This Week

Errors Lecture (in the lab)

Next Week

Tutorial and Test 1 (in the lab)
Chapter 2

Clickers

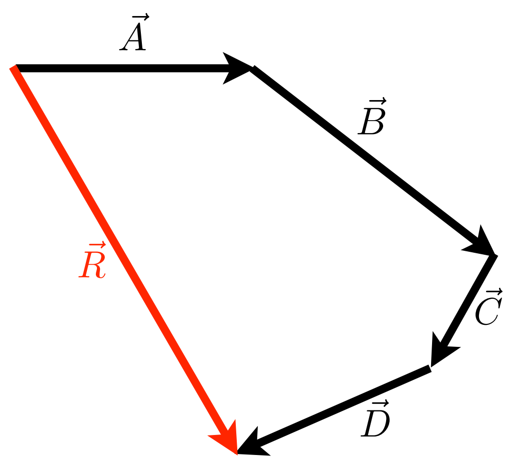
You do **NOT** have to register your clicker for PHYS1020.

You **may** need to need to register it for other courses, for example, for chemistry.

You can use the **same** clicker for all of your courses.

The story so far...

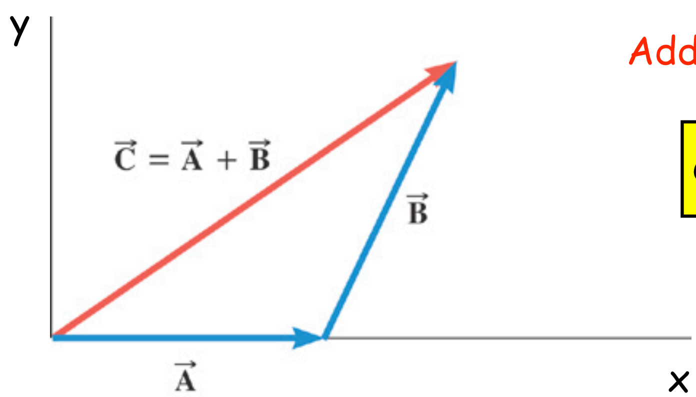
- Vectors have a magnitude and direction and can be broken down into x and y components
- Vectors placed nose to tail - add $\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$



And the components add:

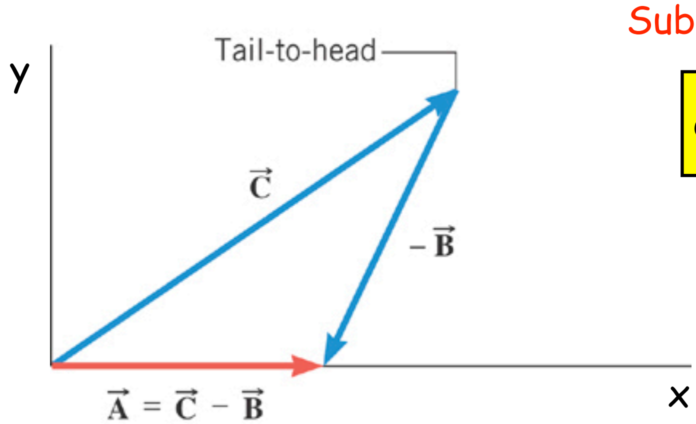
$$R_x = A_x + B_x + C_x + D_x$$

$$R_y = A_y + B_y + C_y + D_y$$



Addition of vectors

$$\vec{C} = \vec{A} + \vec{B}$$

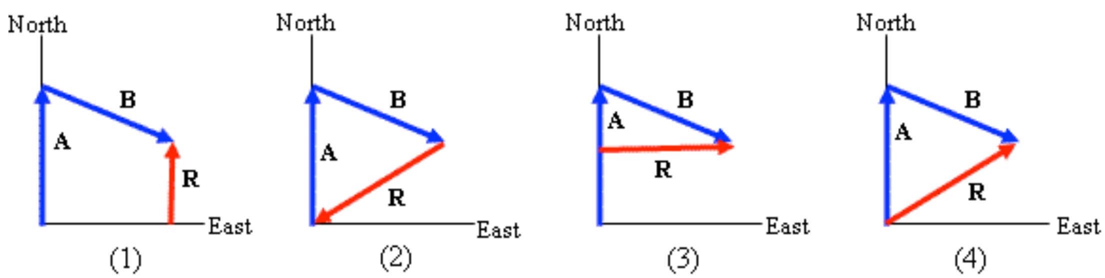


Subtraction of vectors

$$\vec{C} - \vec{B} = \vec{C} + (-\vec{B}) = \vec{A}$$

Clicker Question: Focus on Concepts, Question 1

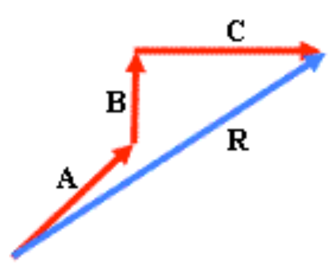
During a relay race, runner A runs a certain distance due north and then hands off the baton to runner B, who runs for the same distance in a direction south of east. The two displacement vectors **A** and **B** can be added together to give a resultant vector **R**. Which drawing correctly shows the resultant vector?



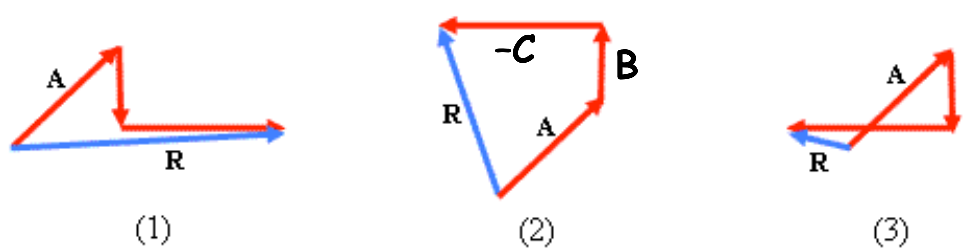
A) 1
B) 2
C) 3
D) 4

Clicker Question: Focus on Concepts, Question 5

The drawing shows three displacement vectors, ***A***, **B**, and ***C***, which are added in a tail-to-head fashion. The resultant vector is labeled **R**.



Which drawing below shows the correct resultant vector for ***A*** + **B** – ***C***?



A) 1 B) 2 C) 3

Units

Table 1.1 Units of Measurement

	System		
	SI	CGS	BE
Length	Meter (m)	Centimeter (cm)	Foot (ft)
Mass	Kilogram (kg)	Gram (g)	Slug (sl)
Time	Second (s)	Second (s)	Second (s)

Dimensional Analysis

Express all quantities in terms of basic units (dimensions) of mass, length and time - [M], [L], [T]   (kg, m, s)

$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{[L]}{[T]}$$

$$\text{Acceleration} = \frac{\text{Change in speed}}{\text{Time}} = \frac{[L]}{[T]} \times \frac{1}{[T]} = \frac{[L]}{[T]^2}$$

Is the following equation dimensionally correct?

$$x = x_0 + v_0 t + \frac{1}{2} a t$$

x, x_0 = positions along x-axis, [L]
v_0 = initial speed, [L]/[T]
t = time, [T]
a = acceleration, $[L]/[T]^2$

Dimensions in equations must match

A mass m is suspended from a spring. The mass is pulled down and released. The mass oscillates up and down in a time T given by:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

where m is the mass (kg) and k is known as the spring constant. What must the dimensions of k be for the equation to be dimensionally correct?

Rearrange to find k in terms of the other variables:

$$k = \frac{4\pi^2 m}{T^2}$$

Dimensions: k is $\frac{[M]}{[T]^2}$ or kg/s^2

Prob. 1.6/54: The variables x, v and a have dimensions:

$x = [\mathrm{L}]$
$v = [\mathrm{L}]/[\mathrm{T}]$
$a = [\mathrm{L}]/[\mathrm{T}]^2.$

The variables are related by:

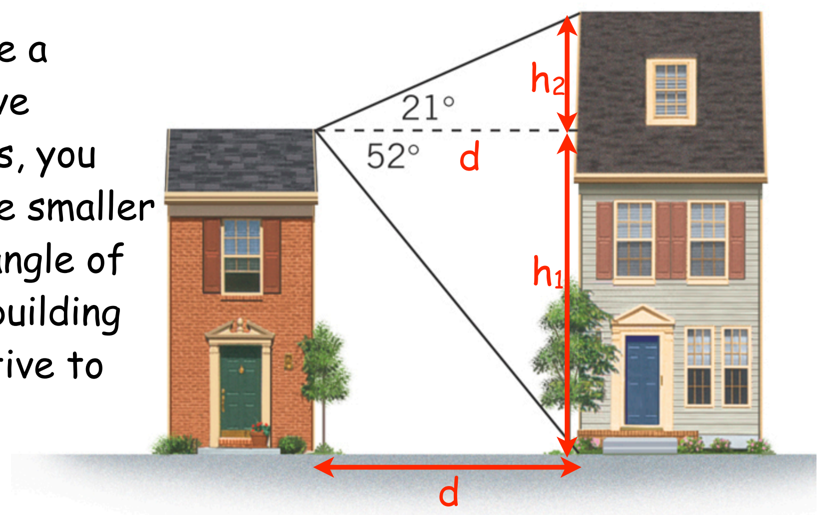
$$v^n = 2ax$$

where n is an integer constant without dimensions. What must be the value of n?

Write down the dimensions of each term in the equation:

$$\underbrace{\frac{[L]^n}{[T]^n}}_{v^n} = \underbrace{\frac{[L]}{[T]^2}}_{a} \times \underbrace{[L]}_{x} = \frac{[L]^2}{[T]^2} \rightarrow n = 2 \qquad v^2 = 2ax$$

Prob. 1.20/62: To settle a dispute over the relative heights of two buildings, you climb to the roof of the smaller building and sight the angle of the roof of the other building and of the ground relative to you, as shown.



Trigonometry: $h_1/d = \tan 52^\circ$, $h_2/d = \tan 21^\circ$

so, $h_2/h_1 = \tan 21^\circ/\tan 52^\circ = 0.3$
and $h_2 = 0.3\ h_1$

Taller building has height $h_1 + h_2 = 1.3\ h_1$

Vector notation: $\vec{A}$ is the same as ***A***

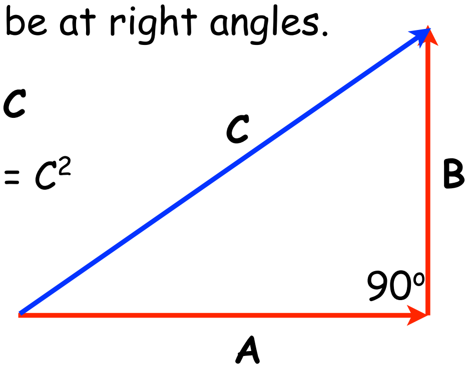
Vectors ***A***, **B** and ***C*** satisfy the vector equation ***A*** + **B** = ***C***, and their magnitudes are related by the scalar equation $A^2 + B^2 = C^2$.

How is vector ***A*** oriented with respect to vector **B**?

The magnitudes of the vectors satisfy Pythagoras' theorem, so ***A*** and **B** must be at right angles.

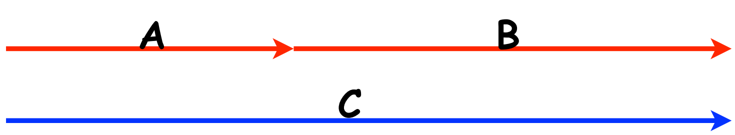
A + **B** = ***C***

$A^2 + B^2 = C^2$



Vectors ***A***, **B** and ***C*** satisfy the vector equation ***A*** + **B** = ***C***, and their magnitudes are related by the scalar equation $A + B = C$.

How is the vector ***A*** oriented with respect to vector **B**?



A + **B** = ***C***

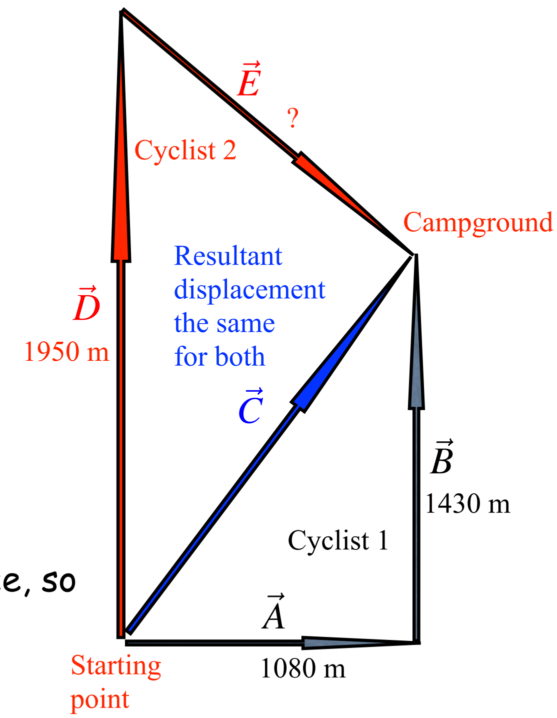
$A + B = C$

Prob. 1.29/26: Vectors

Cyclist 1 rides 1080 m due east, then turns due north and rides 1430 m to the campground.

Cyclist 2 heads due north for 1950 m, then turns directly to the campground.

How far does he have to ride to the campground, and in what direction?



Cyclists 1 and 2 arrive at the same place, so

$$\vec{A}+\vec{B}=\vec{D}+\vec{E} \quad =\vec{C}$$

and, $\vec{E}=\vec{A}+\vec{B}-\vec{D}$

Break vectors down into components and solve...

$$\vec{E}=\vec{A}+\vec{B}-\vec{D}$$

Components:

$$E_x = A_x + B_x - D_x \qquad E_x = 1080 + 0 - 0 = 1080 \text{ m}$$
$$E_y = A_y + B_y - D_y \qquad E_y = 0 + 1430 - 1950 = -520 \text{ m}$$

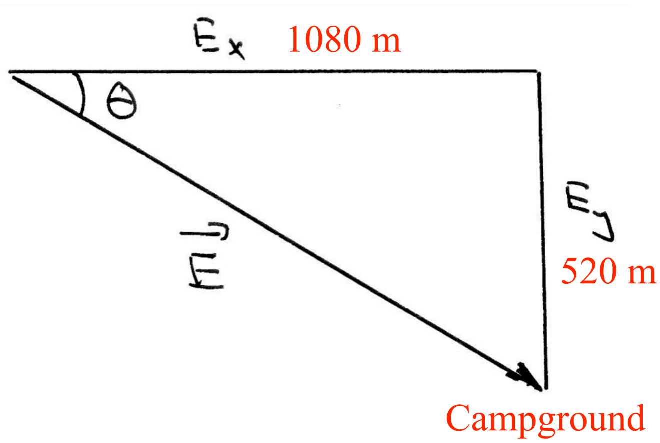
Therefore:

$$E = \sqrt{E_x^2 + E_y^2} = 1200 \text{ m}$$

Direction relative to east:

$$\tan\theta = \frac{|E_y|}{|E_x|} = 520/1080$$

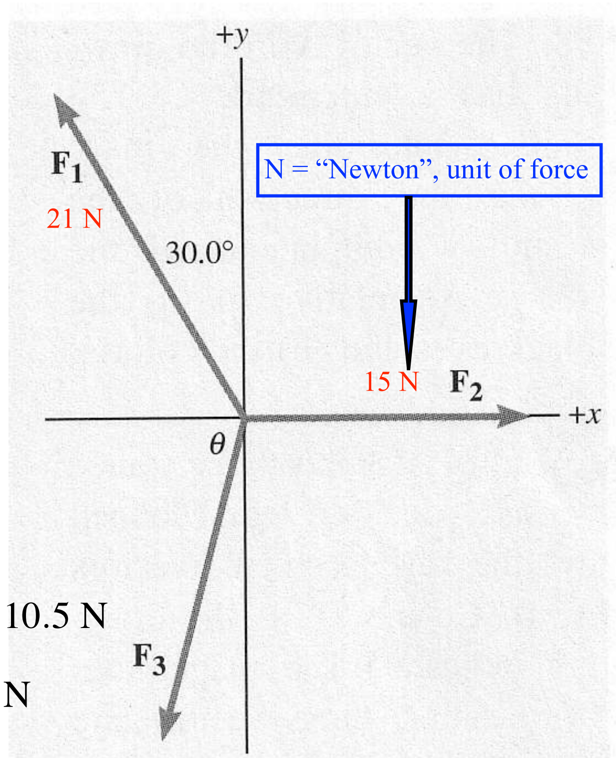
$$\theta = 25.7^\circ, \text{ south of east}$$



Prob. 1.66/46:

Three forces are applied to an object.

What must be the magnitude and direction of $\mathbf{F_3}$ if the sum of the forces is zero?



Need $\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$

So, $\vec{F}_3 = -\vec{F}_1 - \vec{F}_2$

Components:

$F_{1x} = -F_1 \sin 30^\circ = -21 \sin 30^\circ = -10.5 \text{ N}$

$F_{1y} = F_1 \cos 30^\circ = 21 \cos 30^\circ = 18.2 \text{ N}$

$F_{2x} = 15 \text{ N}$

$F_{2y} = 0$

F_{1x} = -10.5 N, F_{1y} = 18.2 N, F_{2x} = 15 N, F_{2y} = 0

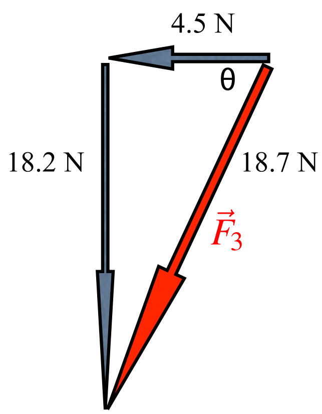
$\vec{F}_3 = -\vec{F}_1 - \vec{F}_2$

Add up the components:

$$F_{3x} = -F_{1x} - F_{2x} = 10.5 - 15.0 = -4.5 \text{ N}$$

$$F_{3y} = -F_{1y} - F_{2y} = -18.2 - 0 = -18.2 \text{ N}$$

$$\text{So, } F_3 = \sqrt{F_{3x}^2 + F_{3y}^2} = \sqrt{4.5^2 + 18.2^2} = 18.7 \text{ N}$$



$\tan\theta = 18.2/4.5 = 4.04 \rightarrow \theta = 76.1^\circ$ south of west

Summary of Chapter 1

Vectors have a magnitude **and** a direction
Scalars have just a magnitude

Vectors add nose to tail
Simplify by breaking vectors into x, y components

Vectors are subtracted by reversing the direction of the vector to be subtracted and then adding:

A - B = A + (-B)

or, $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

Alternative notation for vectors

Dimensions must be the consistent in all terms of an equation
The basic dimensions are mass, length and time
[M], [L] and [T], (kg, m, s)

Next: Chapter 2, Kinematics in One Dimension

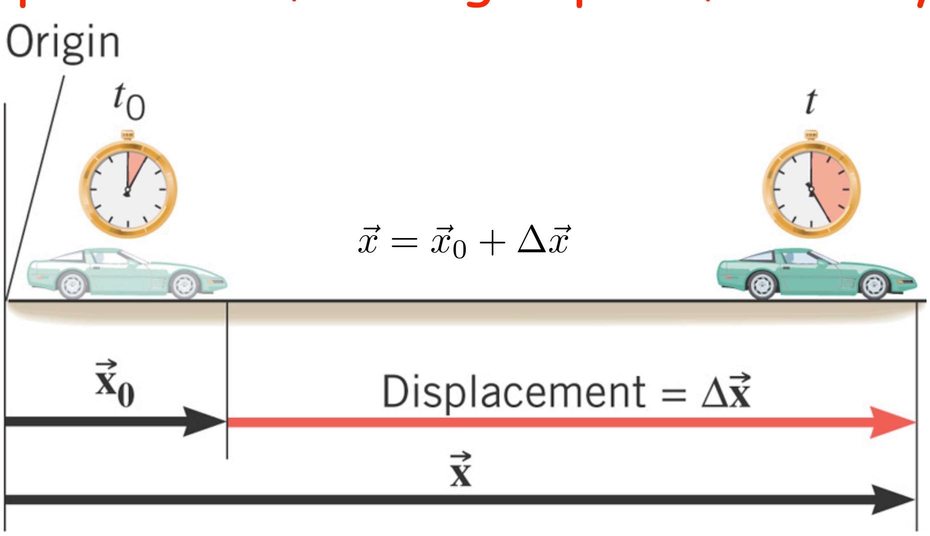
- Motion in a straight line with constant acceleration
- What are average and instantaneous speed, acceleration?
- How to calculate where you are from where you were and how fast you're going and how fast you're accelerating...

Chapter 2: Kinematics in One Dimension

Will cover motion in a straight line with constant acceleration:

- Displacement – not always the same as distance travelled
- Speed, velocity, acceleration
- Equations of motion in one dimension
- Free fall under gravity - which way is up?
- Graphical representation

Displacement, average speed, velocity



Car starts at x_o at time t_o, reaches x at time t

Distance travelled = $x - x_o$

Displacement, $\Delta\vec{x} = \vec{x} - \vec{x}_0$

$$\text{Average speed} = \frac{\text{Distance}}{\text{Elapsed time}} = \frac{x - x_0}{t - t_0}$$

$$\text{Average velocity} = \frac{\text{Displacement}}{\text{Elapsed time}} = \frac{\Delta\vec{x}}{t - t_0}$$

Displacement and distance not necessarily the same

Example: Car travels 50 km to east, then 20 km to west in 1 hour.

Distance travelled = 50 + 20 = 70 km

Average speed = 70 km/h

$$\text{Displacement } = \vec{x}_{final} - \vec{x}_{initial} = 30 \text{ km to east}$$

Average velocity = 30 km/h to east