Homework 4

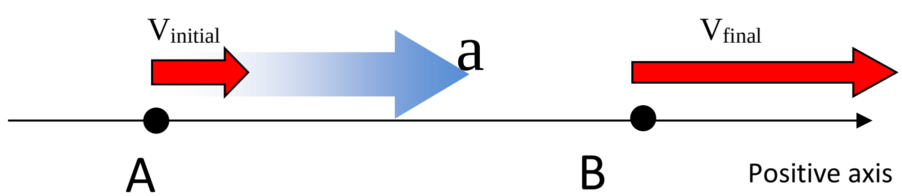
How to calculate displacement of uniformly accelerated object

Last class we have also learned how to calculate the displacement of a uniformly accelerated object. Uniform acceleration (constant acceleration) means that the acceleration does not change as the object is moving.

Example

A car spent time *t* moving with positive acceleration *a* from point A to point B along a straight line. A velocity of the car at the point A was $\vec{V}_{initial}$. In time *t* after the car started from the point A its velocity is

$$\vec{V}_{final} = \vec{V}_{initial} + \vec{a}t \qquad (1)$$



After we have chosen our "positive" axis, we can drop arrows on top of the vectors, but at the same time we have to choose the signs. In our case all the velocities and acceleration are positive, because they are directed along our "positive" direction.

In the case of uniform acceleration the average velocity can be calculated as:

$$V_{average} = \frac{V_{initial} + V_{final}}{2} = \frac{V_{initial} + V_{initial} + at}{2} = \frac{2 \cdot V_{initial} + at}{2} = V_{initial} + \frac{at}{2}$$

Now, to calculate the displacement *D* we have just to multiply the average speed by the time:

$$D = V_{average} \cdot t = \left(V_{initial} + \frac{at}{2} \right) \cdot t = V_{initial} \cdot t + \frac{a \cdot t \cdot t}{2} = V_{initial} \cdot t + \frac{a \cdot t^2}{2} \quad (2)$$

For a negative acceleration (if the car stops) we have:

$$D = V_{initial} \cdot t - \frac{a \cdot t^2}{2} .$$

Now we have another way to calculate displacement a uniformly accelerated object. Instead of calculating the average velocity and multiplying it by the time we can use Formula 2 and calculate the displacement directly using initial velocity, time and acceleration.

Problems:

1. A tennis ball is sent up at a speed of 40m/s. Find its velocity in 6 seconds after the start. Make a scheme.
2. The ball from previous problem reached the maximum height of 160m. In what time the ball reached the highest point of its path? Find the average velocity of the ball at the part of its path between the start and the highest point.
3. A coin is falling down for 3 sec. An initial velocity of the coin is 0. Find the displacement of the coin during the third second.