Topic:	Graphical interpretations
Objective:	FK_10_03

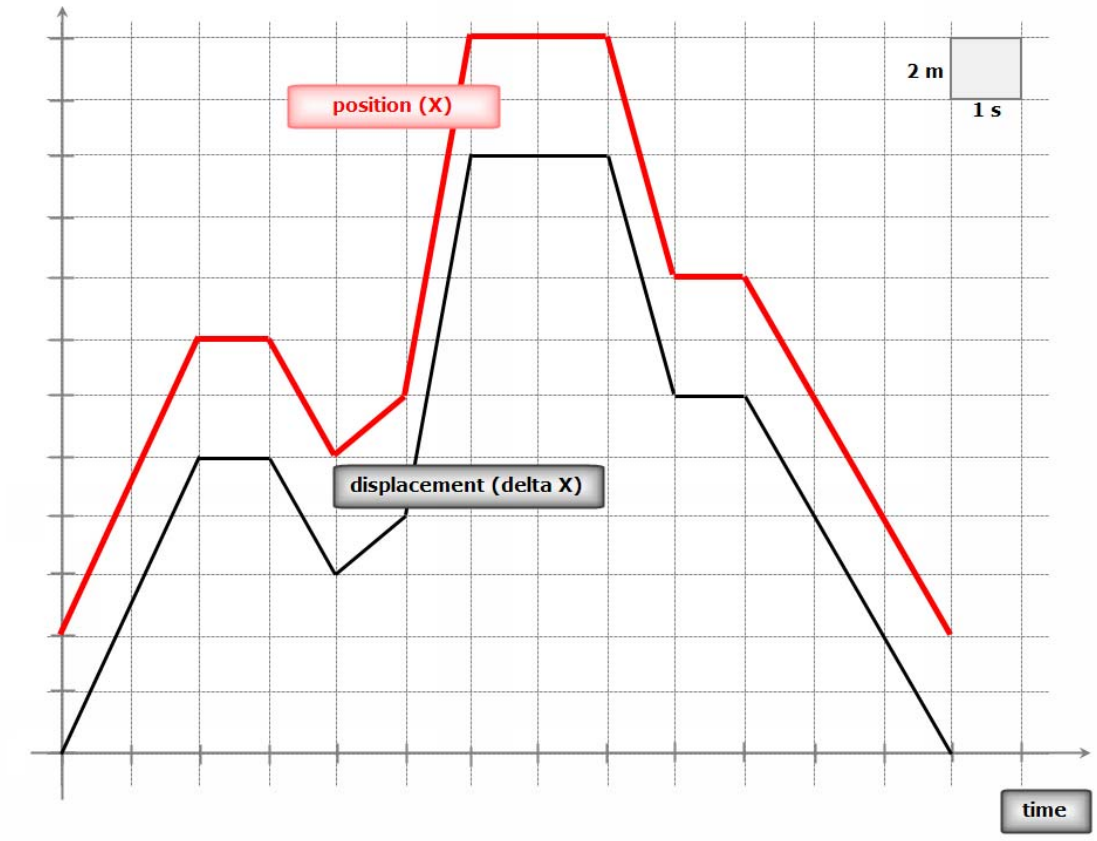
Given different graphics (position-displacement-velocity vs time)
the student must be capable of doing the following:

- **calculate the following variables: displacement, velocity and acceleration**

A body moving along the X axis: determinining the position-time graph

Let's suppose that a body is moving along the X axis according to the graph below and that its initial position is: $\vec{r}_0 = 4\,\vec{i}$ (m)

Determine the position – time graph:



The difference between position (distance from the origin) and displacement (change in position) is the initial position:

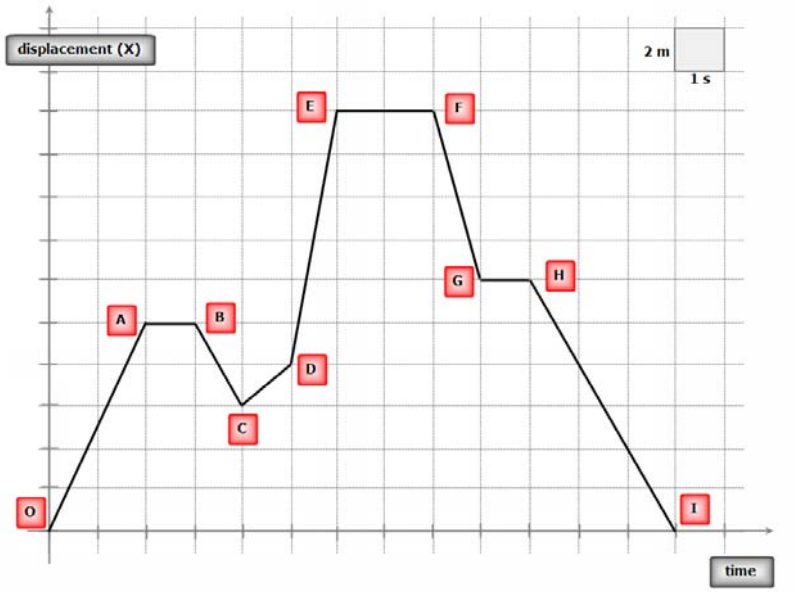
$$\Delta\vec{r} = \vec{r} - \vec{r}_0 \xrightarrow[\text{we can write}]{\text{in our case}} \Delta x = x - x_0 \rightarrow$$

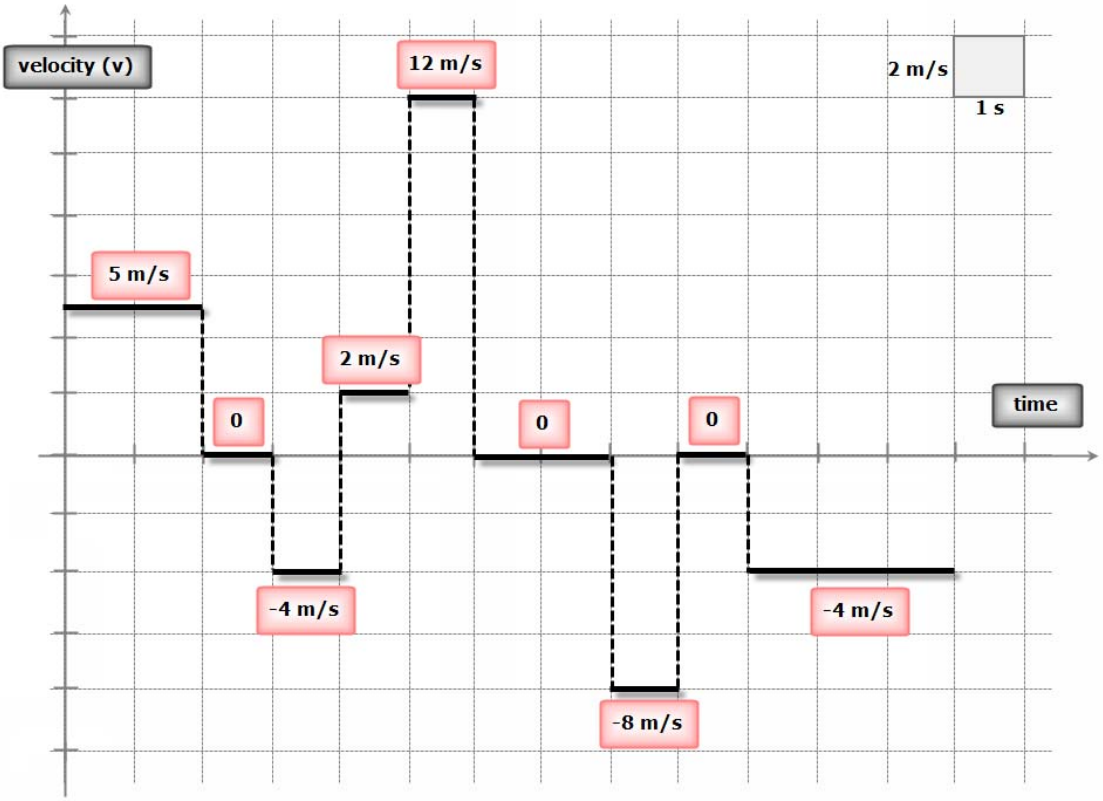
$$\xrightarrow[\text{position and displacement is:}]{\text{the difference between}} x - \Delta x = x_0$$

A body moving along the X axis: determinining the velocity-time graph

In the previous case,

- calculate the velocities of the different sections (O-A, A-B, B-C, C-D, ...)
- calculate the average velocity in the section O-H
- calculate the average speed in the section O-H
- calculate the average velocity in the section O-I
- draw the velocity – time graph





velocity = slope (displacement-time graph)

$OA \rightarrow v = \frac{10\ m}{2\ s} = 5\ \frac{m}{s}$; $AB \rightarrow v = \frac{0\ m}{1\ s} = 0$;

$BC \rightarrow v = \frac{-4\ m}{1\ s} = -4\ \frac{m}{s}$; $CD \rightarrow v = \frac{2\ m}{1\ s} = 2\ \frac{m}{s}$;

$DE \rightarrow v = \frac{12\ m}{1\ s} = 12\ \frac{m}{s}$; $EF \rightarrow v = \frac{0\ m}{2\ s} = 0$;

$FG \rightarrow v = \frac{-8\ m}{1\ s} = -8\ \frac{m}{s}$; $GH \rightarrow v = \frac{0\ m}{1\ s} = 0$;

$HI \rightarrow v = \frac{-12\ m}{3\ s} = -4\ \frac{m}{s}$

The average velocity in O-H:

$$\bar{v} = \frac{\Delta x}{t} = \frac{12\ m}{10\ s} = 1.2\ \frac{m}{s}$$

The average speed in O-H:

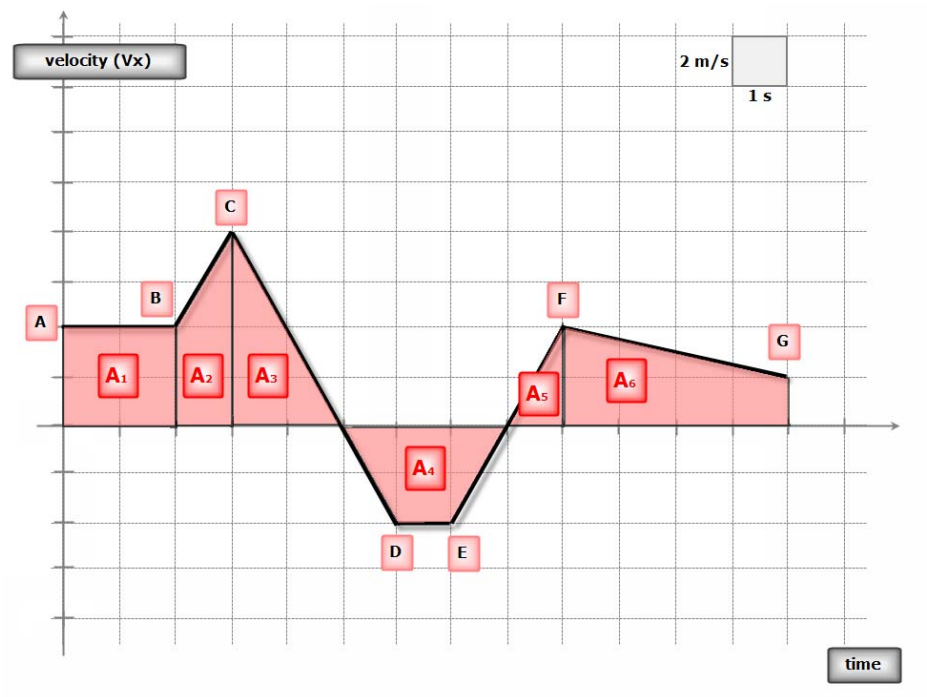
$$speed = \frac{10\ m + 4\ m + 2\ m + 12\ m + 8\ m}{10\ s} = 3.6\ \frac{m}{s}$$

The average velocity in O-I:

$$\bar{v} = \frac{\Delta x}{t} = \frac{0\ m}{10\ s} = 0$$

Velocity – time graph: exercise

Displacement (area below):



$\Delta x_1 = A_1 = 4 \frac{m}{s} * 2\ s = 8\ m$; $\Delta x_2 = A_2 = 4 \frac{m}{s} * 1\ s + \frac{1}{2} * 4 \frac{m}{s} * 1\ s = 6\ m$;

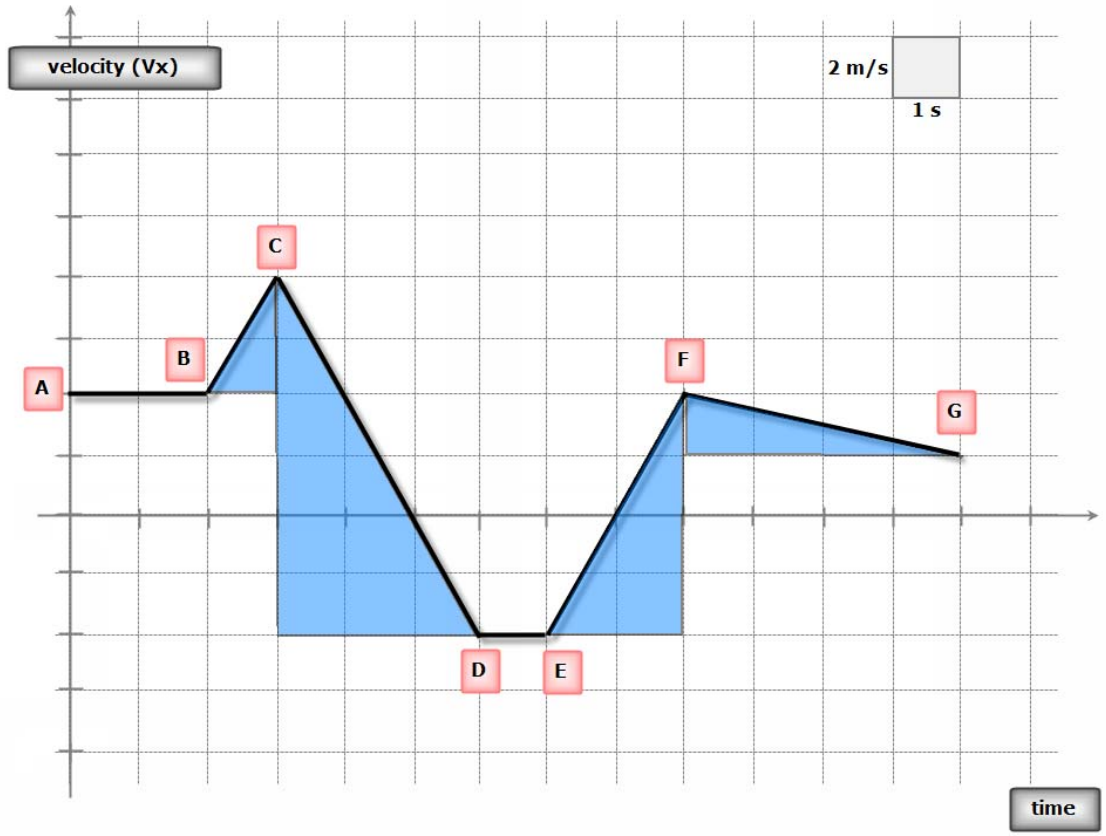
$\Delta x_3 = A_3 = \frac{1}{2} * 8 \frac{m}{s} * 2\ s = 8\ m$; $\Delta x_4 = A_4 = \frac{1\ s + 3\ s}{2} * (-4 \frac{m}{s}) = -8\ m$;

$\Delta x_5 = A_5 = \frac{1}{2} * 4 \frac{m}{s} * 1\ s = 2\ m$; $\Delta x_6 = A_6 = \frac{2 \frac{m}{s} + 4 \frac{m}{s}}{2} * 4\ s = 12\ m$;

$\Delta x_T = A_T = 8\ m + 6\ m + \cancel{8\ m} - \cancel{8\ m} + 2\ m + 12\ m = 28\ m$

Velocity – time graph: exercise

Acceleration (slope):



OA $\rightarrow$ a = slope = 0; BC $\rightarrow$ a = slope = $\frac{4\ m/s}{1\ s}$ = 4 $\frac{m}{s^2}$;

CD $\rightarrow$ a = slope = $\frac{-12\ m/s}{3\ s}$ = - 4 $\frac{m}{s^2}$; DE $\rightarrow$ a = slope = 0;

EF $\rightarrow$ a = slope = $\frac{8\ m/s}{2\ s}$ = 4 $\frac{m}{s^2}$; FG $\rightarrow$ a = slope = $\frac{-2\ m/s}{4\ s}$ = - 0.5 $\frac{m}{s^2}$;