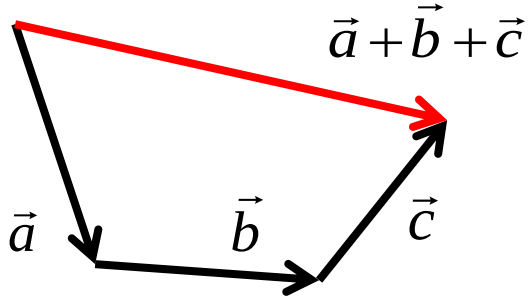
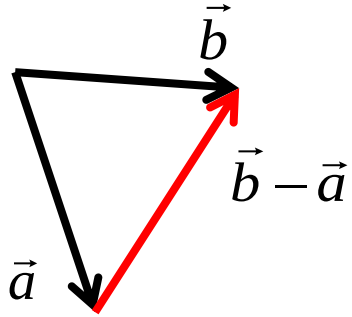
Vectors

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

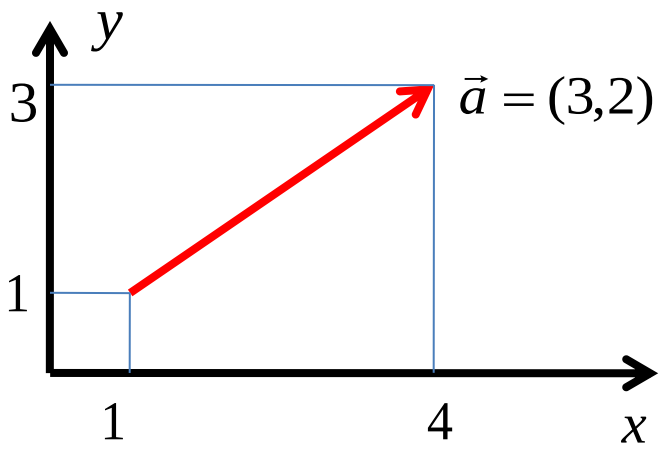
Vectors can be added:



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 $\vec{b}=(b_x,b_y)$,

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

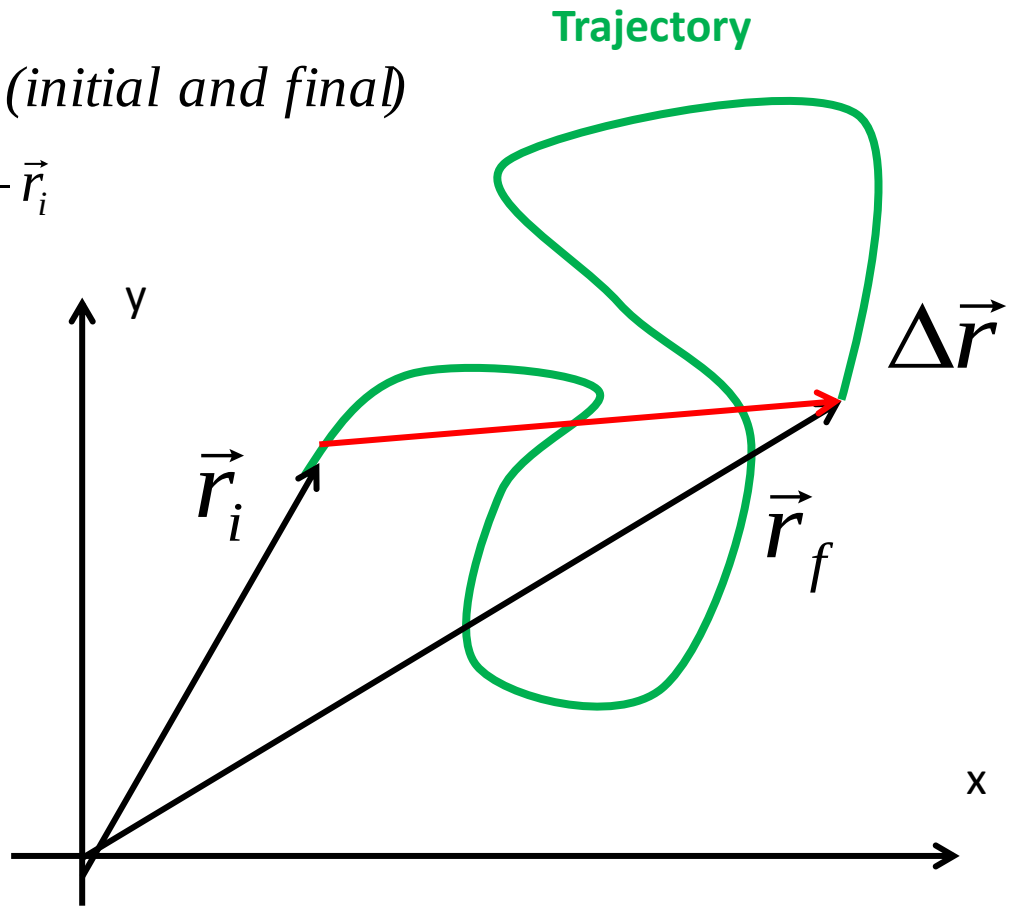
$\vec{a}-\vec{b}=(a_x-b_x,a_y-b_y)$

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



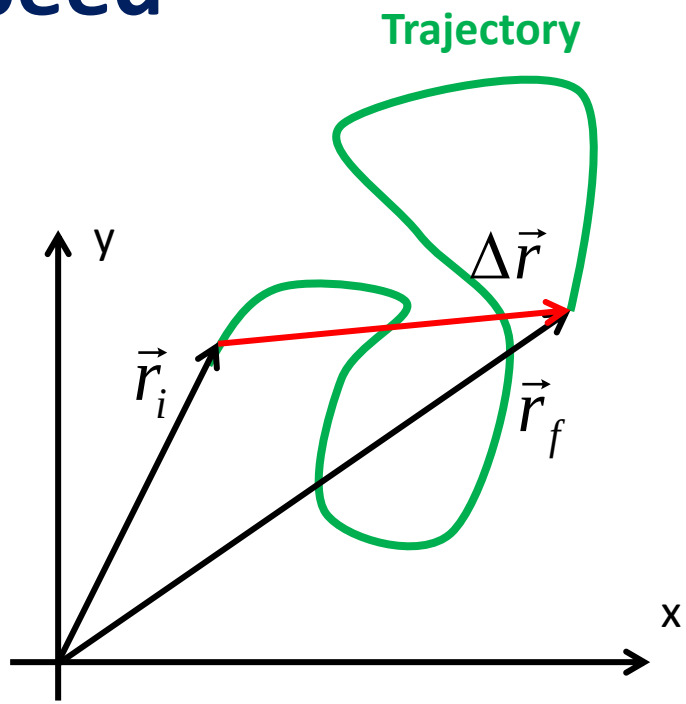
Displacement *and* **Position** *are* *vectors*

Velocity and Speed

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

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

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)

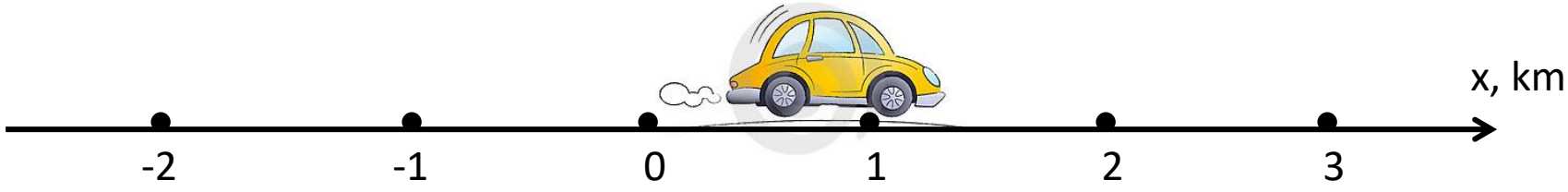
Average ***speed:***

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

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

1D motion

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



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

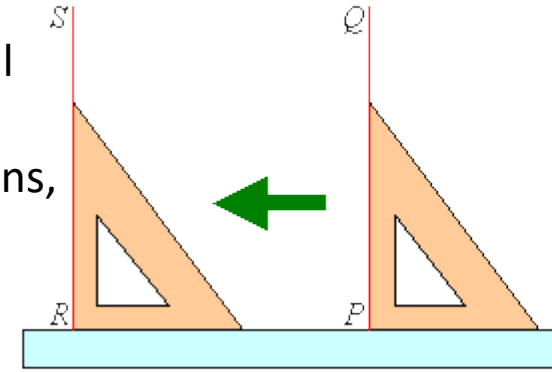
velocity in 1D (can be positive or negative)

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

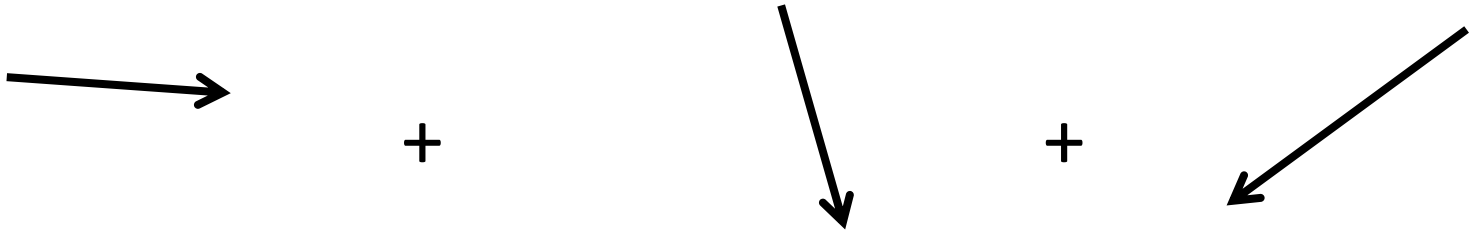
speed (d is the total distance travelled)

Homework 1

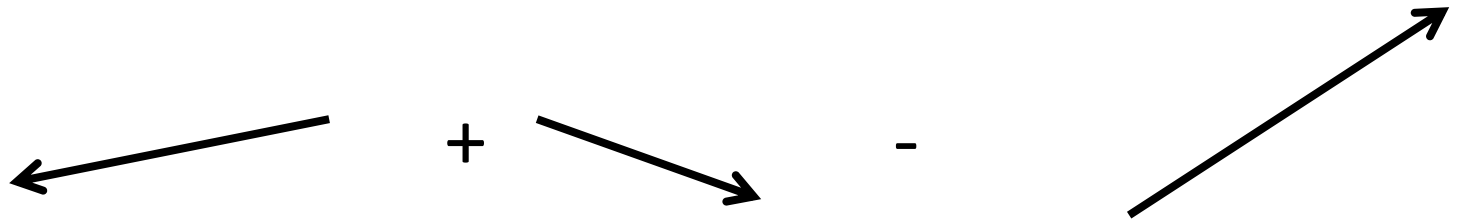
Problem 1. Find the result of operations with vectors. Use graphical method (with pencil and rulers)
Since you will need to redraw vectors while preserving their directions, use the "sliding ruler" trick shown on the right.



a)



b) The assignment is the same as in (a). Note the “-” sign:



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.

The picture shows the path of an ant that it covered in 1 minute. Find its average **speed** (in m/s). You will need to come up with a creative way to measure the distance travelled. Please describe it. Use anything you want.

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