

VECTORS

Motivating Question: An Airplane flies north with an airspeed of 575 mph. If the wind is blowing 30° north of east at 50 mph, what is the speed of the plane as measured from the ground? What if the wind blew south of west?



Vectors vs. Scalars

One of the numbers below does not fit in the group. Can you decide which one? Why?

- 35 ft
- 161 mph
- -70° F
- 200 m 30° East of North
- 12,200 people

Vectors vs. Scalars

The answer is: 200 m 30° East of North

Why is it different?

All the others can be completely described with only a numerical magnitude. Numbers with that property are called **SCALARS**.

Numbers that need both magnitude and direction to be described are called **VECTORS**.

Notation

- Vectors are written as arrows.
 - The *length* of the arrow describes the *magnitude* of the vector.
 - The *direction* of the arrow indicates the *direction* of the vector...
- Vectors are written in **bold text** in your book
- On the board we will use the notation below...



Adding Vectors

Case1: Collinear Vectors

What is the ground speed of an airplane flying with an air speed of 100 mph into a headwind of 100 mph?



Adding Collinear Vectors

When vectors are parallel, just add magnitudes and keep the direction.

Ex: 50 mph east + 40 mph east = 90 mph east



Adding Collinear Vectors

When vectors are antiparallel, just subtract the smaller magnitude from the larger and use the direction of the larger.

Ex: 50 mph east + 40 mph west = 10 mph east



An Airplane flies north with an air speed of 650 mph. If the wind is blowing east at 50 mph, what is the speed of the plane as *measured from the ground*?

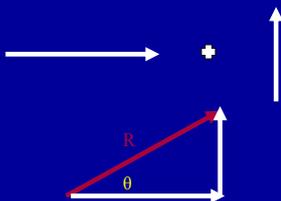


Adding Perpendicular Vectors

When vectors are perpendicular, just sketch the vectors in a HEAD TO TAIL orientation and use right triangle trigonometry to solve for the resultant and direction.

Ex: 50 mph east + 40 mph south = ??

Adding Perpendicular Vectors



Use Pythagorean Theorem to solve for R and Right triangle trig. To solve for θ

Adding Perpendicular Vectors

Use the Pythagorean Theorem and Right Triangle Trig. to solve for R and θ ...

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

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

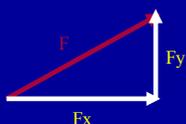
Examples

Ex1: Find the sum of the forces of 30 lb south and 60 lb east.

Ex2: What is the ground speed of a speed boat crossing a river of 5mph current if the boat can move 20mph in still water?

Vector Components

- Vectors can be described using their *components*.
- The *Components* of a vector are two perpendicular vectors that would add together to yield the original vector.
 - Components are notated using subscripts.



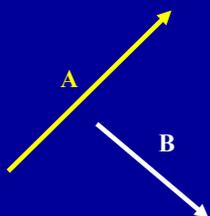
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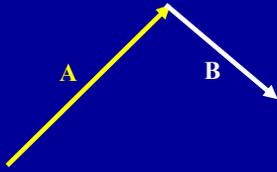
Adding Vectors with Scale Diagrams

- When vectors are not parallel or perpendicular the only way to add them is by drawing a SCALE DIAGRAM
- Add the vectors head to tail.
- Measure R and θ with a ruler and protractor.

Adding Vectors by Components

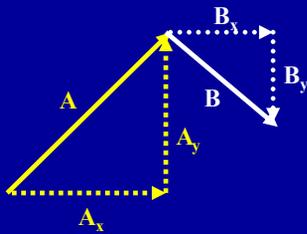


Adding Vectors by Components



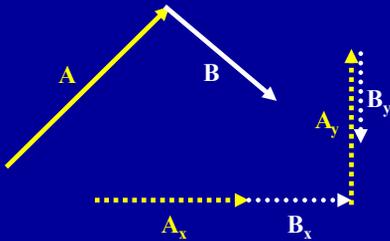
Transform vectors so they are *head-to-tail*.

Adding Vectors by Components



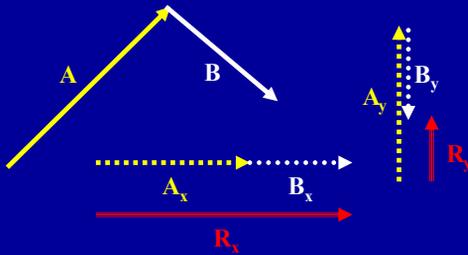
Draw components of each vector...

Adding Vectors by Components



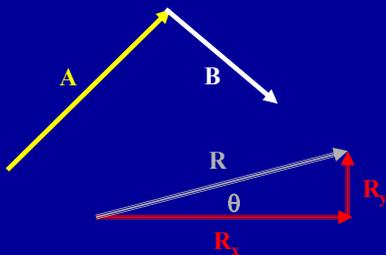
Add components as collinear vectors!

Adding Vectors by Components



Draw resultants in each direction...

Adding Vectors by Components



Combine components of answer using the head to tail method...

Adding Vectors by Components

Use the Pythagorean Theorem and Right Triangle Trig to solve for R and q...

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

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

Examples

Find the sum of the forces... 140 lb at 40 deg. North of west and 220 lb at 30 deg north of east...

Comparing Methods

Why is the component method a better method than the scale diagram method?

Challenge: The Strongman...

When the strongman suspends the 10 lb telephone book with the rope held *vertically* the tension in each strand of rope is 5 lbs. If the strongman could suspend the book from the strands pulled *horizontally* as shown, the tension in each strand would be:

- a) about 5 lbs
- b) about 10 lbs
- c) about 20 lbs
- d) more than a million lbs

