Motion at constant acceleration
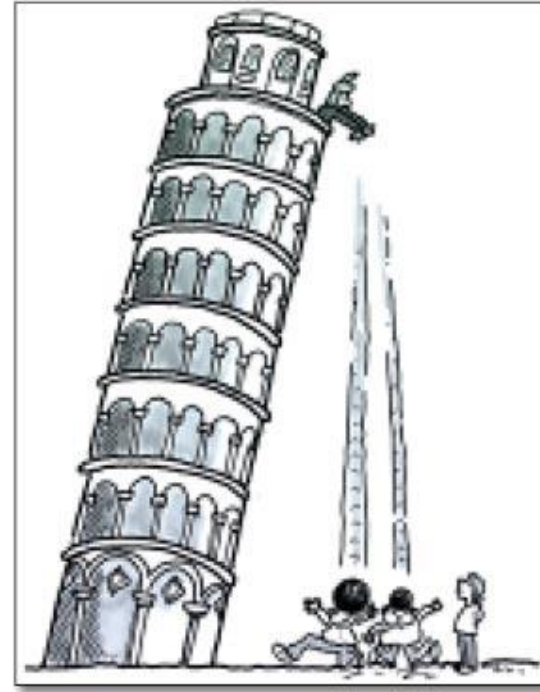
- **Acceleration:**

$$a = \frac{\text{change in velocity}}{\text{change in time}} = \frac{\Delta v}{\Delta t}$$

- **If there were no air resistance, all objects in Earth gravity would fall with the same acceleration, g=9.8 m/s²**

- **For motion at constant acceleration *a* , with no initial speed, the displacement after time *t* is:**

Galileo Galilei's experiment in Pisa (possibly, a legend)

$$Dx = v_{average}t = \left(\frac{0 + at}{2}\right) \times t = \frac{at^2}{2}$$

Vectors

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

$$\vec{a}$$

Vectors can be added:

$$\vec{a} + \vec{b} + \vec{c}$$

$$\vec{a} \quad \vec{b} \quad \vec{c}$$

and subtracted:

$$\vec{b}$$

$$\vec{b} - \vec{a}$$

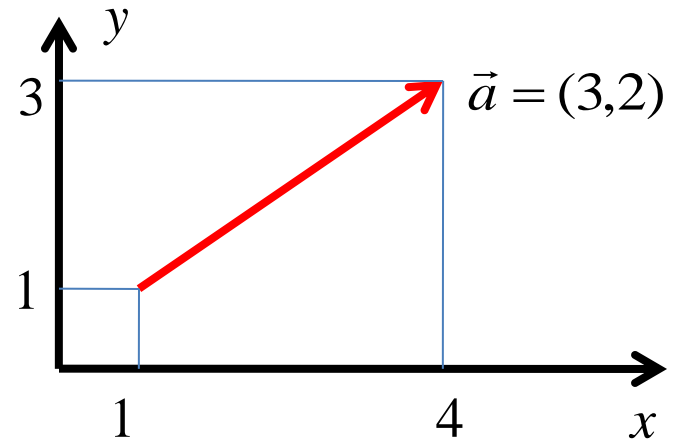$$\vec{a}$$
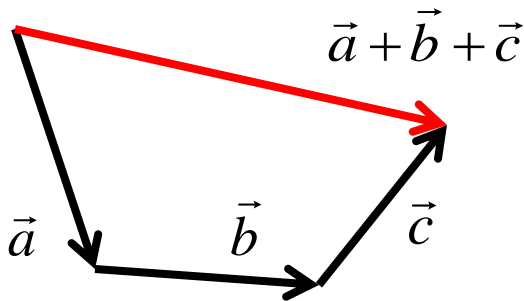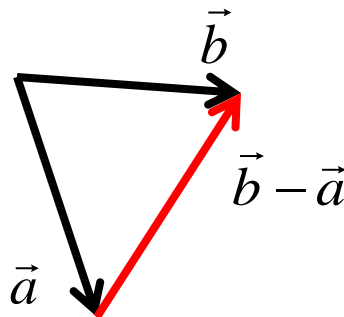
If there is a coordinate system, a vector can be expressed as a set of ***components*** along X and Y axes in 2D, or along X,Y,Z in 3D:

$$\vec{a} = (3,2)$$

$+,-$ 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 : $|\vec{a}| = \sqrt{a_x^2 + a_y^2}$

Velocity and Speed

Trajectory

$\vec{r}_i, \vec{r}_f$ - 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:*

$$\vec{v} = \frac{\Delta\vec{r}}{\Delta t}$$
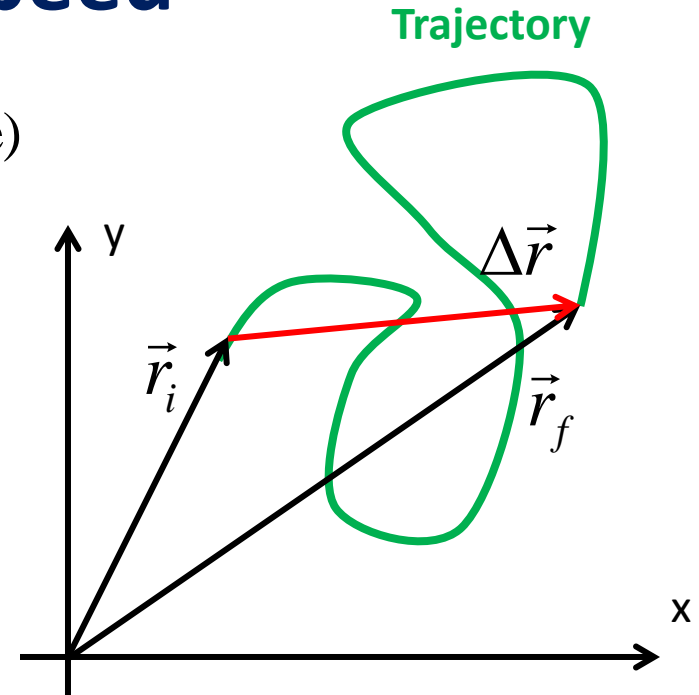
d – distance travelled (length of the trajectory)

Average *speed:*

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

Distance *and* **Speed** *are <u>scalars</u>*
Displacement *and* **Velocity** *are <u>vectors</u>*
Other examples of <u>vectors</u>: **Acceleration** *and* **Force**

Homework

Problem 1.

Suppose that you are trying to reproduce an experiment of Galileo by dropping a rock from certain tower. The time of its free fall turns out to be t=5.0 seconds. How tall is the tower?

Problem 2.

A SchoolNova student was wandering in THE 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. 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.