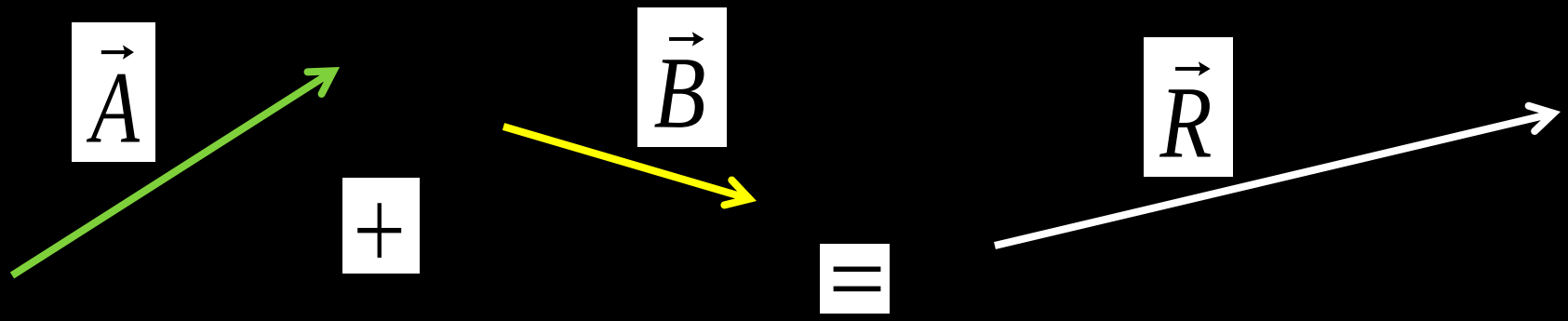


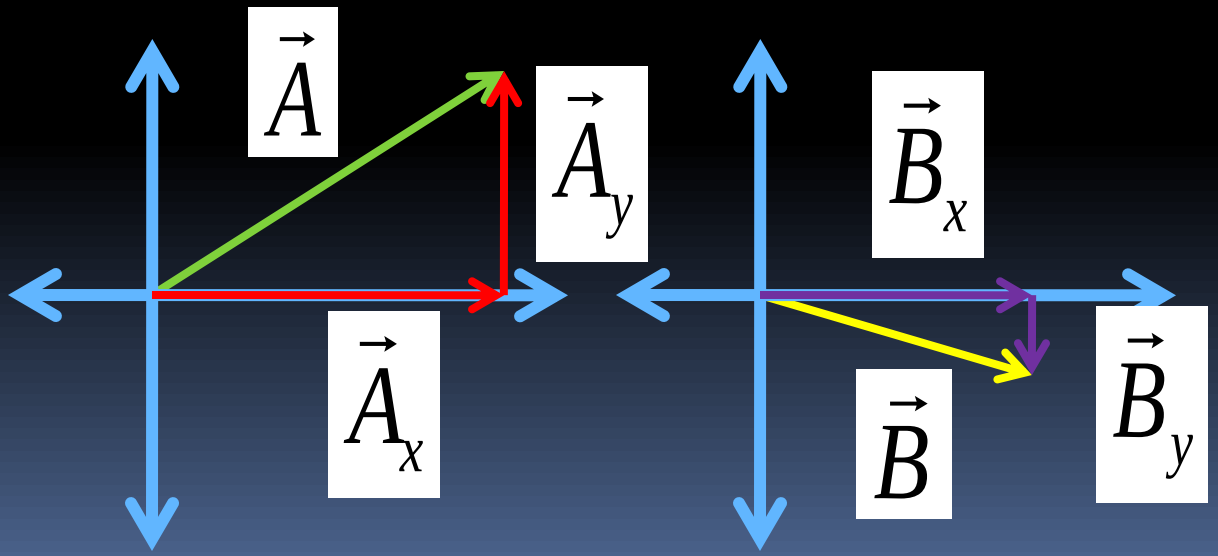


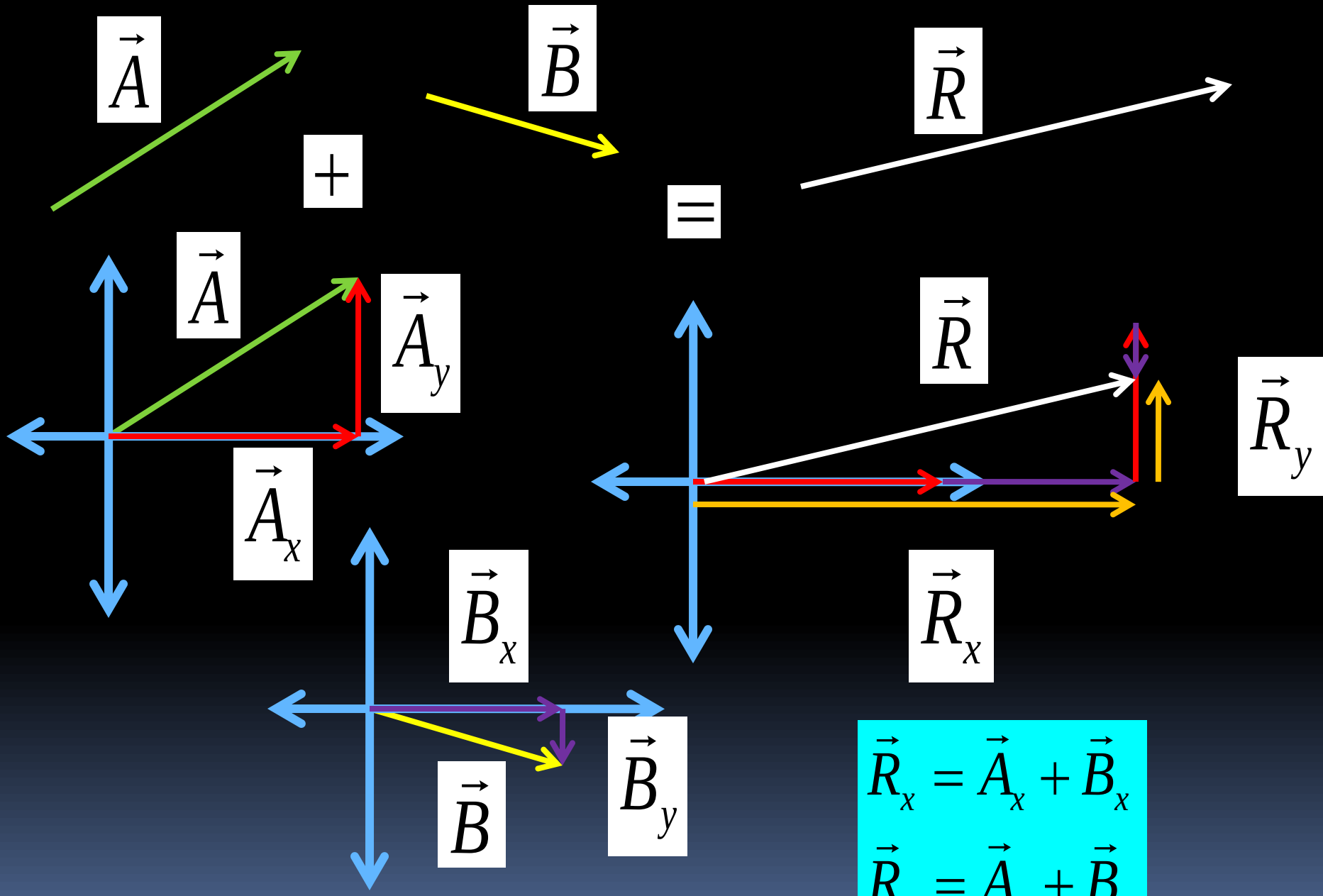
Adding Vectors Head-To-Tail by Components



Adding Vectors Head-To-Tail by Components





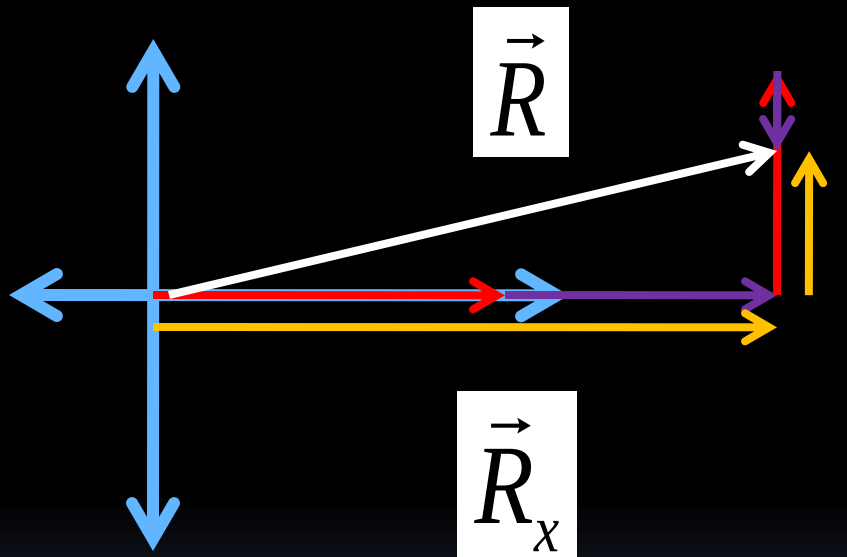


$$\vec{R}_x = \vec{A}_x + \vec{B}_x$$

$$\vec{R}_y = \vec{A}_y + \vec{B}_y$$

Pythagorization

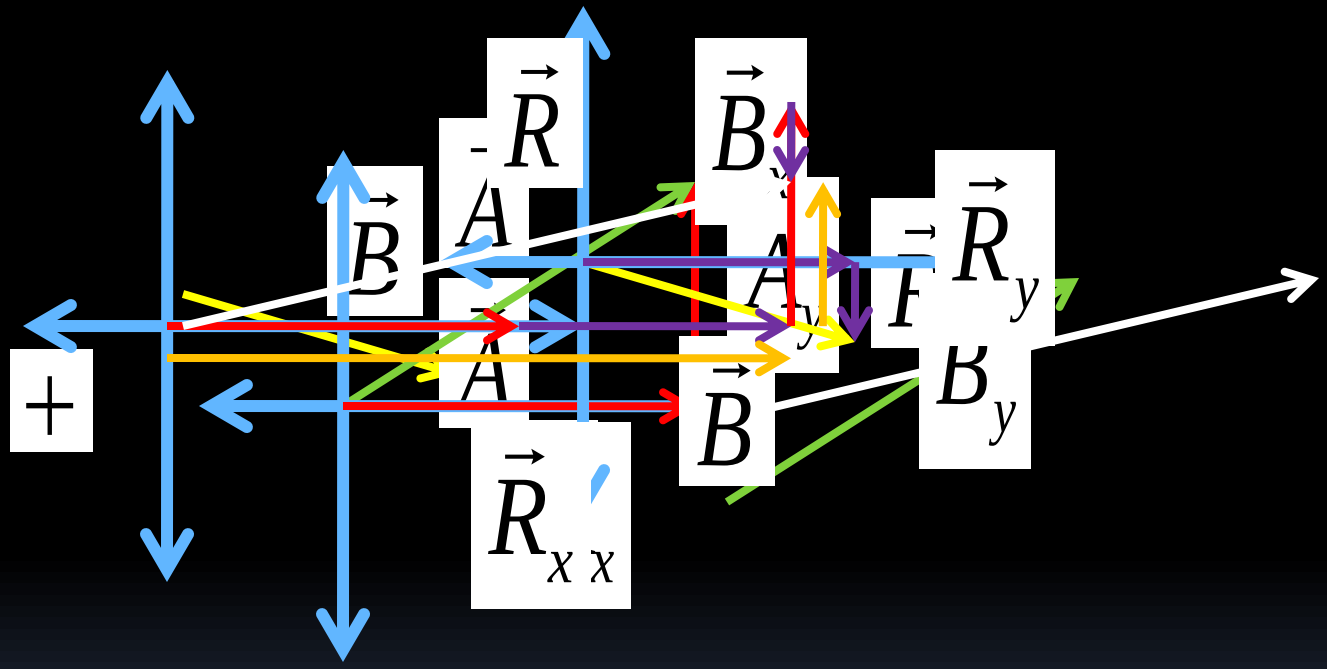
$$\vec{R}^2 = \vec{R}_x^2 + \vec{R}_y^2$$



$$\vec{R}_x = \vec{A}_x + \vec{B}_x$$

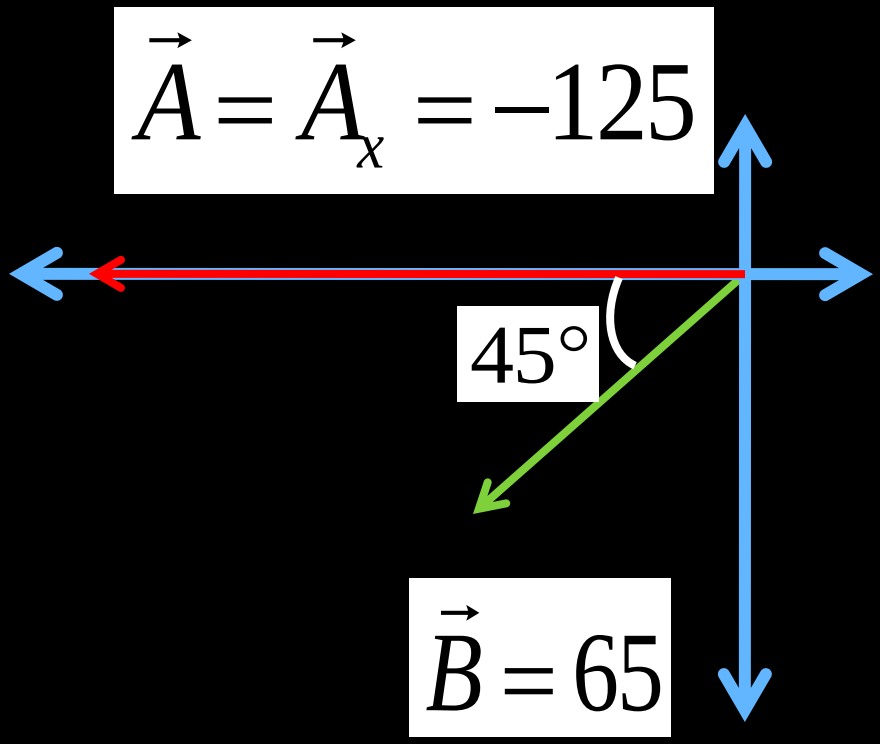
$$\vec{R}_y = \vec{A}_y + \vec{B}_y$$

Solve for x = 3



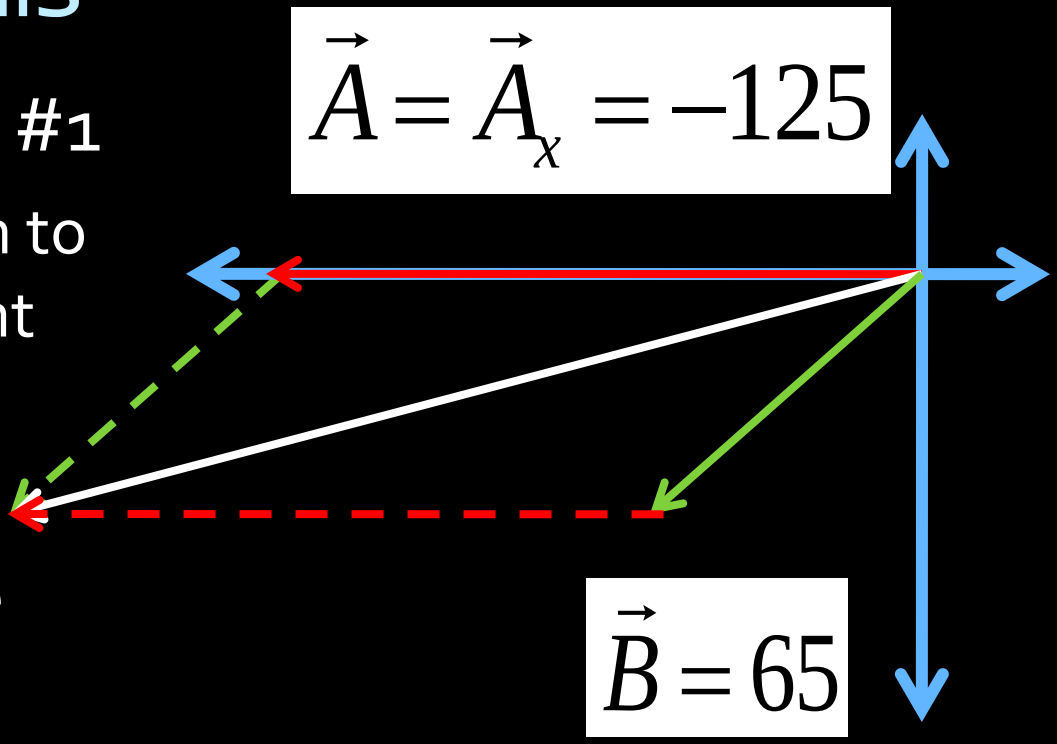
Sample Problems

- Homework Problem #1
  - Vector A lies on the negative x-axis with magnitude 125
  - "Southwest" means halfway between south and west, so 45° below the negative x-axis
  - Vector B lies 45° below the negative x-axis with a magnitude of 65.
  - Make drawings close to scale.



Sample Problems

- Homework Problem #1
  - Graphically add them to see what the resultant should look like
  - Just eyeballing it, the resultant should be about 15° and 165km



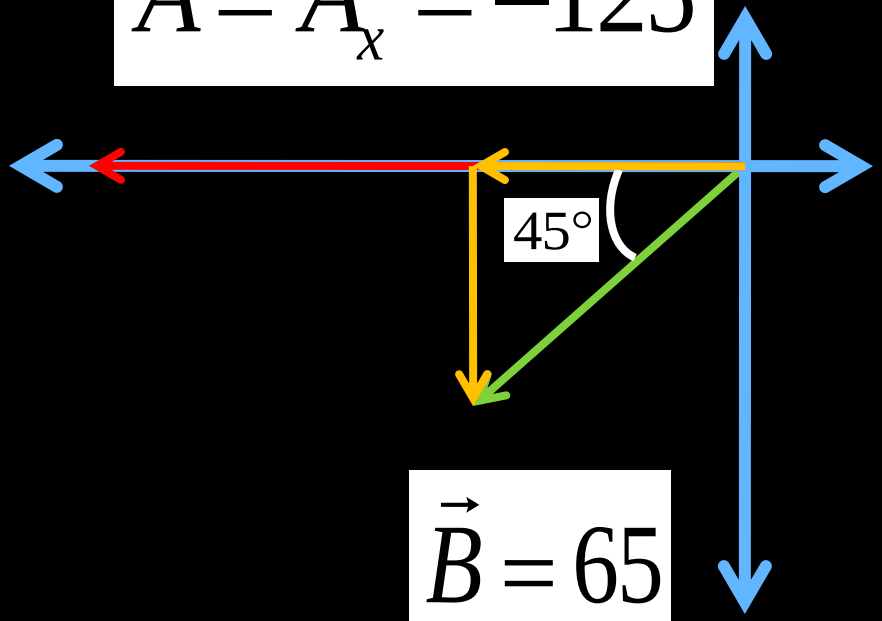
Sample Problems

- Homework Problem #1
  - The components of vector A are easy because it lies on the x-axis

$$\vec{A}_x = -125$$

$$\vec{A}_y = 0$$

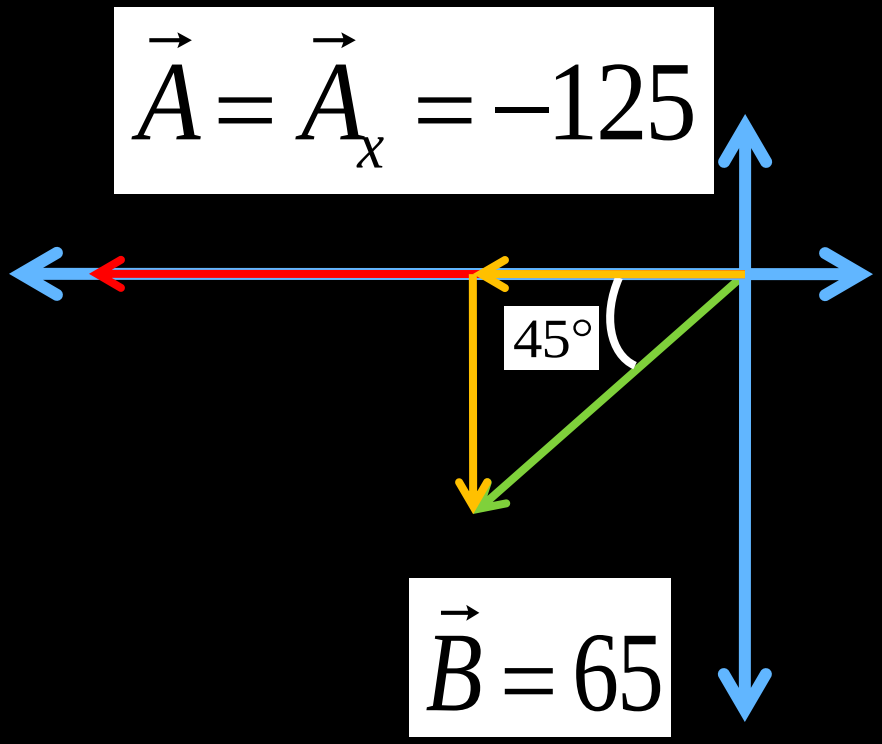
$$\vec{A} = \vec{A}_x = -125$$



$$\vec{B} = 65$$

Sample Problems

- Homework Problem #1
  - Now it's time to find the components of vector B.
  - Make sure that your components graphically add to get your vector – this determines if your components are positive or negative.
  - Both components of vector B are negative.

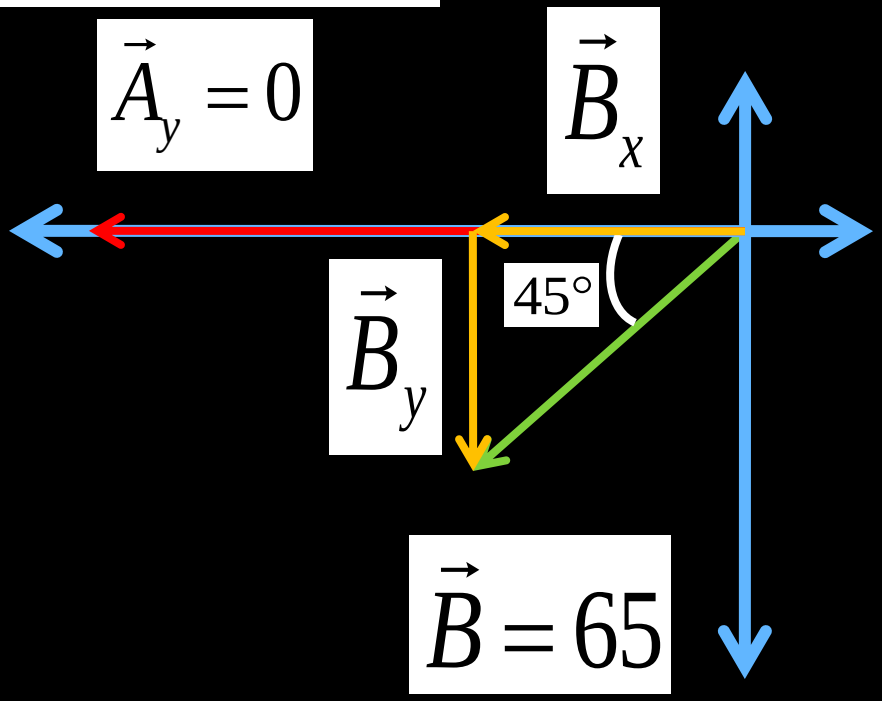


Sample Problems

- Homework Problem #1

$$\vec{A} = \vec{A}_x = -125$$

$$\vec{A}_y = 0$$



$$\cos 45° = \frac{B_x}{65}$$

$$(65)\cos 45° = B_x = -46.0$$

$$\sin 45° = \frac{B_y}{65}$$

$$(65)\sin 45° = B_y = -46.0$$

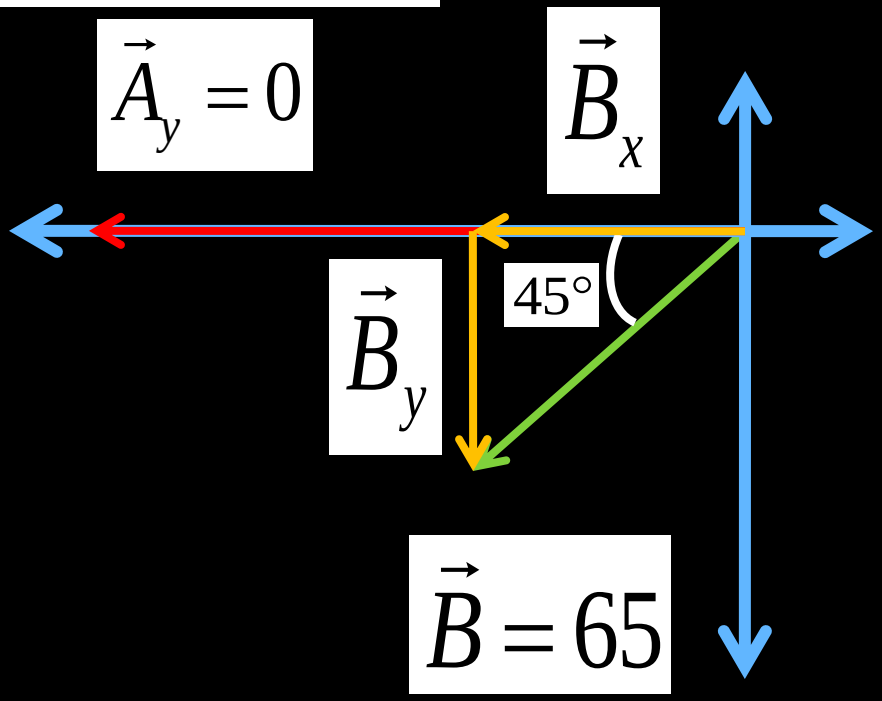
Make sure your calculator is in degrees and not radians!!!

Sample Problems

- Homework Problem #1
  - Time to find components

$$\vec{A} = \vec{A}_x = -125$$

$$\vec{A}_y = 0$$



$$B_x = -46.0$$

$$B_y = -46.0$$

$$R_x = A_x + B_x$$

$$R_x = -125 + -46 = -171$$

$$R_y = A_y + B_y$$

$$R_y = 0 + -46 = -46$$

Sample Problems

- Homework Problem #1
  - Time to find components

$$\vec{A} = \vec{A}_x = -125$$

$$\vec{A}_y = 0$$

$$\vec{B}_x$$

$$\vec{B}_y$$

45°

$$\vec{B} = 65$$

$$R_x = -171$$

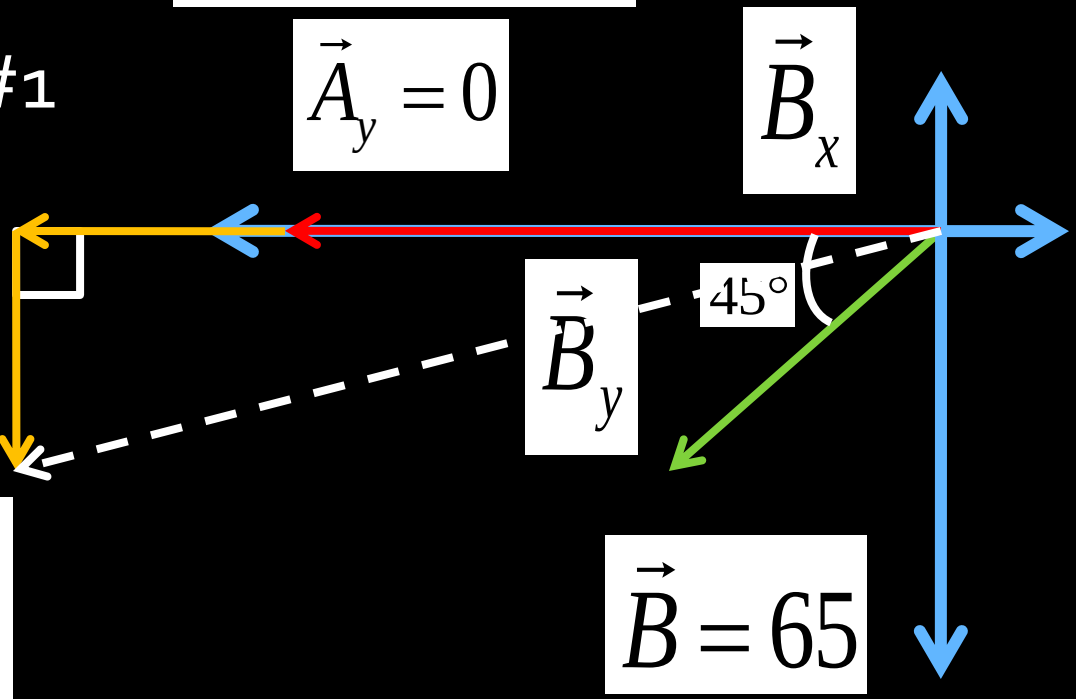
$$R_y = -46$$

Sample Problems

- Homework Problem #1
  - Time to find resultant

$$\vec{A} = \vec{A}_x = -125$$

$$\vec{A}_y = 0$$



$$R_x = -171$$

$$R_y = -46$$

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

$$R = \sqrt{(-171)^2 + (-46)^2}$$

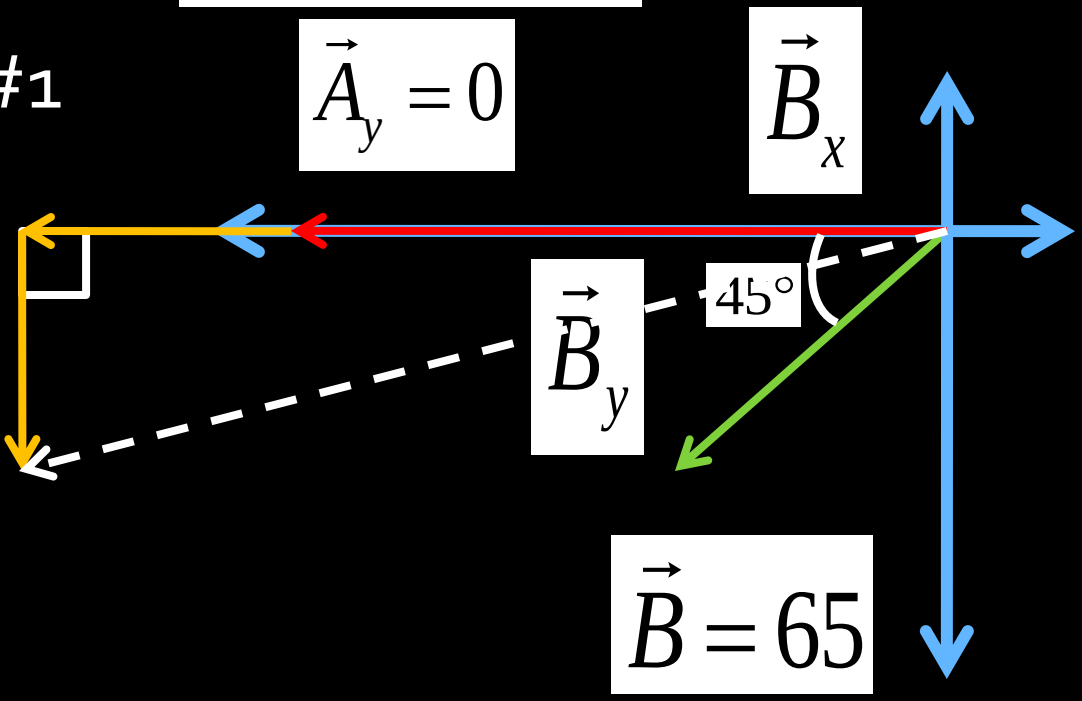
$$R = 177km$$

Sample Problems

- Homework Problem #1
  - Time to find resultant

$$\vec{A} = \vec{A}_x = -125$$

$$\vec{A}_y = 0$$



$$R_x = -171$$

$$R_y = -46$$

$$R = 177km$$

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

$$\theta = \tan^{-1}\frac{R_y}{R_x}$$

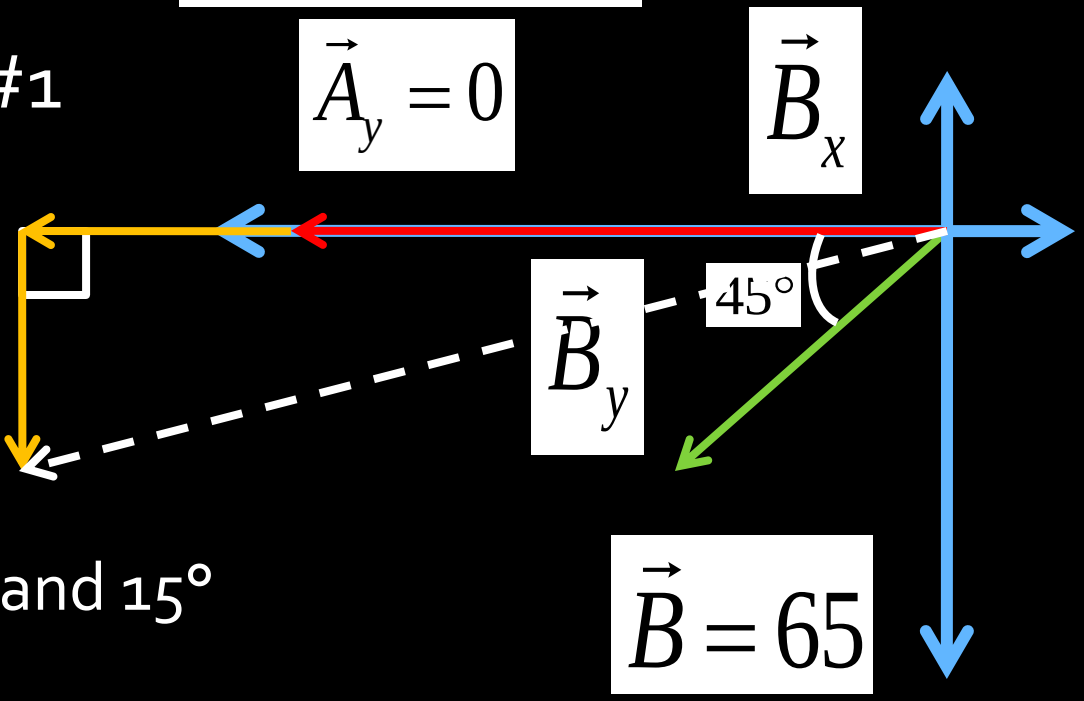
$$\tan^{-1}\frac{-46}{-171} = 15.1°$$

Sample Problems

- Homework Problem #1

$$\vec{A} = \vec{A}_x = -125$$

$$\vec{A}_y = 0$$



$$R = 177km$$

$$\theta = 15.1°$$

- The resultant is 177 km and 15° south of west
- OR, 177 km and 195°, OR 255° WSW on a compass!!!
  - Compass goes clockwise from North
  - "Standard" for coordinate plane is CCW from +x-axis

Problem-Solving Process

1. Draw a diagram
2. Choose x- and y-axes
3. Resolve each vector into components
4. Find the value of each component using sine, cosine and tangent (watch signs!)
5. Add x- and y-components to find resultant
6. Find magnitude and direction of resultant using Pythagorean theorem and inverse tangent

Objectives

- Use trigonometry to find the x- and y-components of a given vector.
- Add two vectors by adding their components to find the components of the resultant.
- Use $\tan^{-1}$ to find the direction of the resultant and Pythagorean Theorem to find the magnitude.

Learning Objective(s):

- The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.

Learning Objective(s):

- The student is able to design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces.

Essential Knowledge(s):

- *Forces are described by vectors.*
  - Forces are detected by their influence on the motion of an object.
  - Forces have magnitude and direction.
- If an object of interest interacts with several other objects, *the net force is the vector sum of the individual forces*.

Enduring Understanding(s):

- All forces share certain common characteristics when considered by observers in inertial reference frames.
- Classically, the acceleration of an object interacting with other objects can be predicted by using

$$\vec{a} = \frac{\vec{F}}{m}$$

Big Idea(s):

- The interactions of an object with other objects can be described by forces.

QUESTIONS?

Homework

Lsn 3-4, #1-16