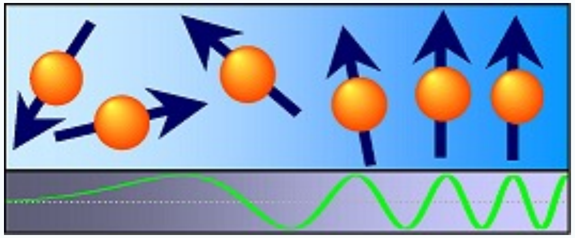
Experimental Physics
EP1 MECHANICS

- Motion Along a Line -



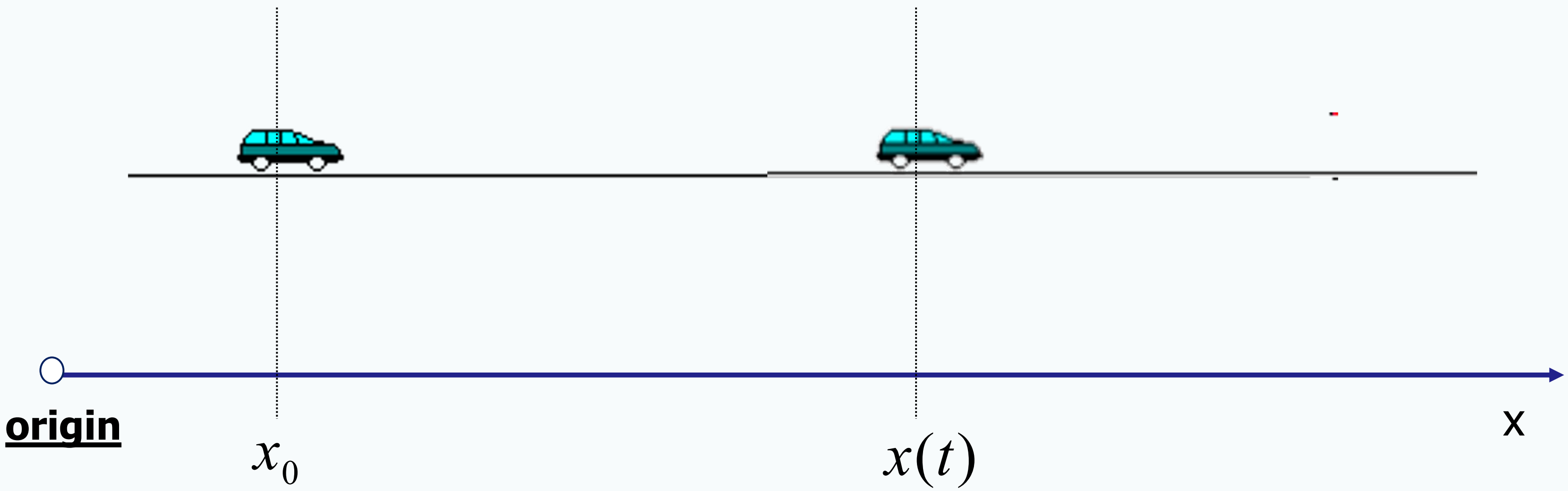
Rustem Valiullin

https://www.physgeo.uni-leipzig.de/en/fbi/applied-magnetic-resonance

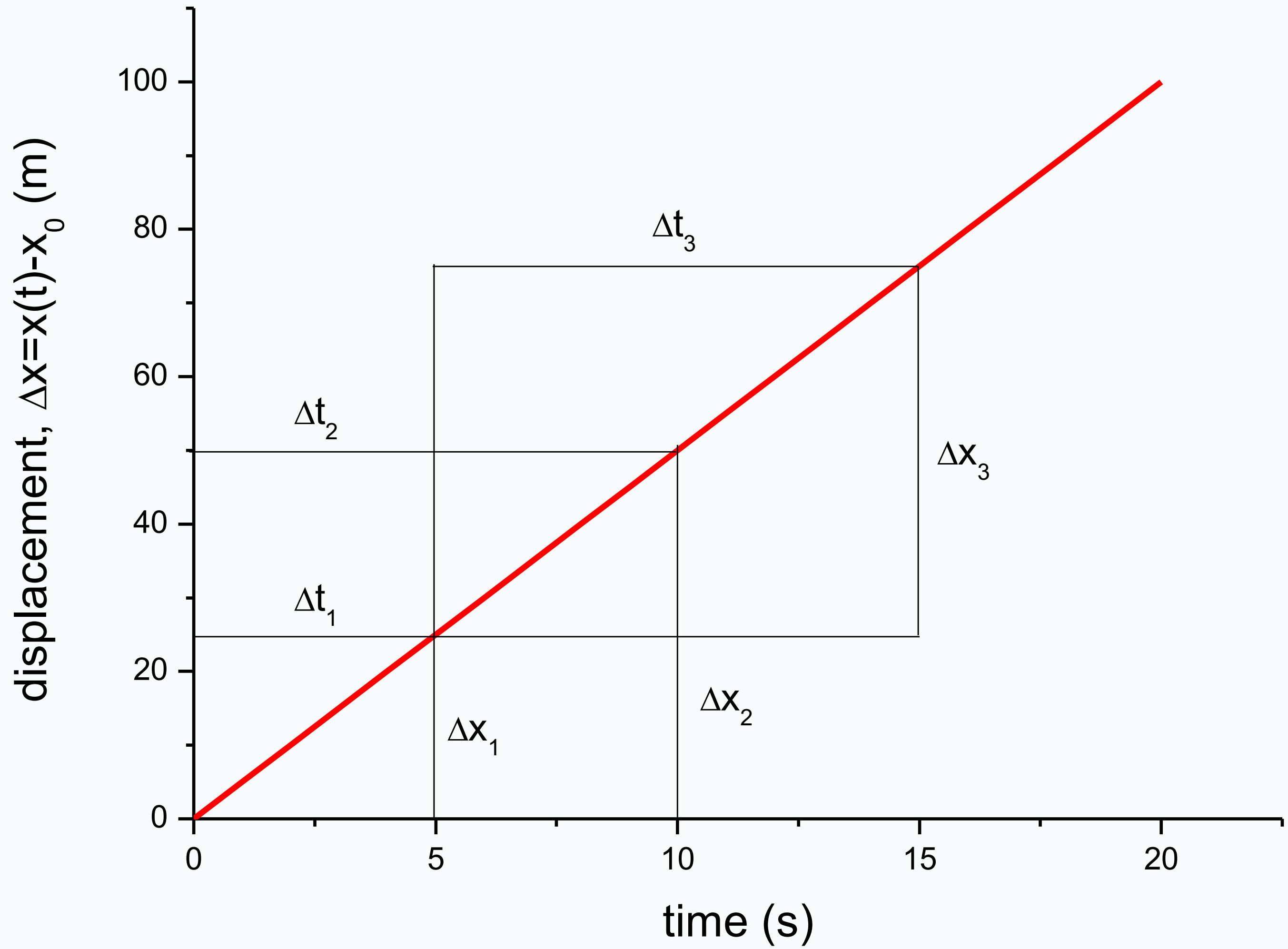
Kinematics

Three fundamental concepts on which kinematics is based upon:

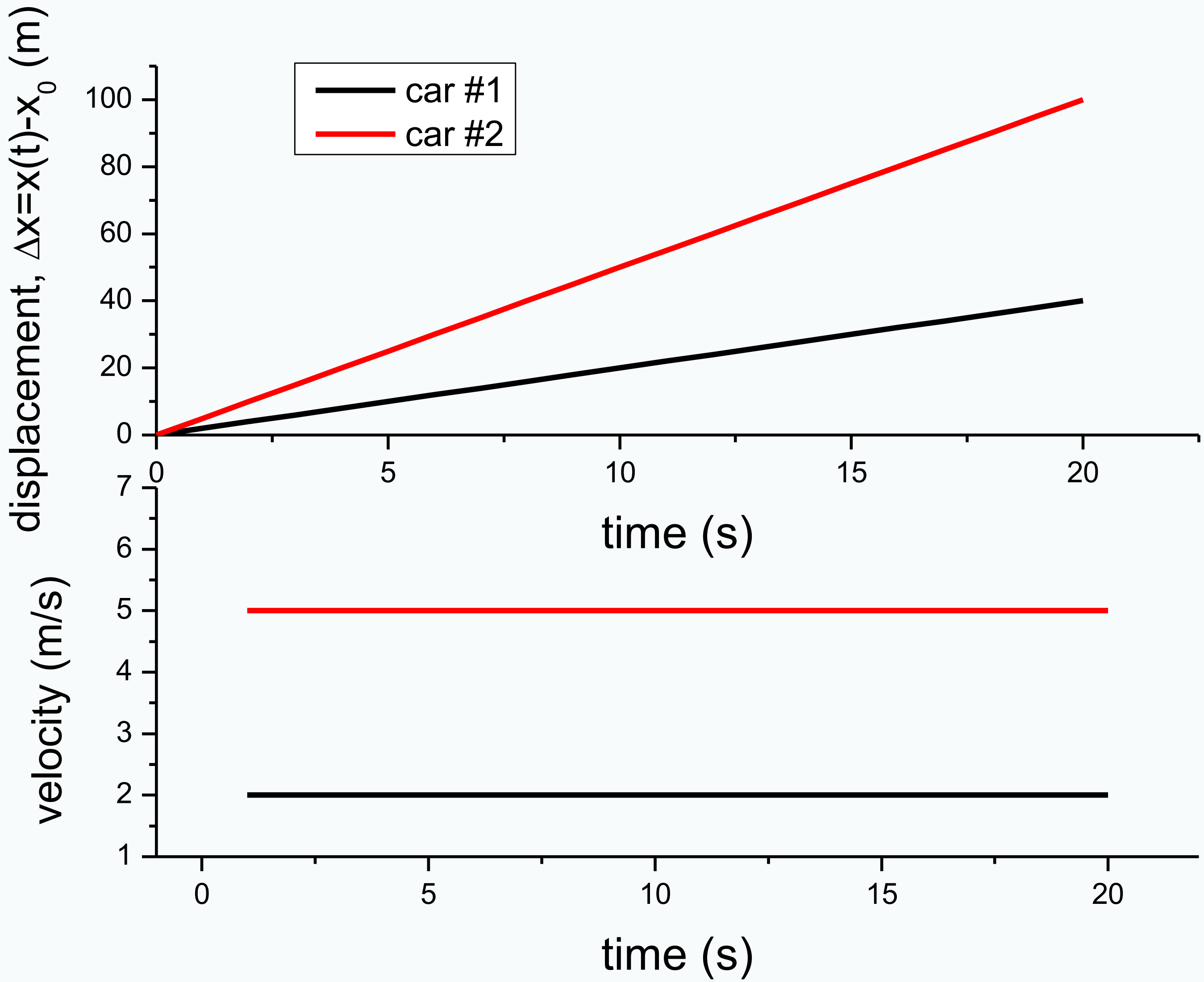
displacement **velocity** **acceleration**



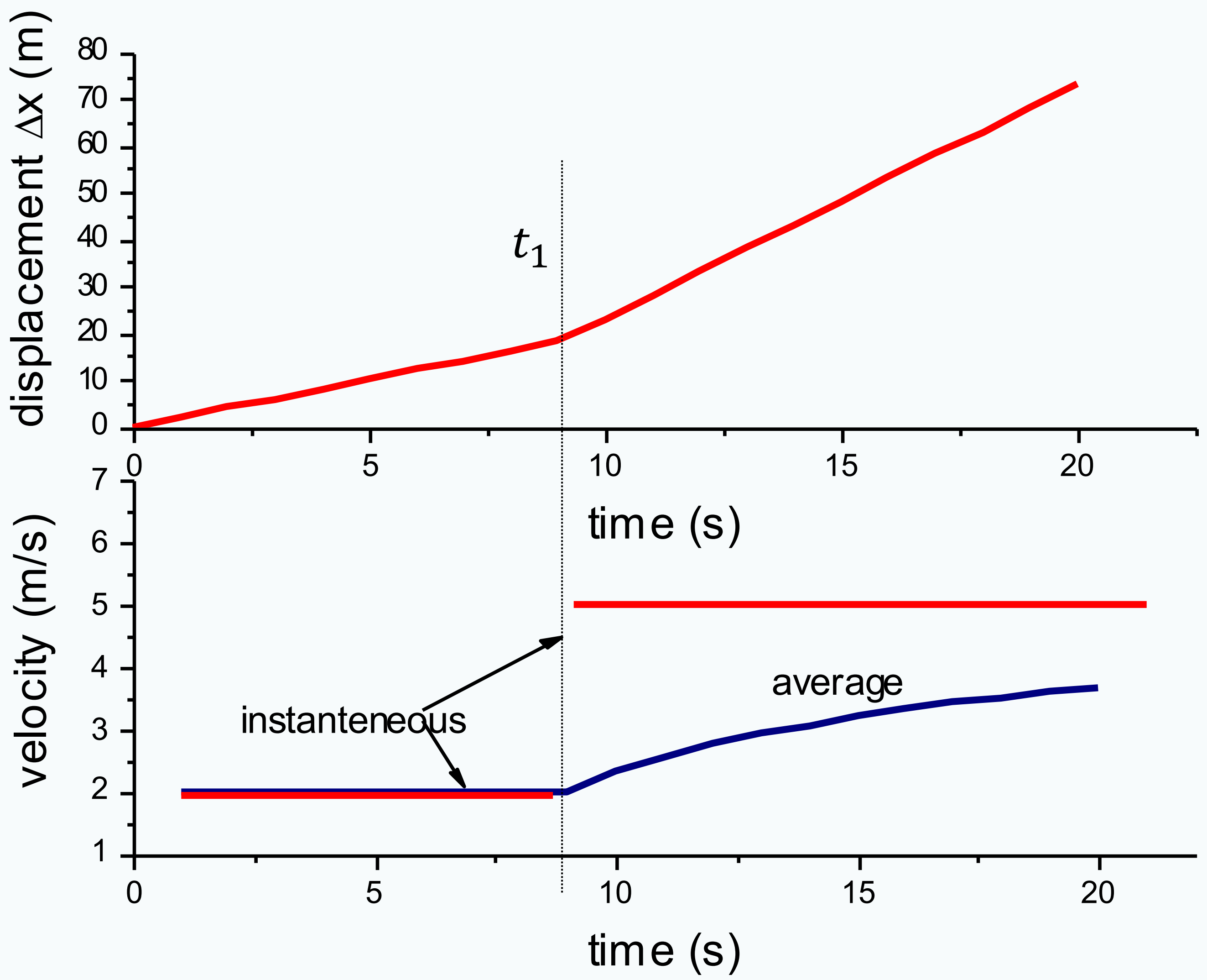
Constant velocity



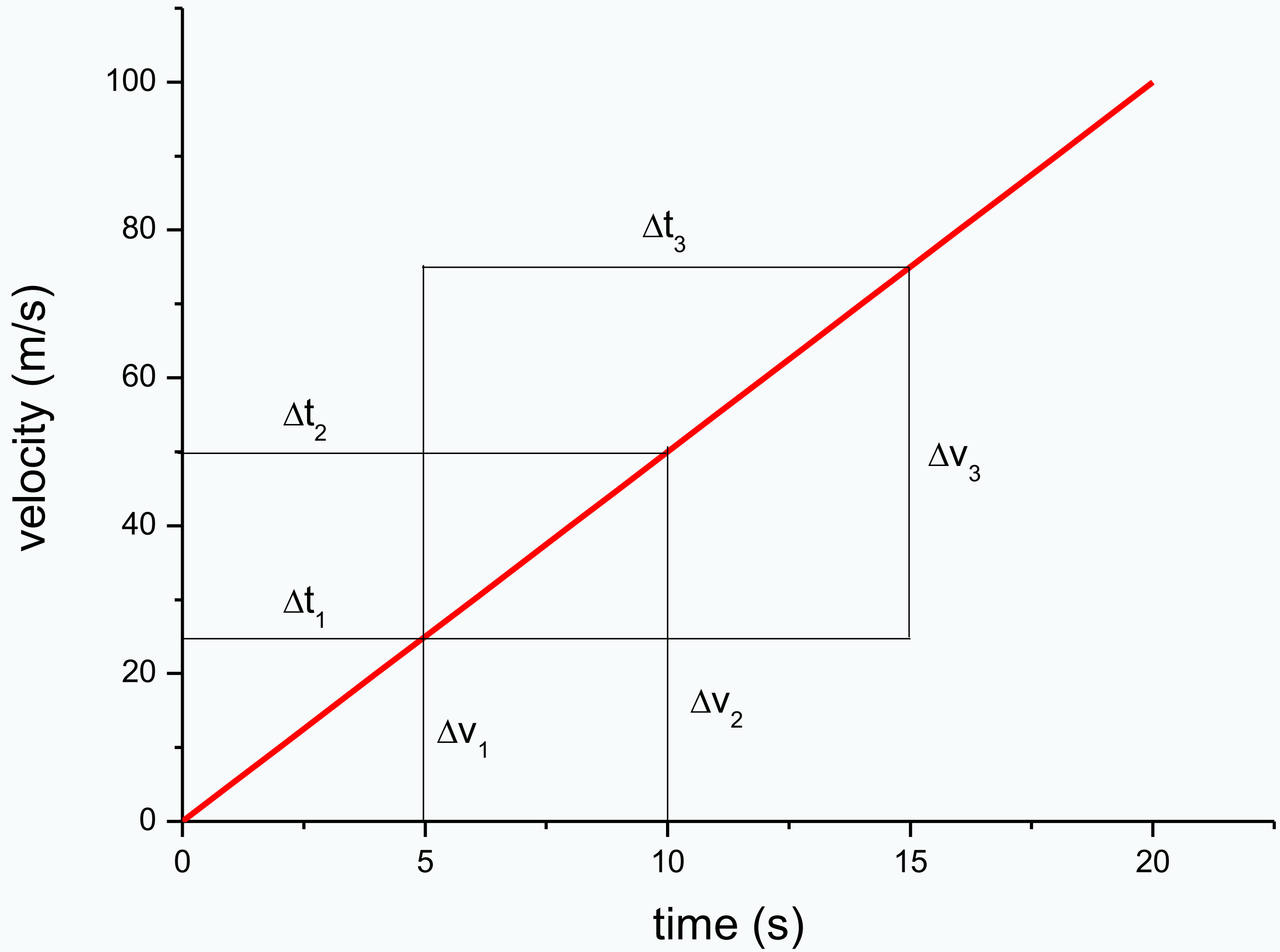
Constant velocity



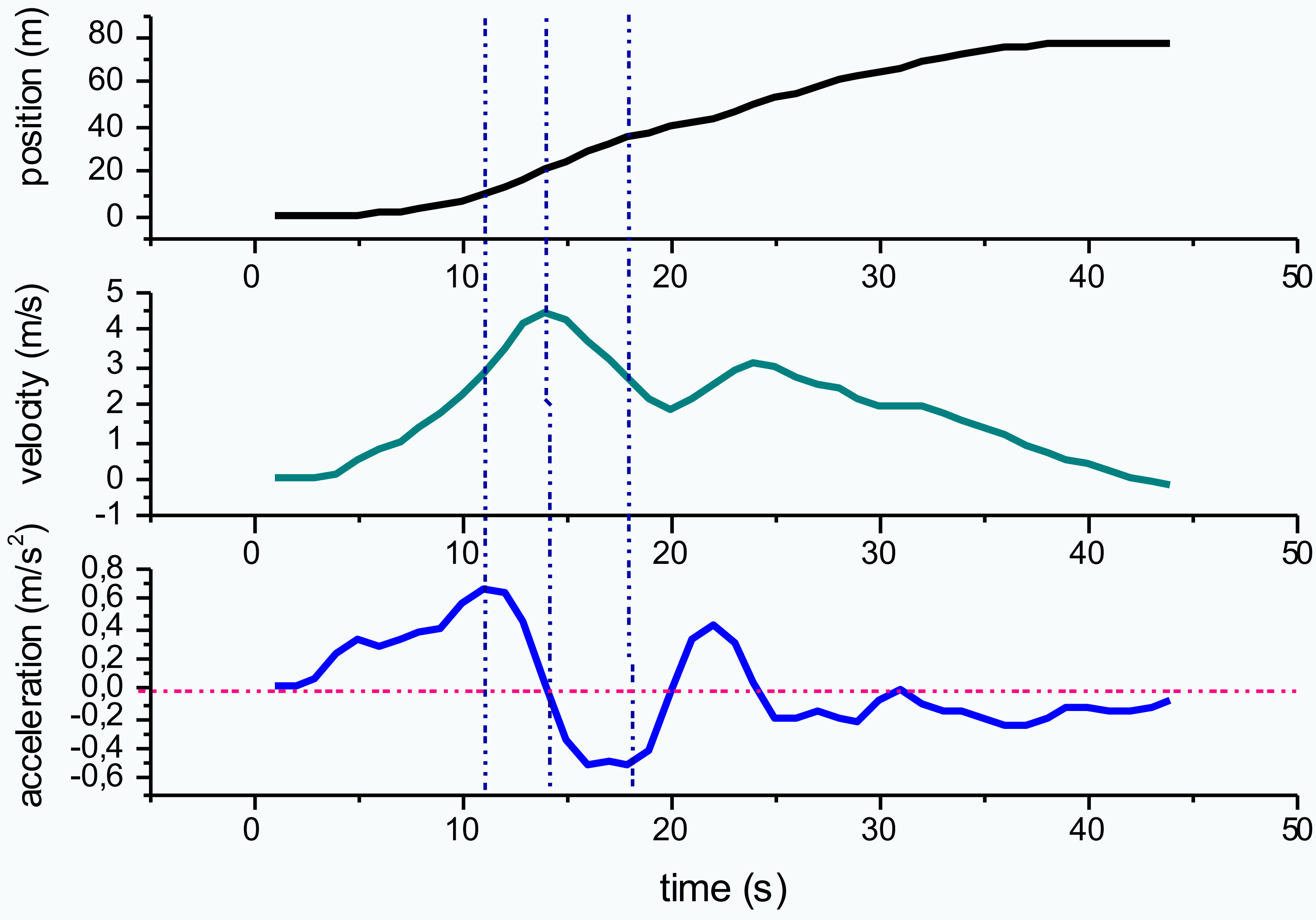
Changing velocity



Constant acceleration



Complex motion



Constant-acceleration kinematic equations

Number	Equation	Missing
1	$v=v_0+at$	Δx
2	$x=x_0+v_0t+at^2/2$	v
3	$v^2=v_0{}^2+2a(x-x_0)$	t
4	$x=x_0+(v+v_0)t/2$	a
5	$x=x_0+vt-at^2/2$	v_0

Free-fall acceleration

$$y_0 = 142 \text{ m}$$

$$a = -g = -9.8 \text{ ms}^{-2}$$

Time to reach the surface?
Suppose it was the Moon?

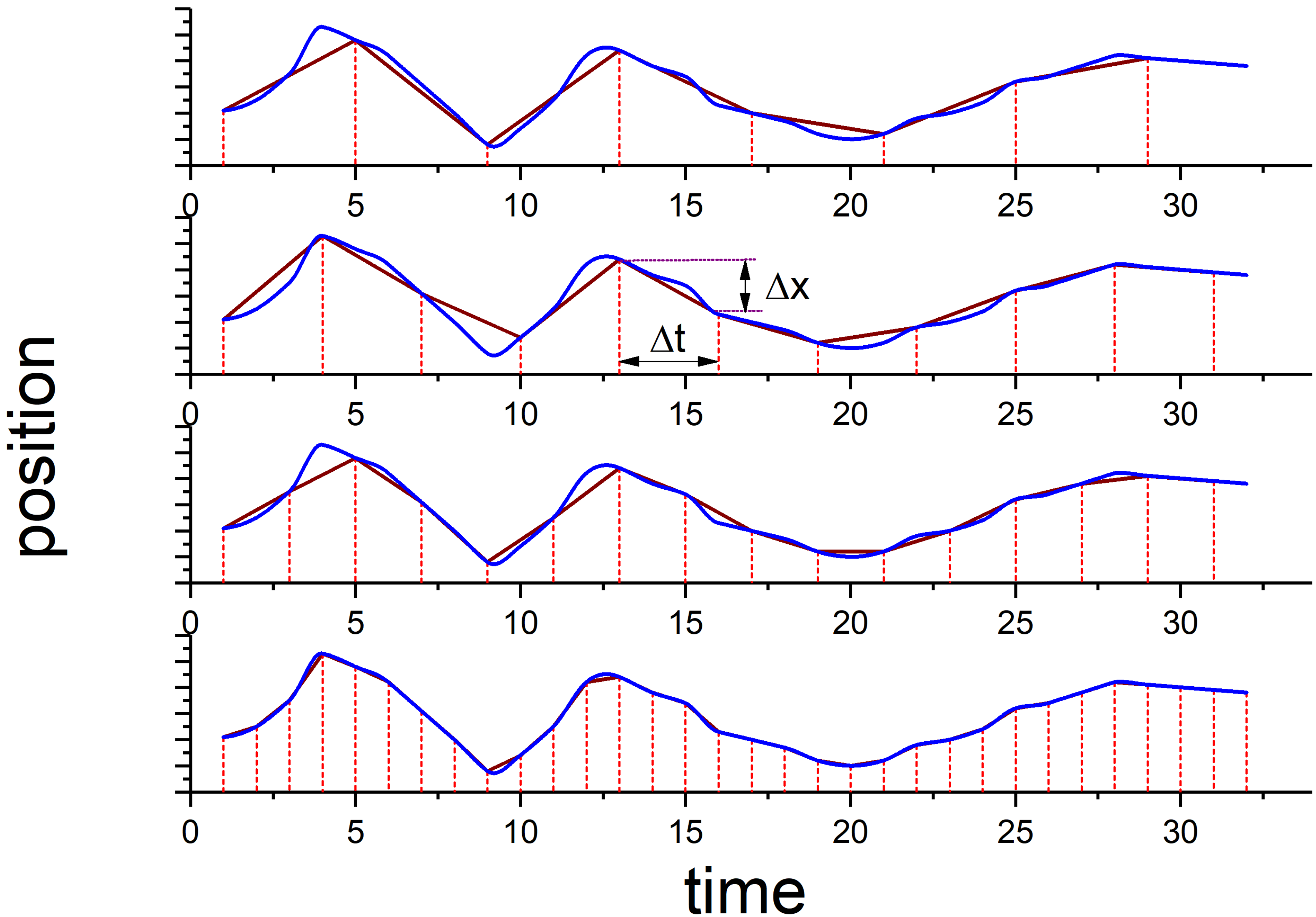
Position after each second
of the fall?

What will be the velocity
when the ball hits the surface?

How long does it take to
reach the half-height?

Suppose that we throw the ball upwards with an initial velocity of 20 m/s. What is the overall time to reach the ground?

Integral calculus



Kinematic equation from calculus

$$dv = a\,dt \qquad \int dv = \int a\,dt = a\int dt$$

$$v = a\,t + const = at + v_0$$

$$dx = v\,dt \qquad \int dx = \int v\,dt = \int (v_0 + a\,t)dt$$

$$x = \int v_0 dt + \int a\,t dt = v_0 t + \frac{1}{2}at^2 + const$$

$$\boxed{x = x_0 + v_0 t + \frac{1}{2}at^2}$$

To remember!

- Kinematics is about <u>position</u>, <u>displacement</u>, <u>velocity</u> and <u>acceleration</u>.
- <u>Average</u> and <u>instantaneous</u> velocities.
- <u>Average</u> and <u>instantaneous</u> accelerations.
- Five equations we have derived describe motion of a particle with <u>constant acceleration</u>.
- Important examples of such motion are <u>free-falling objects</u>.