Homework 4.

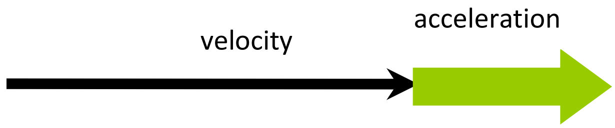
Acceleration

Last time we discussed *acceleration*. In everyday life we use the word *acceleration* to describe increase of the speed of a moving object. Acceleration in physics has different meaning. It is change in *velocity* per unit time. Any time the speed and/or the direction of motion of an object changes we deal with *accelerated* motion. An example of acceleration motion is falling. We know that any object falls down with acceleration of ~10m/s$^2$ (9.8 m/s$^2$, to be exact).

Acceleration is a vector – it has both magnitude and direction.

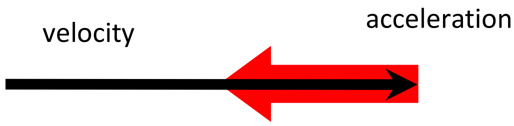
For the case of rectilinear motion (just to remind – this is the motion along a straight line) there are two major cases:

1. Acceleration is directed along the velocity.




In this case the velocity and acceleration have same sign and speed of the object is *increasing* with time. The acceleration magnitude gives us the rate of the speed increase. For example acceleration of 5meters per second per second (this is not a typo!) means that the speed increases for 5m/s every second. It is usually denoted as 5m/s$^2$ (five meter per second square)

2. Acceleration is directed oppositely to the velocity.




In this case the velocity and acceleration have opposite signs and speed of the object is *decreasing* with time. The acceleration magnitude gives us the rate of the speed decrease. For example, acceleration of -5meters per second per second means that the speed decreases for 5m/s every second.

For some complicated types of motion (oscillations of a pendulum, for example) acceleration changes with time. We will study only the motion at a constant acceleration ("constant" means "does not change") . If we know acceleration and initial velocity we can easily find the velocity at any later moment:

$$\vec{V} = \vec{V}_0 + \vec{a} \cdot t \qquad (1)$$

***Velocity after the time t*** = ***Initial velocity*** plus ***Acceleration*** multiplied by the ***time***

For example, if you just let a pebble go down, the initial velocity is zero. But you can throw the pebble down. In this case the pebble starts accelerating from nonzero velocity.

Just to remind, arrows on top of some characters in formula (1) mean that the corresponding physical parameters are vectors. When you will be solving problems, after you chose the "positive" direction you will be able to put correct signs before ***V, V₀*** and ***a***. After the signs are chosen you can consider these parameters as a regular numbers and you do not need to use the arrows anymore.

Problems:

1. Imagine that you dropped a penny from Empire State Building (please, never do it in a real life!). Calculate the speed of the coin in 5 seconds.
2. Explain (and make a scheme) what happens to a pebble if you throw it vertically up?
3. A solder shoots vertically up. The bullet starts moving up at a speed of 400m/s. In what time the bullet will stop?
4. A ball falls down from the height of 10m and hits the ground in 1 second. Find average velocity of the ball and compare it to the velocities of the ball in the beginning and in the end of the motion.