PHYSICAL QUENTITIES DESCRIBING MOTION

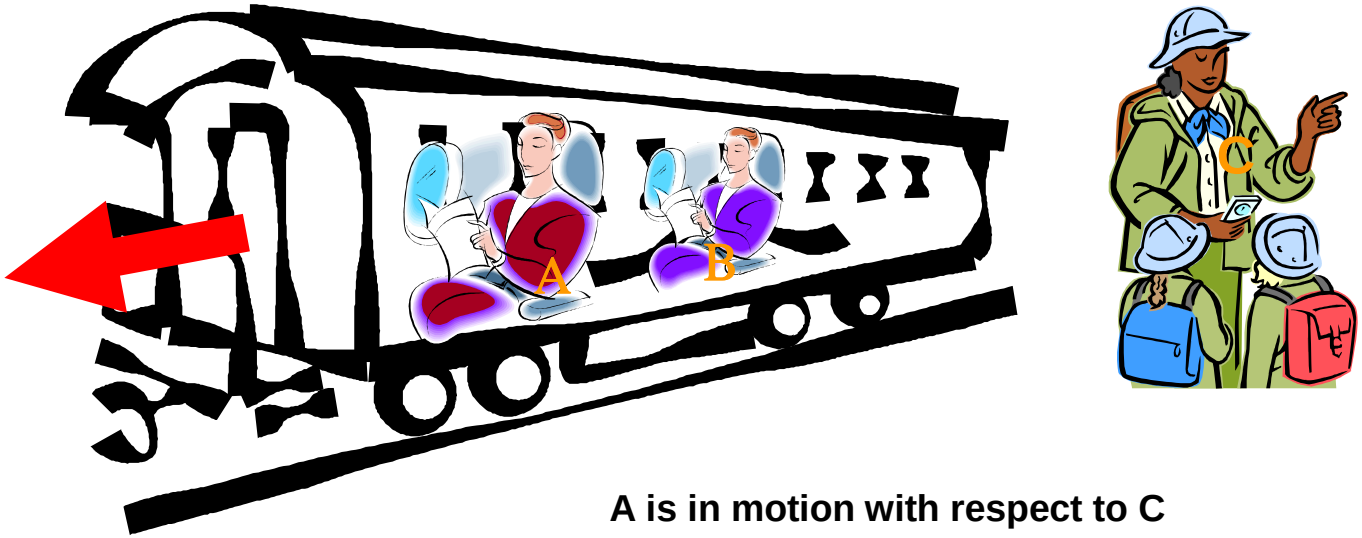
Questions:

- ✓**What is motion?**
- ✓**Displacement in motion along a staight line.**
- ✓**Average velocity in motion along a straight line.**
- ✓**Instantaneous velocity in motion along a straight line.**
- ✓**Average acceleration in motion along a straight line.**
- ✓**Instantaneous acceleration in motion along a straight line.**
- ✓**Quantities describing motion.**
- ✓**Motion along a straight line with constant velocity.**
- ✓**Motion along a straight line with constant acceleration.**
- ✓**Find instantaneous acceleration for a particle moving in a circle with constant speed.**
- ✓**What is the diffrence between tangential acceleration and radial acceleration.**

WHAT IS MOTION?

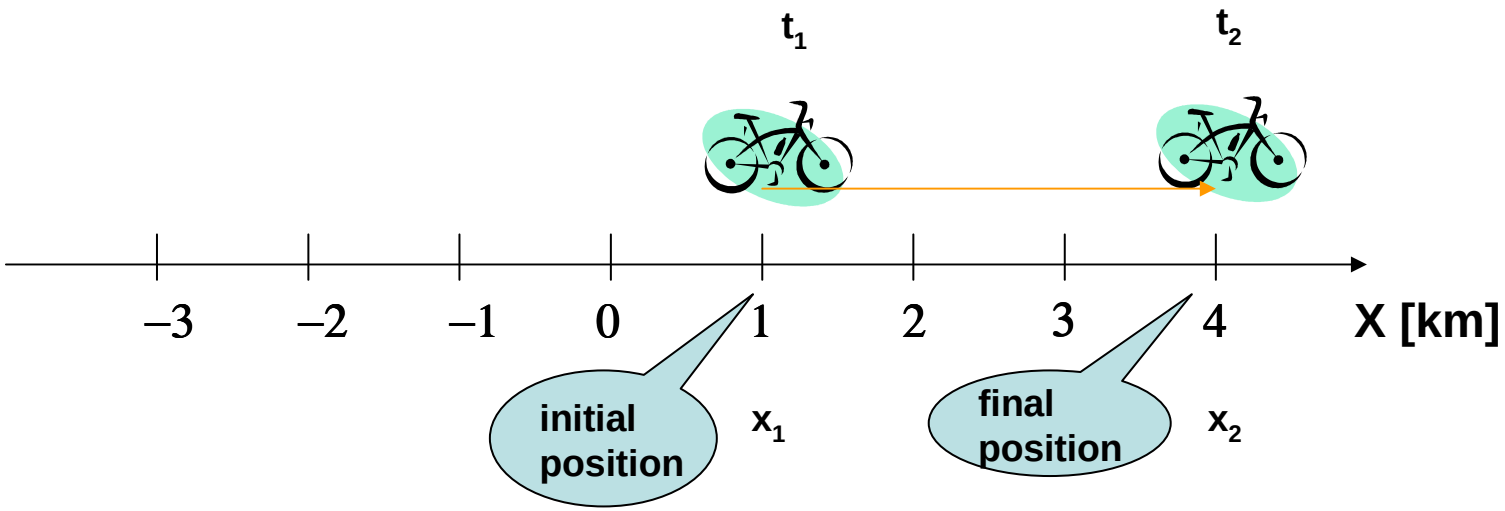
Motion is a change in position of an object with respect to time.

Motion is always observed and measured relative to a frame of reference. As a result of this the *absolute motion* cannot be determined; this is emphasised by the term *relative motion.*



A is in motion with respect to C
A is at rest with respect to B

Displacement in motion along a straight line.



$$\Delta x = x_2 - x_1$$

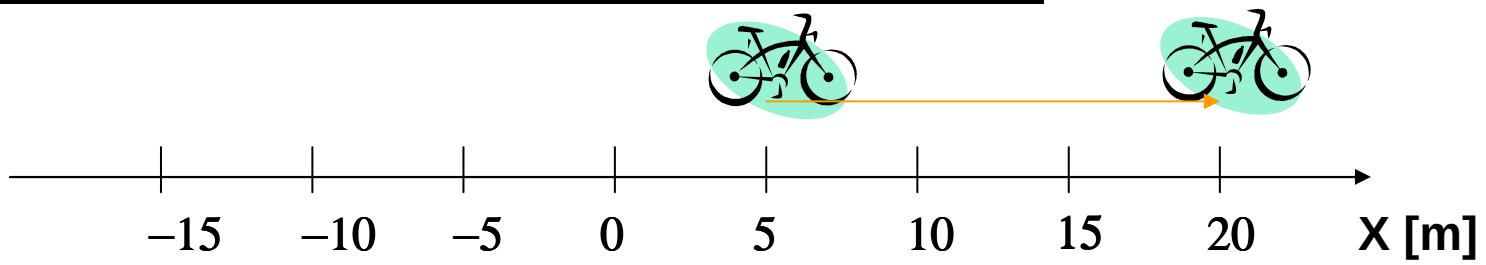
$$\Delta t = t_2 - t_1$$

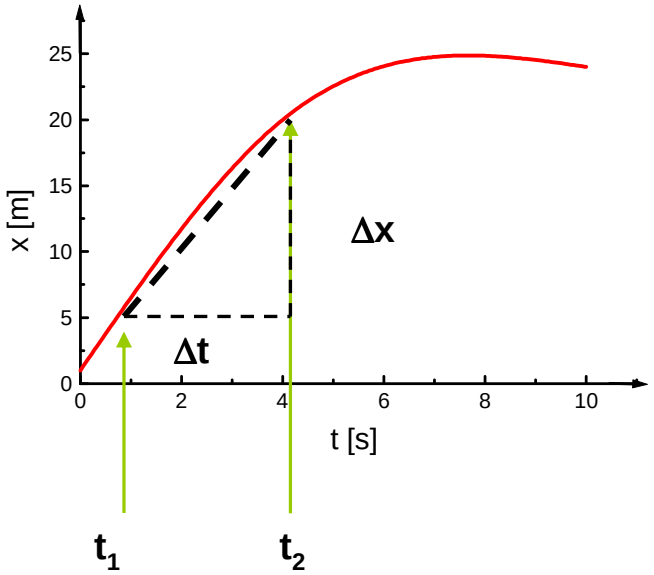
Checkpoint

There are four pairs of initial and final positions along an x axis: (a) -3 m, +5 m; (b) -3 m, -7 m; (c) 7 m, -3 m; (d) 1 m, -1 m. In all cases calculate displacement and its magnitude.

PHYSICAL QUENTITIES DESCRIBING MOTION

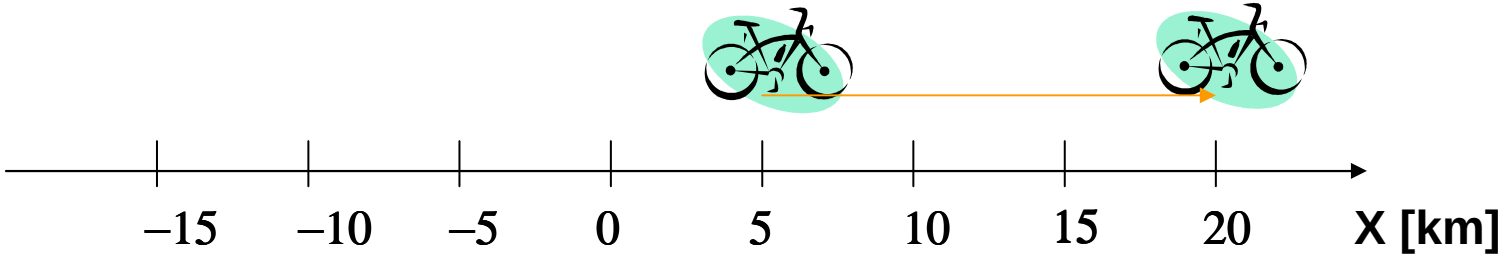
Average velocity in motion along a straight line.

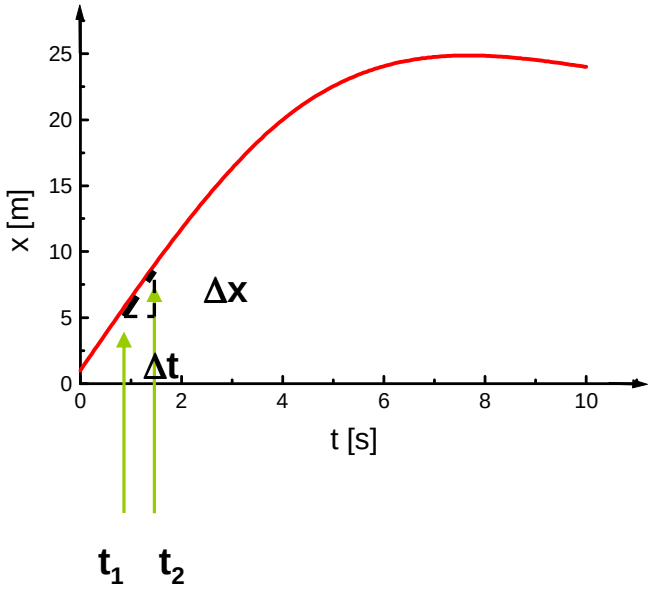




$$V_{av} = \frac{\Delta x}{\Delta t}$$

Instantaneous velocity in motion along a straight line.





$$V = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$

$$V = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

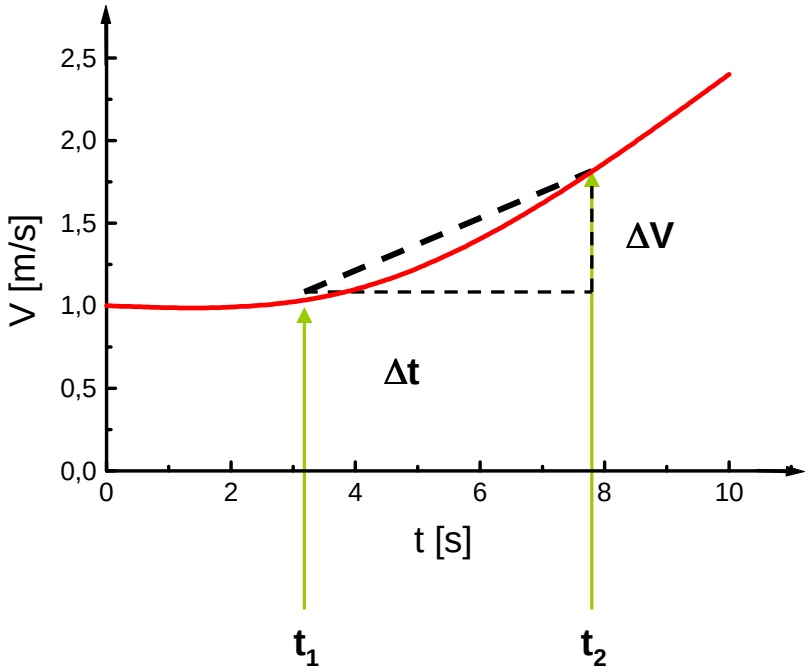
Speed is the magnitude of velocity

Checkpoint

The position of a particle is given by the following equation: (a) $x=3t-2$; (b) $x=-3t^2-2$; (c) $x=2$. In each equation, x is in meters and t is in seconds. Calculate velocity and make a plot of velocity versus time. Consider only $t>0$.

PHYSICAL QUENTITIES DESCRIBING MOTION

Average accereration in motion along a straight line.

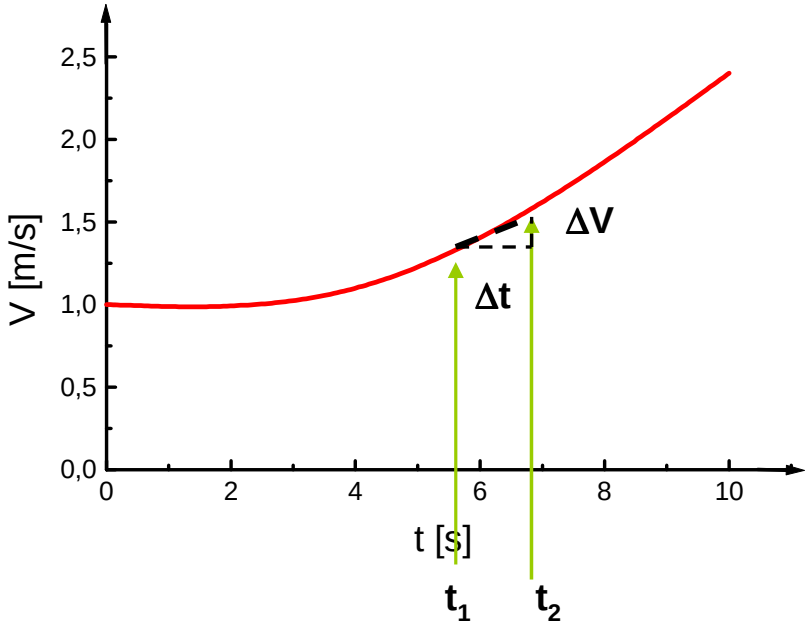


$$a_{av} = \frac{\Delta V}{\Delta t}$$

$$a_{av} = \frac{V_2 - V_1}{t_2 - t_1}$$

PHYSICAL QUENTITIES DESCRIBING MOTION

Instantaneous accereration in motion along a straight line.

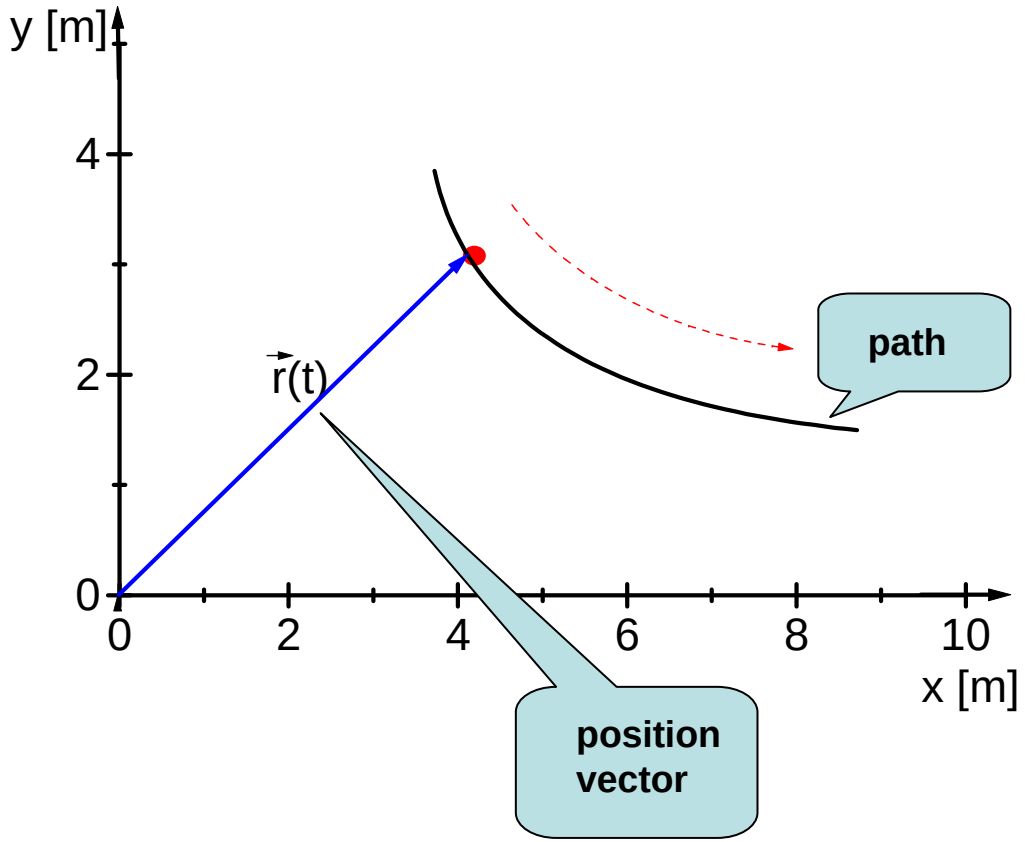


$$a = \lim_{\Delta t \to 0} \frac{\Delta V}{\Delta t} = \frac{dV}{dt}$$

Checkpoint

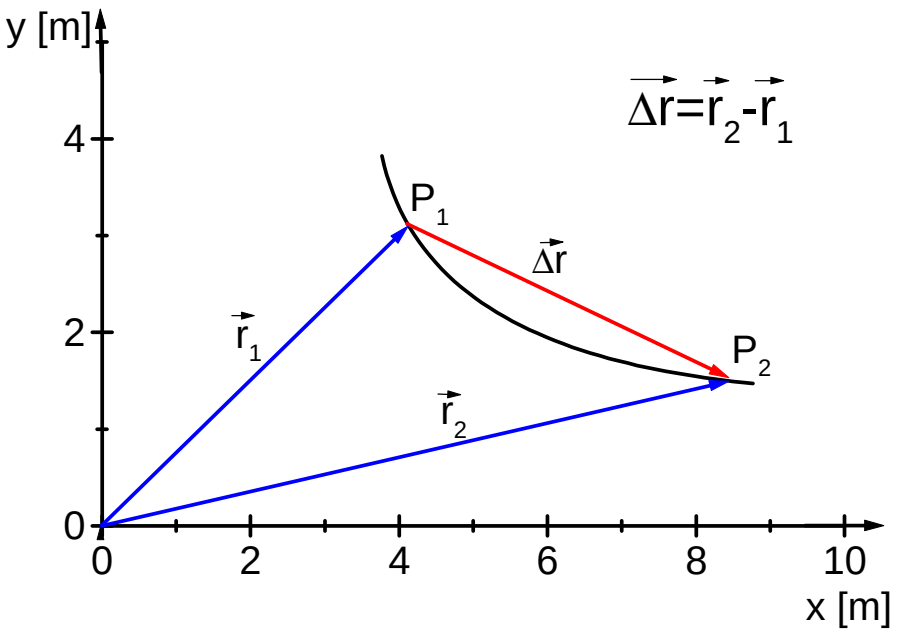
The position of a particle is given by the following equation: $x=2t^2+t-1$. In this equation, x is in meters and t is in seconds. Calculate velocity and acceleration. Make plots of velocity versus time and acceleration versus time. Consider only $t>0$.

Motion in a plane



PHYSICAL QUENTITIES DESCRIBING MOTION

Quantities describing motion



Displacement:

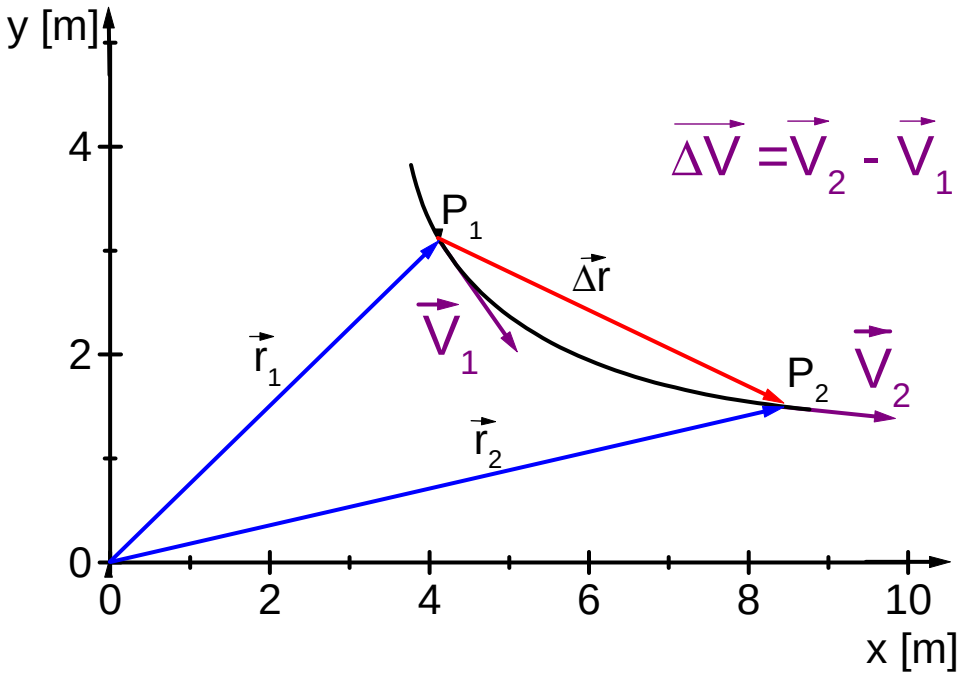
$$\vec{\Delta r} = \vec{r}_2 - \vec{r}_1$$

Average velocity:

$$\vec{V}_{av} = \frac{\vec{\Delta r}}{\Delta t}$$

Instantaneous velocity:

$$\vec{V} = \lim_{\Delta t \to 0} \frac{\vec{\Delta r}}{\Delta t} = \frac{d\vec{r}}{dt}$$



Average acceleration

$$\vec{a}_{av} = \frac{\vec{\Delta V}}{\Delta t}$$

Instantaneous acceleration

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\vec{\Delta V}}{\Delta t} = \frac{d\vec{V}}{dt}$$

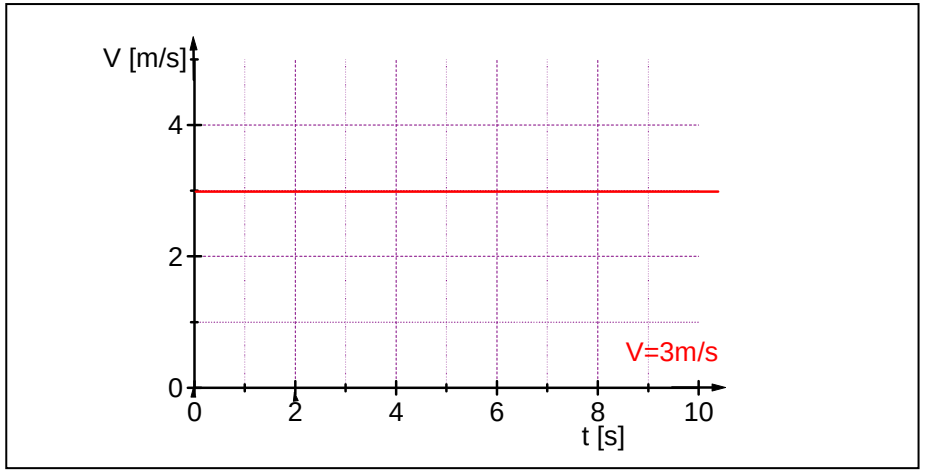
Motion along a straight line with constant velocity

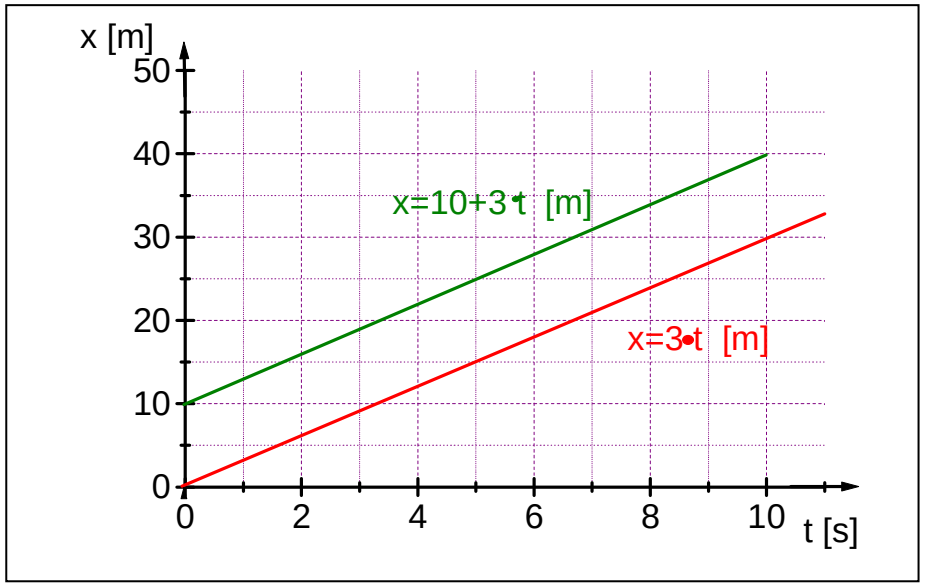
$$\vec{V} = \text{const}$$

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

$$x = x_o + V\,t$$

$$(or\ \ s = s_o + V\,t)$$





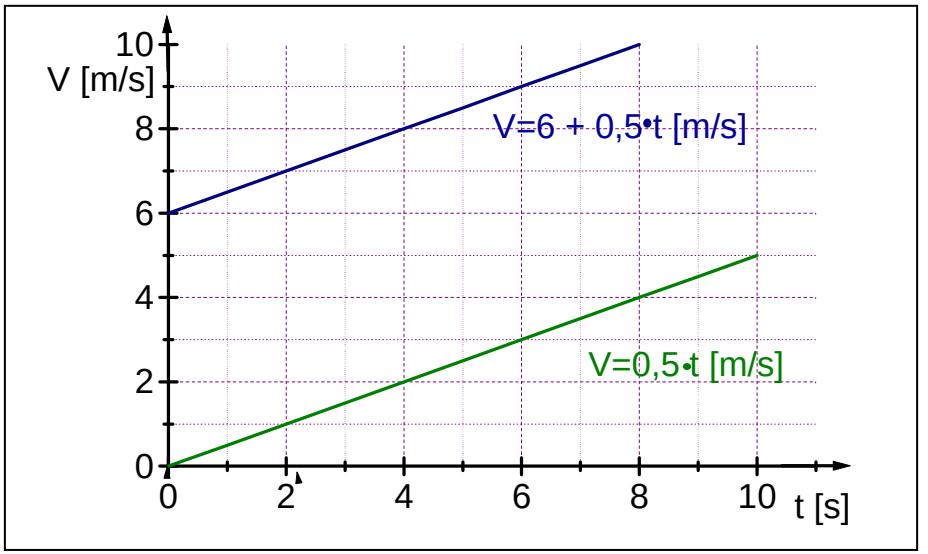
Motion along a straight line with constant acceleration

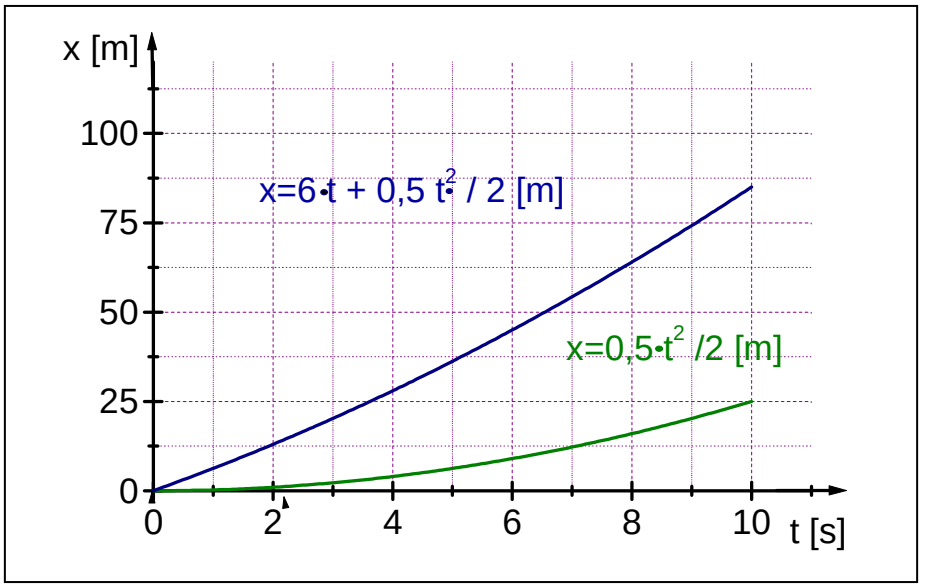
Case 1

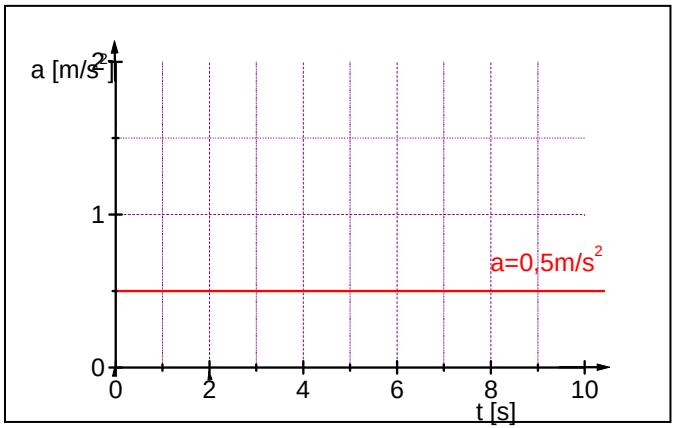
$\vec{a}$=const & $\vec{V}_0$ is of the same direction as $\vec{V}_o$ or V_o=0 !

$$V = V_o + a\,t$$

$$x = V_o\,t + a\,t^2/2$$





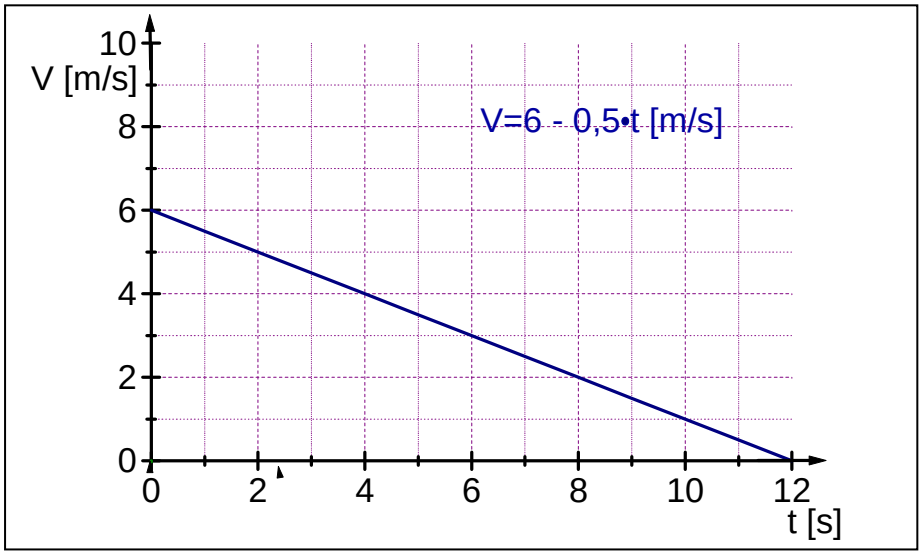


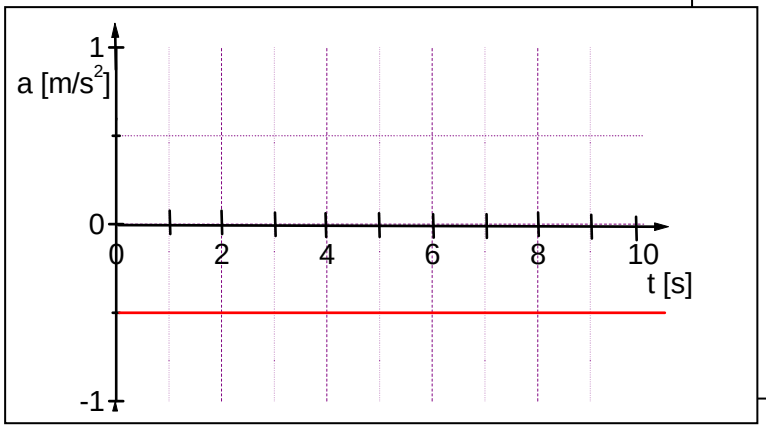
Case 2

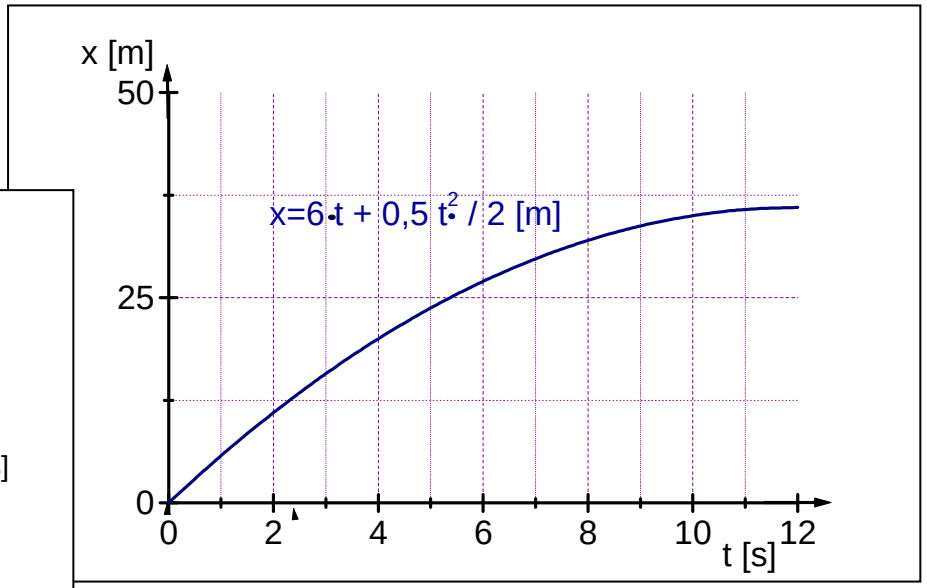
$\vec{a}$=const & $\vec{V}_0$ is of opposite direction as $\vec{V}_o$!

$$V = V_o - a\,t$$

$$x = V_o\,t - a\,t^2/2$$



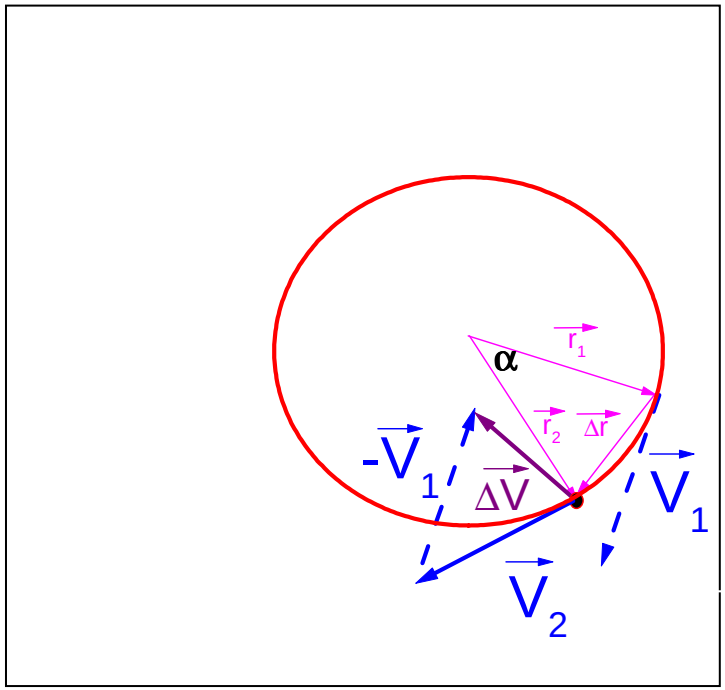


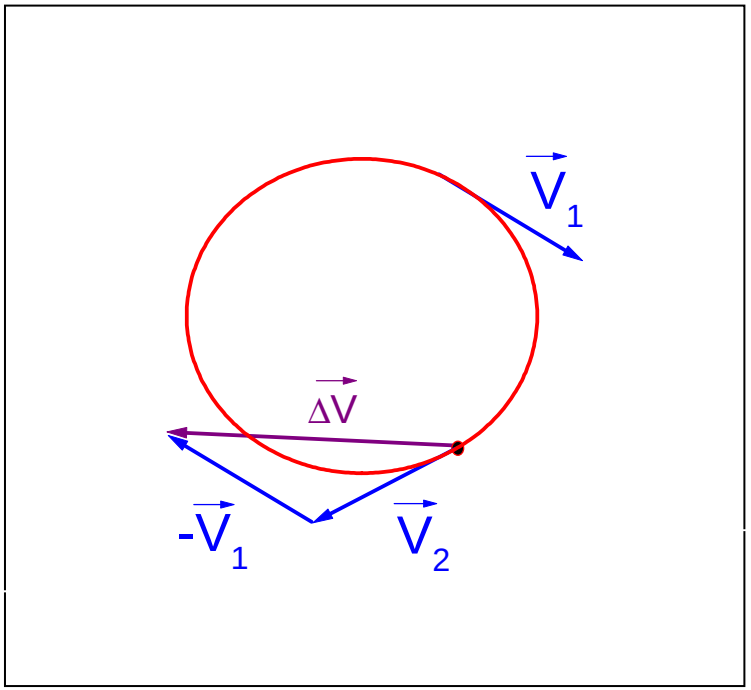


Checkpoint

A one coin is dropped from the Pacholek tower. It starts from rest and falls freely. Compute its position and velocity after 0.5 s and 1.0 s. The acceleration due to gravity is equal to 9.8 m/s^2 and it is downward.
The tower is 15 m high. Find the velocity, which the coin will approch at ground.

Find instantaneous acceleration for a particle moving in a circle with constant speed



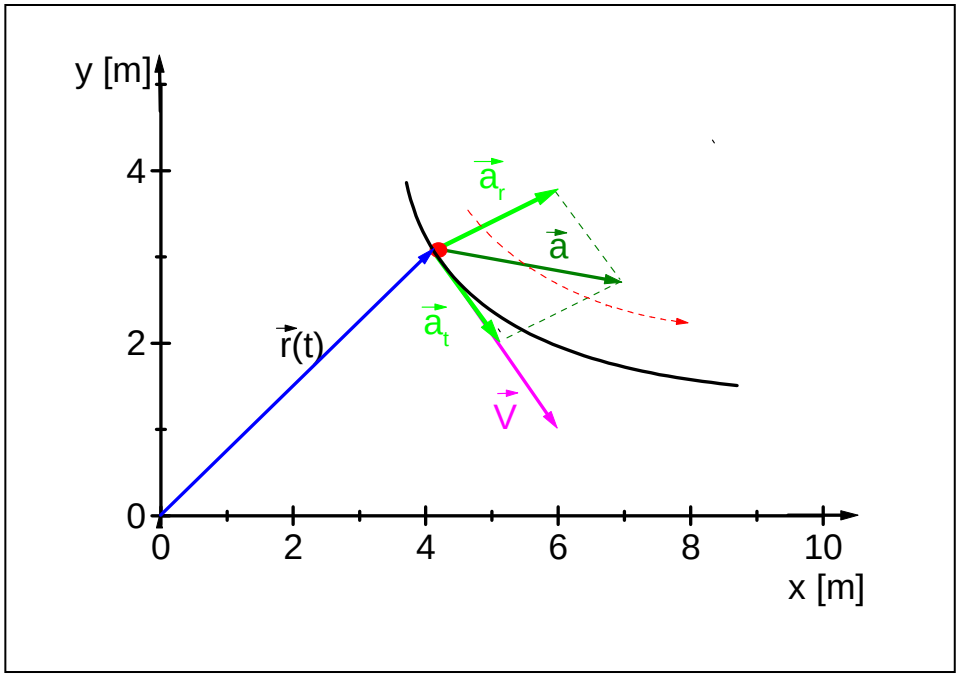


$$\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta \vec{V}}{\Delta t}$$

For small value of α: $\frac{s}{r} = \frac{\Delta V}{V}$

$$\frac{\Delta V}{\Delta t} = \frac{V \Delta t}{r} \Rightarrow \frac{\Delta V}{\Delta t} = \frac{V^2}{r} \Rightarrow a = \frac{V^2}{r}$$

What is the diffrence between tangential acceleration and radial acceleration



a_t is tangent to the path of a particle and arises from a change in the magnitude of velocity.
a_r is directed perpendicular to the path and arises from a change in the direction of velocity.