Chapter 1: Vectors

Definitions

Quantities used in Physics can be categorized as either scalars or vectors.

A scalar is _____

A vector is_____

Vectors and scalars are mutually exclusive, i.e. no quantity can be both.

Examples: 5.0 km : _____
5.0 km, [North] : _____

Some common quantities used in Physics (or science in general):

Scalars	Vectors

Representing Vectors

Arrows are used to represent vector quantities.

On a diagram
Length of arrow: _____
Where the arrow points: _____

Example: Two kids pull on a toy in opposite directions. Draw the forces involved.

Vector Addition

When we add 2 or more vectors together, we get a vector.
That vector is called the RESULTANT.
Just like with numbers, the order in which we add vectors does not matter.

There are 2 ways to add vectors:

- Graphically
- By components

Adding Vectors Graphically

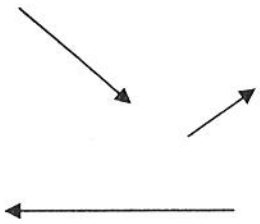
To add vectors graphically, your drawing MUST BE TO SCALE!!!

Graphical method #1: Head to Tail

- Draw vectors "one after the other"
- Draw magnitudes and directions (angles) to scale

Examples:

1. Add the vectors below.



2. Dog runs 50.0 m to the [East], then 40.0 m [South], then 30.0 m [West]. Draw the resultant displacement of the dog.

Graphical Method #2: Tail to Tail (Parallelogram)

- Draw vectors tail to tail
- Complete the parallelogram
- Resultant is from tails of vectors to opposite corner of the parallelogram

Notes: - this method only works for 2 vectors at a time.

Example: Find the sum of the two vectors below.

Some simple operations on vectors

Consider the vector $\vec{A}$:

$3\vec{A}$:

$\frac{1}{2}\vec{A}$

$-\vec{A}$

Examples:

Consider the vectors below.

$\vec{A}$:

$\vec{B}$: 

$\vec{C}$: 

Draw the sum of the following vectors.
Measure the magnitude and angle of the resultant vector.

1) $\vec{A}+\vec{C}$:

2) $2\vec{A}-\vec{B}$:

3) $\vec{B}-\vec{C}$:

And with a grid…

The "semi-graphical" method: using the cosine law
(This is especially useful if you are only looking for the magnitude.)

Adding Vectors by Components

There are 3 ways to express a vector (non-graphically).

1) Using magnitude and angle from the positive x-axis

2) Using a magnitude and an angle with N, E, S, W

3) Using the x and y components of the vector

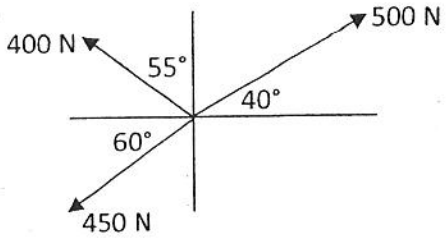
To add vectors using components:

1) Split vectors into x and y components.
2) Add the x components together (this gives the x component of the resultant)
3) Add the y components together (this gives the y component of the resultant)
4) Sketch the x and y for the resultant.
5) Calculate the magnitude $\rightarrow$ Pythagoras
6) Find the direction (angle) $\rightarrow \tan\theta$

Examples

1) Add (3.0 m, 6.0 m) and (2.0 m, -8.0 m)

2) Find the resultant of the following forces.



Word Problems

When solving word problems with vectors:

- Start by drawing the situation.
- Find the required vector. (IT MAY NOT BE THE RESULTANT!)

Examples

1) A swimmer wishes to cross a river that flow at a rate of 1.0 m/s. The swimmer can swim at a speed of 2.5 m/s. What is the resultant velocity of the swimmer as she crosses the river?

2) During a football practice, a player sprints 30.0 m [N], then shuffles 10.0 [E] and finally runs 20.0 m [W25°N] backwards. What is the resultant displacement of the player?

3) On a camping trip, you and a friend leave the tent with your compass and walk, 1.2 km [S], then 3.6 km [W], then 0.5 km [N] and finally 4.3 km [E]. At this point, you decide you have had enough, so you walk directly back to your tent. Give the vector that would represent your displacement as you return to the tent.

4) A plane can fly at a maximum speed of 400 m/s. The wind blows from the east at a speed of 100 m/s. The plane is flying from Montreal to New York City, which is located directly south of Montreal. What heading should the plane take so that it actually gets to New York?