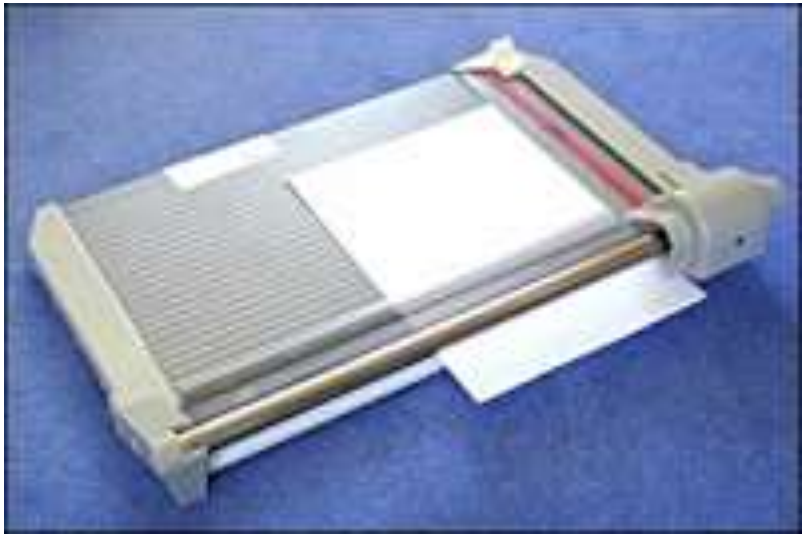


UNIFORM MOTION

LINEAR MOTION

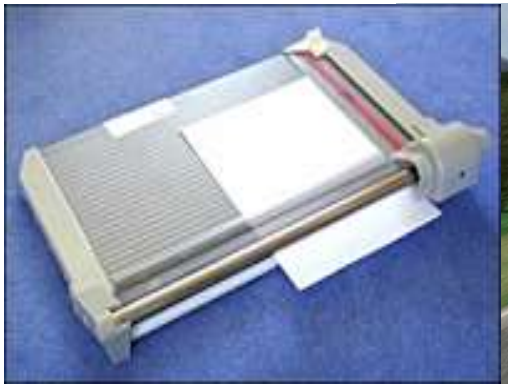
Linear motion (also called **rectilinear motion**) is a motion along a straight line and can therefore be described mathematically using only one spatial dimension.

The linear motion can be of two types:
- uniform linear motion with constant velocity or zero acceleration
- non uniform linear motion with variable velocity or non-zero acceleration.

Non-uniform linear motion is further divided in two types:
- unifomly accelerated linear motion
- uniformly decelerated linear motion

The motion of a particle (a point-like object) along a line can be described by its position x, which varies with t (time). An examples of linear motion are:

- car moving in straight line
- train moving on a straight track
- moving bullet in air
- piece of a paper as it travels from one side of copy machine to the other



One may compare linear motion to general motion. In general motion, a particle's position and velocity are described by vectors which have a magnitude and direction. In linear motion, the directions of all the vectors describing the system are equal and constant which means the objects move along the same axis and do not change direction.

UNIFORM LINEAR MOTION

Uniform linear motion describes an object that is moving in the straight line at a constant velociy. A body in uniform motion covers equal distance in equal intervals of time.

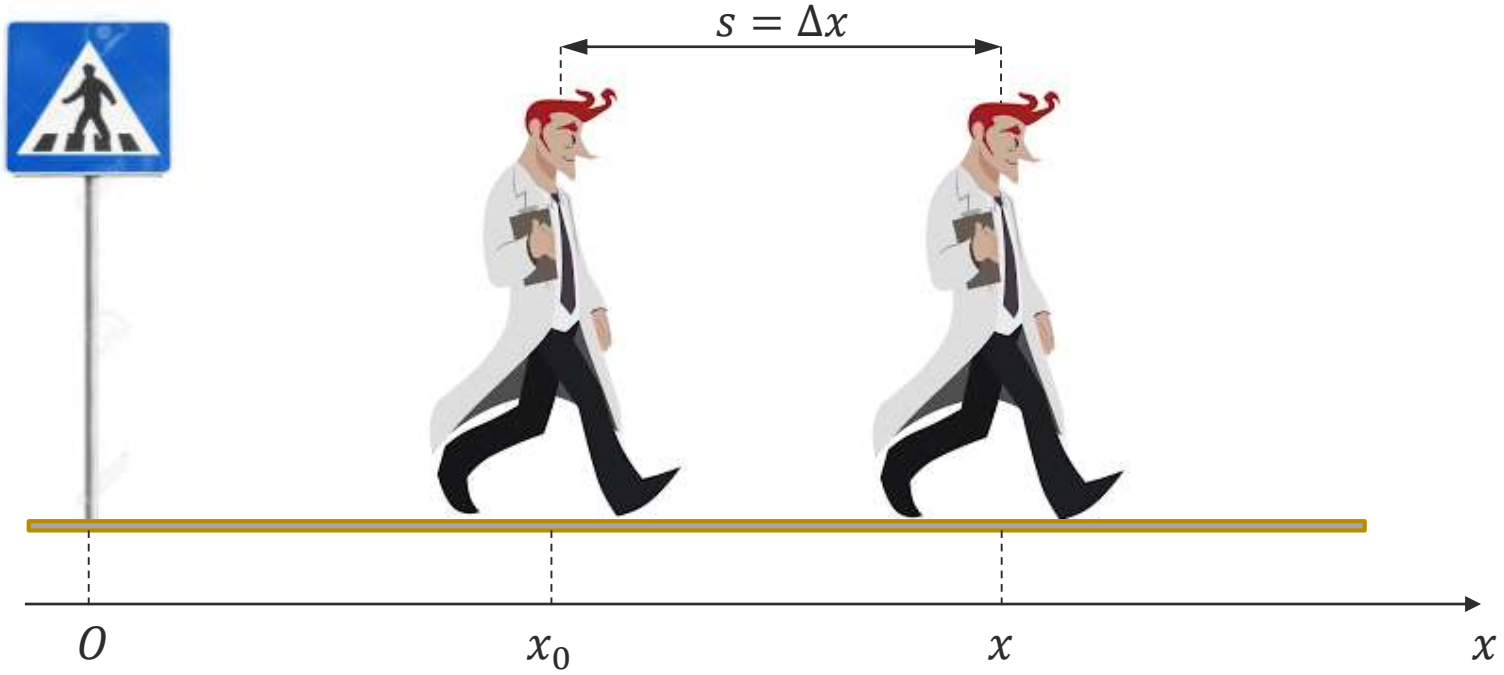
The velocity in a uniform linear motion is defined as the ratio of the displacement and the time over which this displacement occurs:

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

where v and Δx are the magnitudes of the corresponding vectors.

Let's mark the initial instant with $t_1 = 0$, and instant $t_2 = \mathrm{t}$ and $\Delta t = t_2 - t_1 = t$.

For the x-axis, we take the line along which the man is moving. We choose the direction of motion of the body as the positive direction of the axis (picture)



The distance *s* of a body in a uniform rectilinear motion is equal to the magnitude of the displacement. Consequently, the distance of a man in the motion is equal to the magnitude of the velocity multiplied by the time:

$$s = v \cdot t$$

Thus we obtain the following expression for the x-coordinate of the man at instant *t:*

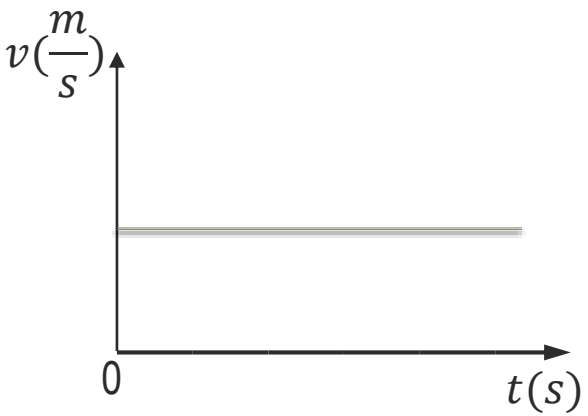
$$x = x_0 + s = x_0 + vt$$

where x_0 is the coordinate of the body at the initial instant t_1 = 0.

If the man is moving in negative direction of the x axis, than the expression for the x-coordinate of the body at instant *t* is given by: $x = x_0 - s = x_0 - vt$

Example:The initial coordinate of a man moving with a constant velocity 5 m/s is -10m.
When does the man reach the point with coordinate 10m? What distance does the man cover in this time?

UNIFORM MOTION GRAPHS



Graph of velocity versus time

Time is on the x-axis and velocity is on the y-axis.

The straight horizontal line in the graph shows that the body velocity does not change as time goes by, so the body is moving at a constant velocity.

Velocity is positive and body is moving to the right.

Graph of displacement versus time

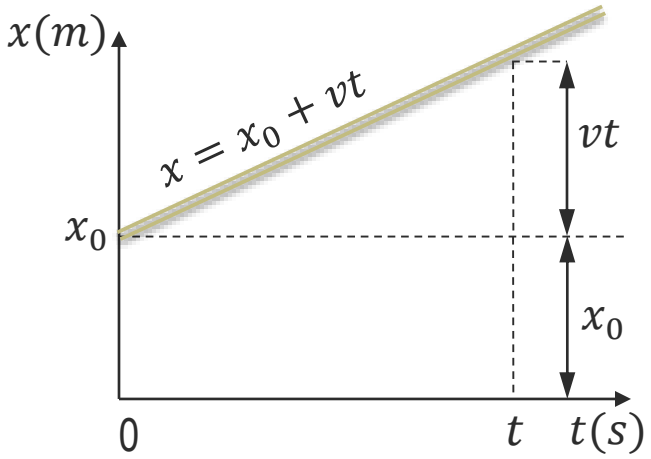
Time is on the x-axis and displacement is on the y-axis.

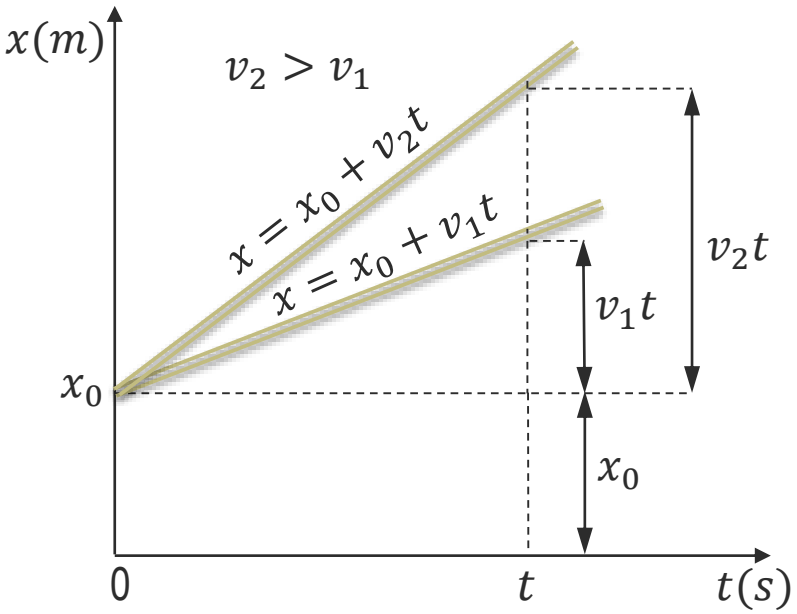
Comparing this graph with standard equation of a straight line, y=kx+n, we see that slope of this graph gives the velocity.

The word *slope* is often used in reference to the graphs of physical data. Regardless of the type of data, the *slope* is given by:

$$\text{Slope}=\frac{\text{change in vertical axis}}{\text{change in horizontal axis}}$$

The slope of graph is positive, which means that the velocity is positive.





Graph of displacement versus time

The slope of the line graphs depends on the value of the velocity (it shows how fast the object is going).

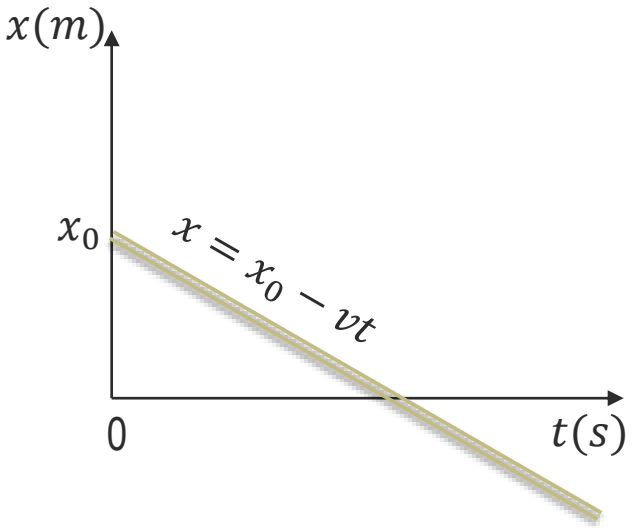
The picture shows two graphs for two different values of velocity . For the same time t the coordinate of a body with velocity v_2 is larger than the distance of a body with velocity v_1. So the graph with the larger velocity v_2 is steeper than the graph with a smaller velocity v_1. So if the value of velocity is higher (body is traveling faster), than the graph of displacement versus time is steeper.

Graph of displacement versus time

Time is on the x-axis and displacement is on the y-axis.

The time when the graph intersects the the axis is the time the moving object goes past point O, the point from which displacement is measured.

The slope of graph is negative, which means that the velocity is negative.

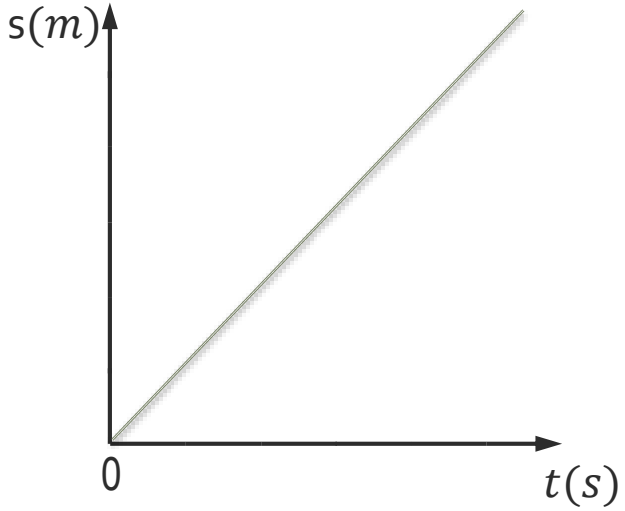


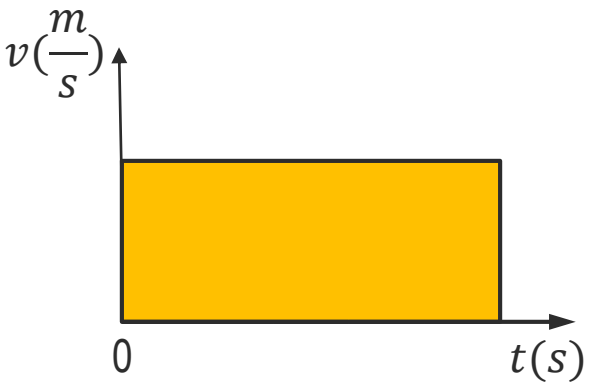
Graph of distance versus time

Time is on the x-axis and distance is on the y-axis.

A graph of distance versus time for uniform motion gives a diagonal line. It goes through the origin.

Time is increasing to the right, and distance is increasing constantly with time (it means it has the same increase in distance in a given time). Constant speed is shown by diagonal line on a graph.





The area under the velocity versus-time graph in a particular time interval equals the displacement in that time interval.

This area takes on the shape of a rectangle can be calculated using the appropriate equation.

PROBLEMS

1. During a hard sneeze, your eyes might shut for 0.50 s. If you are driving a car at 90 km/h during such a sneeze, how far does the car move during that time?

. 2. The distance between the towns A and B is 180km. Two cars set off simultaneously from the towns towards each others. The car from A travels at velocity $72\ \frac{km}{h}$, and one from B at velocity $65\ \frac{km}{h}$.
Find the time that will elapse before they meet and distance of towns A and B from meeting point?

3. Two cars are moving along the same straight road in the same direction. The car at the front has velocity of 50km/h and the car at the back has velocity of 100 km/h.If in the starting point, the distance between two cars was 30 km, how long will it take second car to catch the first one?

4. Let Δt=5s be the time that elapses from the moment you see the flash of lightning until the moment when the lightning strike is heard. If the speed of sound is 340 m/s and the speed of light is 300,000 km/s determine the distance from the lightning strike?

5. Man walks 60m for 40s. Draw the graph showing:
   a) variation of velocity with time
   b) variation of distance with time

6. The graph shows variation of car velocity with time.
   Find the average speed of the car for 50s of motion?