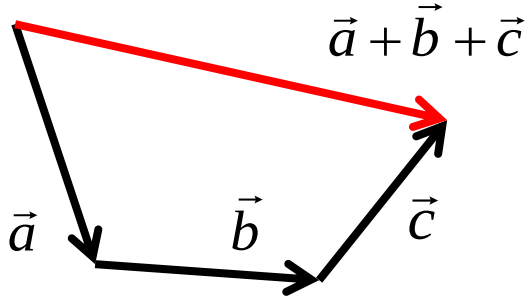
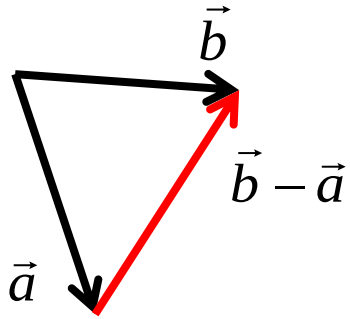
Vectors

Vectors are ***directed line segments***, they have magnitude (length) and direction

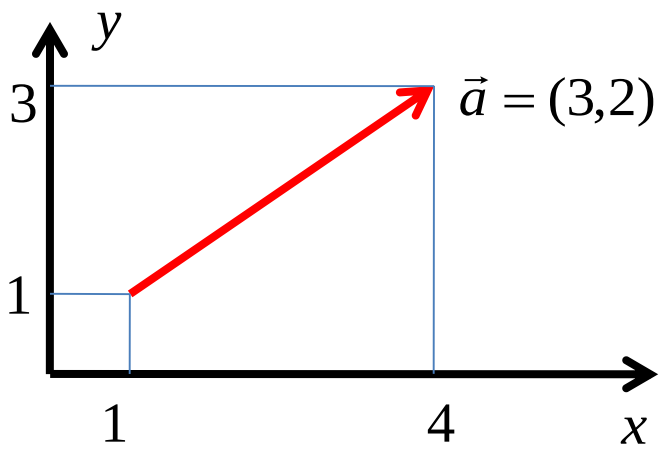
Vectors can be added:



and subtracted:



If there is a coordinate system, a vector can be expressed as a set of ***components*** along X and Y axes in 2D, or along X,Y,Z in 3D:



+,– operations are done for each component :

if $\vec{a}=(a_x,a_y)$ and $\vec{b}=(b_x,b_y)$,

$\vec{a}+\vec{b}=(a_x+b_x,a_y+b_y)$

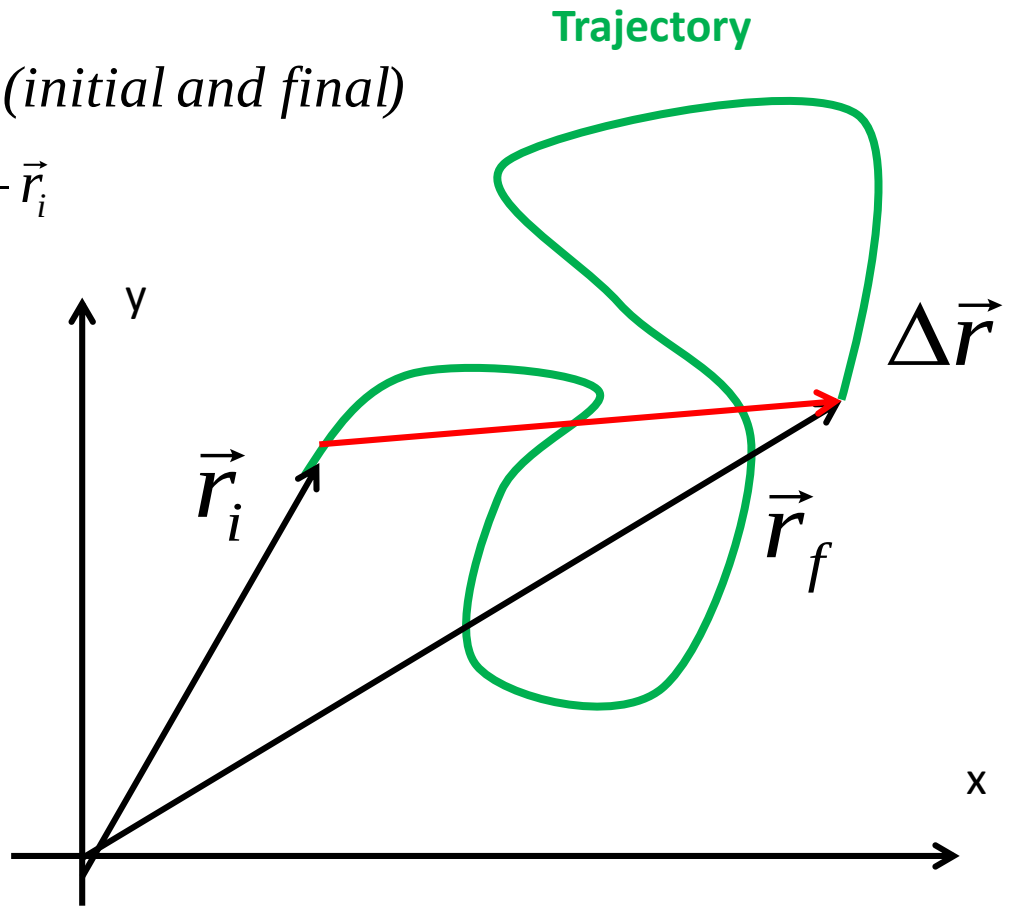
$\vec{a}-\vec{b}=(a_x-b_x,a_y-b_y)$

To find *magnitude* of a vector, use Pythagorean Theorem : $|\vec{a}|=\sqrt{a_x^2+a_y^2}$

Position and Displacement

$\vec{r}_i, \vec{r}_f$ - *Position vectors (initial and final)*

Displacement: $\Delta\vec{r} = \vec{r}_f - \vec{r}_i$



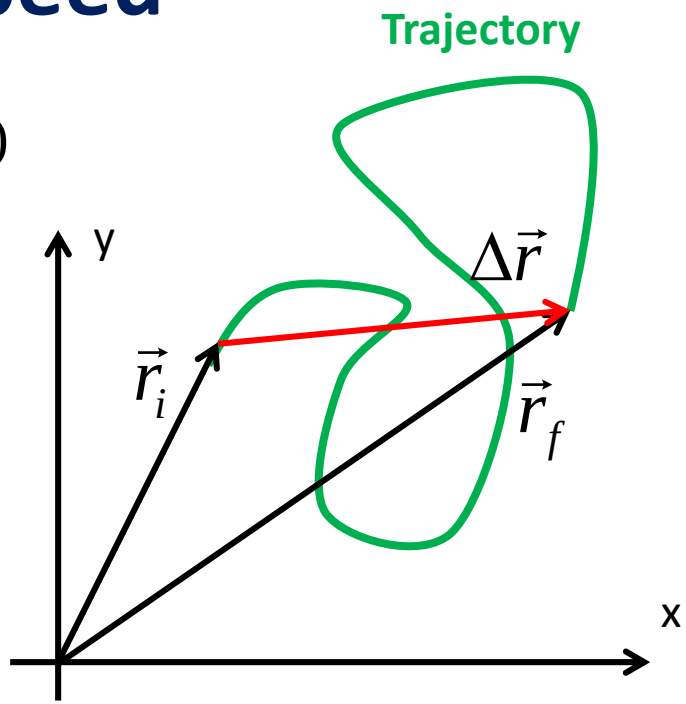
Displacement *and* **Position** *are* <u>*vectors*</u>

Velocity and Speed

$\vec{r}_i, \vec{r}_f$ - position vectors (initial and finite)

displacement : $\Delta\vec{r} = \vec{r}_f - \vec{r}_i$

travel time : $\Delta t = t_f - t_i$



Average ***velocity:***

$$\vec{v} = \frac{\Delta\vec{r}}{\Delta t}$$

d – distance travelled (length of the trajectory)

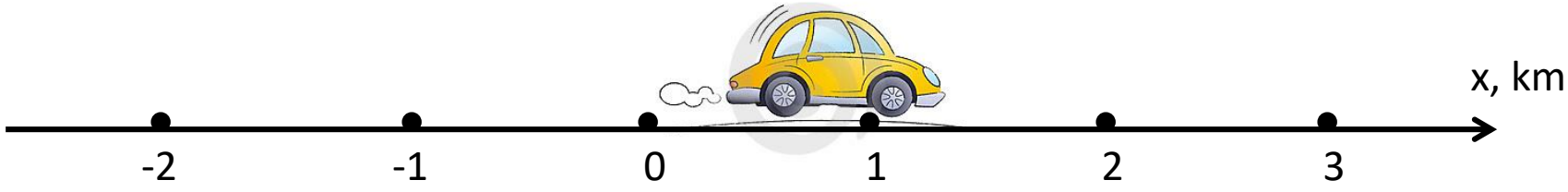
Average ***speed:***

$$v = \frac{d}{\Delta t}$$

NB: **Distance** *and* **Speed** *are* *scalars*
Displacement *and* **Velocity** *are* *vectors*

1D motion

Consider 1D motion: only one coordinate ***x*** changes with ***t***:



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

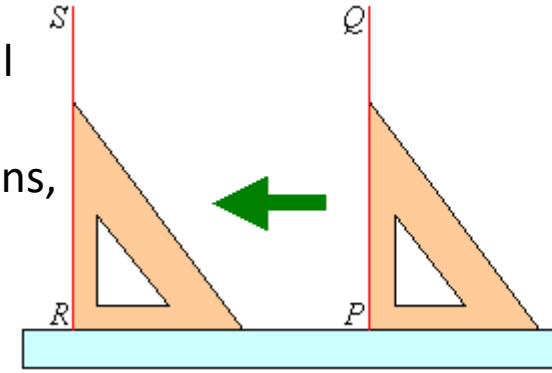
velocity in 1D (can be positive or negative)

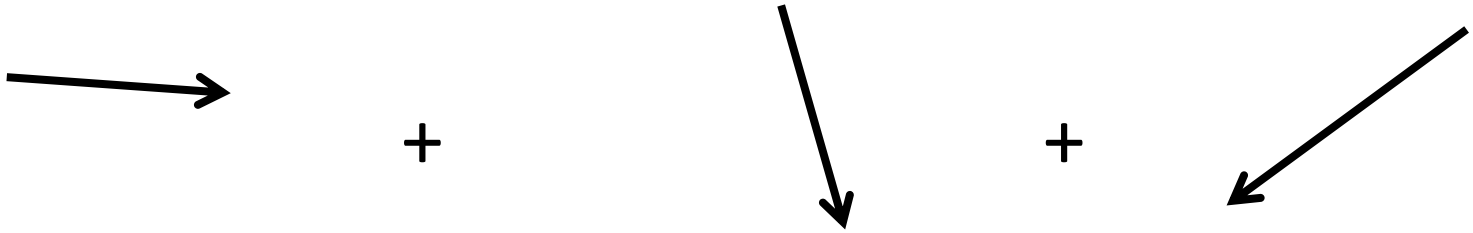
$$v = \frac{d}{\Delta t}$$

speed (d is the total distance travelled)

Homework 2

Problem 1. Find the result of operations with vectors. Use graphical method (with pencil and rulers)
Since you will need to redraw vectors while preserving their directions, use the "sliding ruler" trick shown on the right.





Problem 2.

A SchoolNova student was wandering in woods and got lost. Fortunately, he had a tracker that sends out an information about his movements. According to this tracker, the student first walked 1 km to South-East (SE), than 3 km to SW (South-West), and finally 2 km North. Using this information , determine how far is he from where he started, and in which direction should he go to come back.

Solve the problem graphically (by drawing the displacement vectors on a Quad-ruled paper).

Problem 3

A student travels from school to home by foot, with average speed ***v***, picks a bike and rides it back 3 times as fast (that is, with speed **3v**), along the same route.

a) Find the total time of this round trip, if the distance travelled each way is ***d***.

b) Find the average speed of the whole trip (you need to obtain the general formula that contains ***v*** and possibly ***d***).