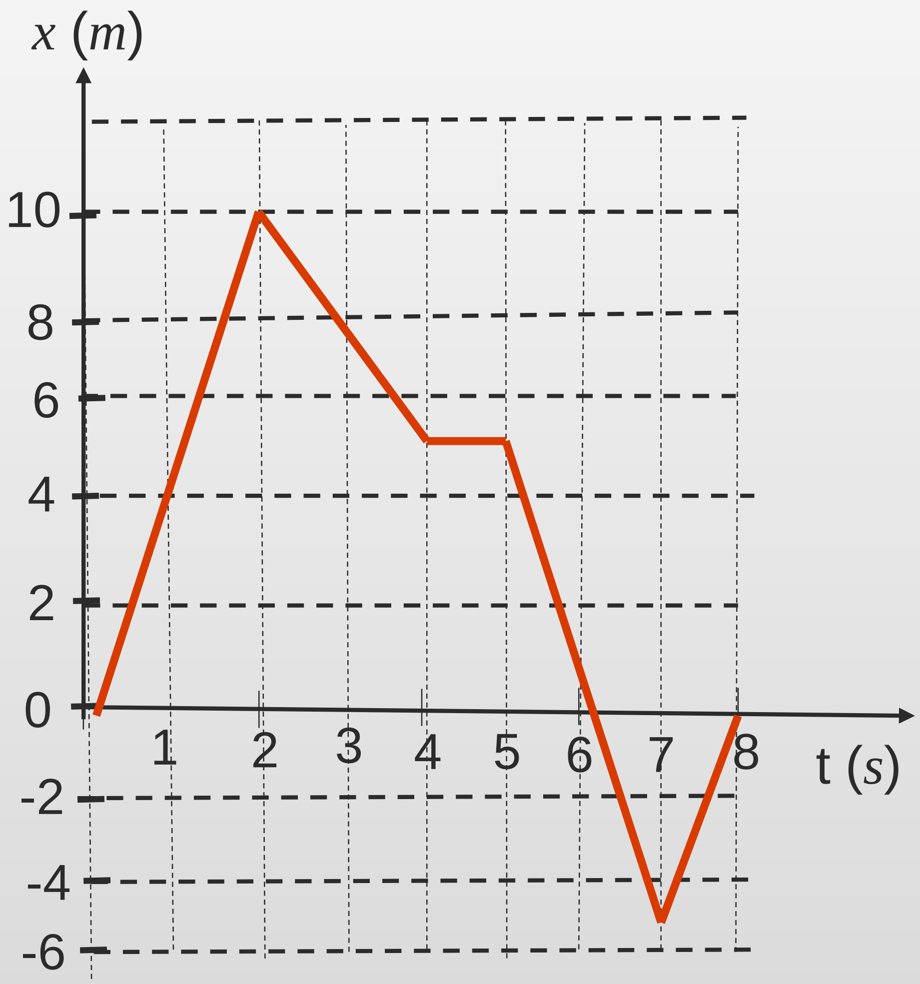
By Prof. Rashad Badran

Finding Average Velocity from a Given Graph:

Problem

The position versus time for a certain particle moving along the x axis is shown. Find the average velocity in the time intervals (a) 0 to 2 *s*, (b) 0 to 4 *s*, (c) 2 *s* to 4 *s*, (d) 4 *s* to 7 *s*, and (e) 0 to 8 *s*



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Finding Average Velocity from a Given Graph:

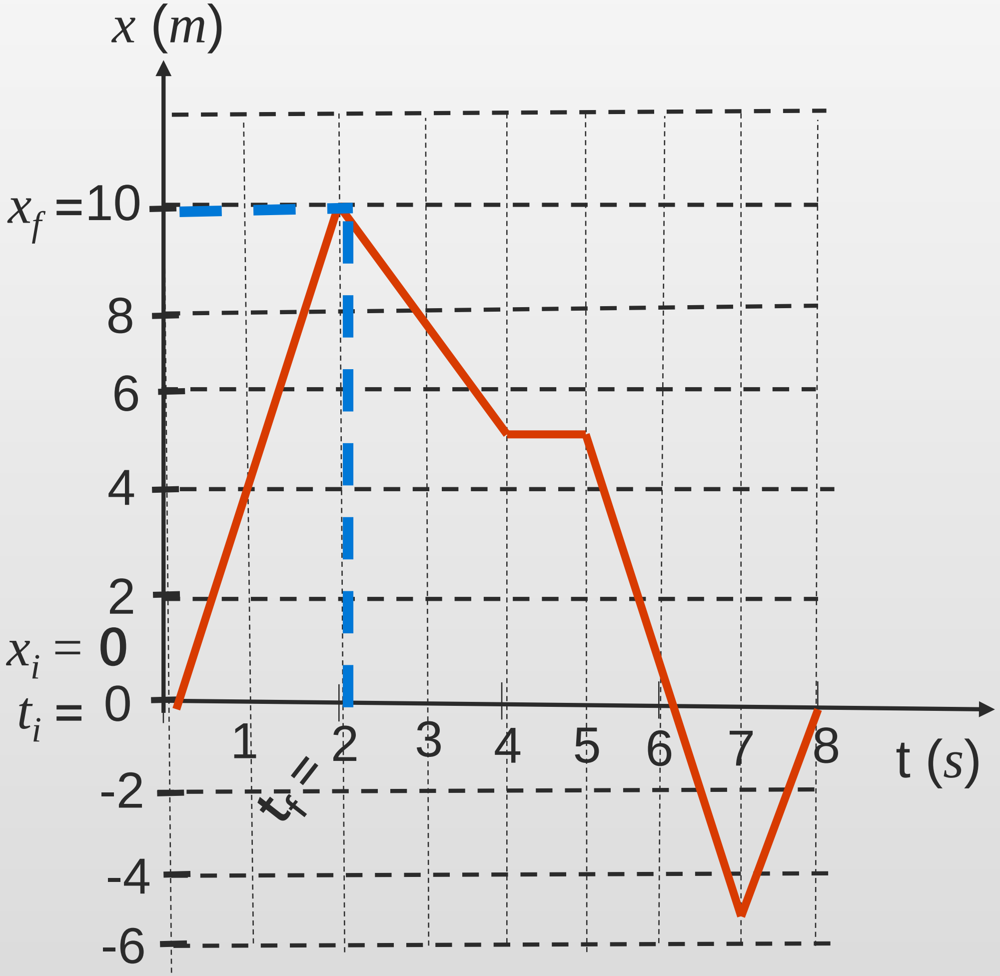
Solution:

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

(a) From $t_i = 0$ to $t_f = 2\ s$: $x_i = 0$, $x_f = 10m$

$$v_{avg.} = \frac{10m - 0}{(2-0)s} = +5m/s$$

, or 5 m/s due east



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Finding Average Velocity from a Given Graph:

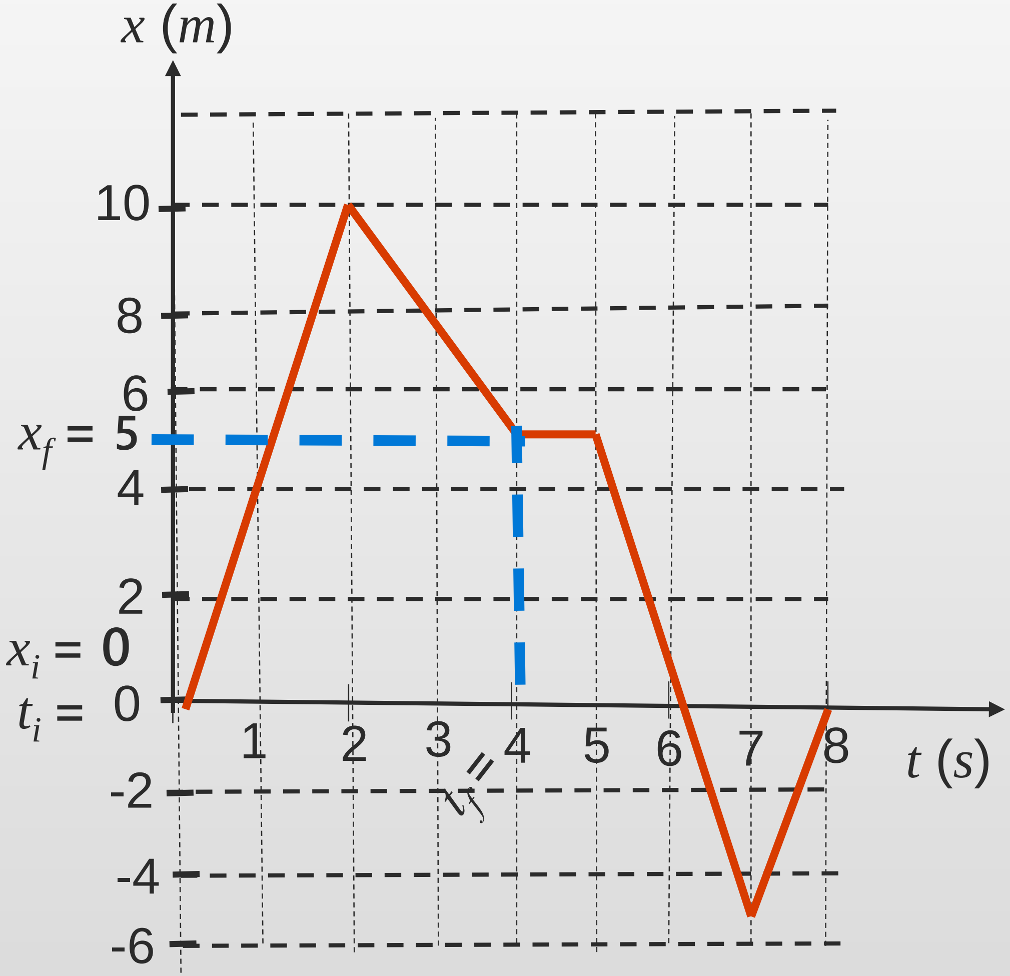
Solution:

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

(b) From $t_i = 0$ to $t_f = 4\ s$: $x_i = 0$, $x_f = 5m$

$$v_{avg} = \frac{5m - 0}{(4-0)s} = +1.25m/s$$

, or 1.25 m/s due east



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Finding Average Velocity from a Given Graph:

Solution:

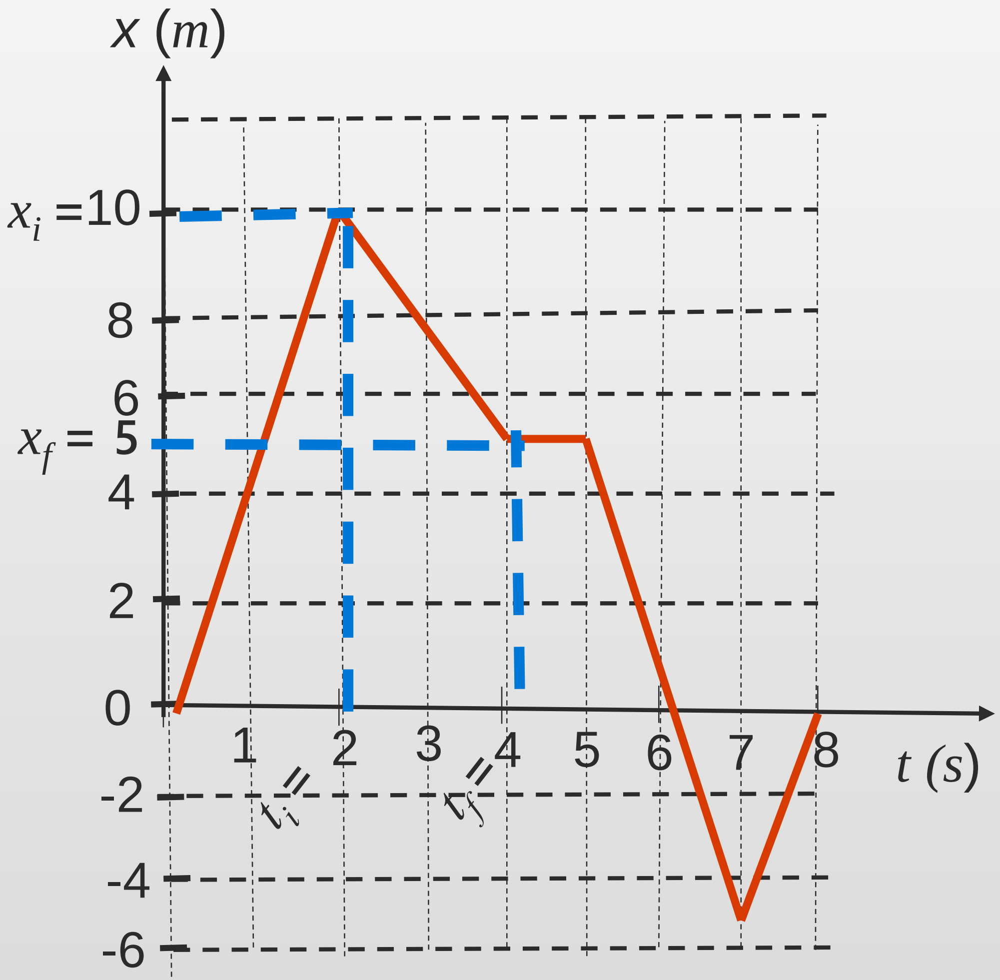
$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

(c) From $t_i = 2\ s$ to $t_f = 4\ s$:

$x_i = 10\ m, \quad x_f = 5\ m$

$$v_{avg.} = \frac{5m - 10m}{(4-2)s} = -2.5m/s$$

, or 2.5 m/s due west



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Finding Average Velocity from a Given Graph:

Solution:

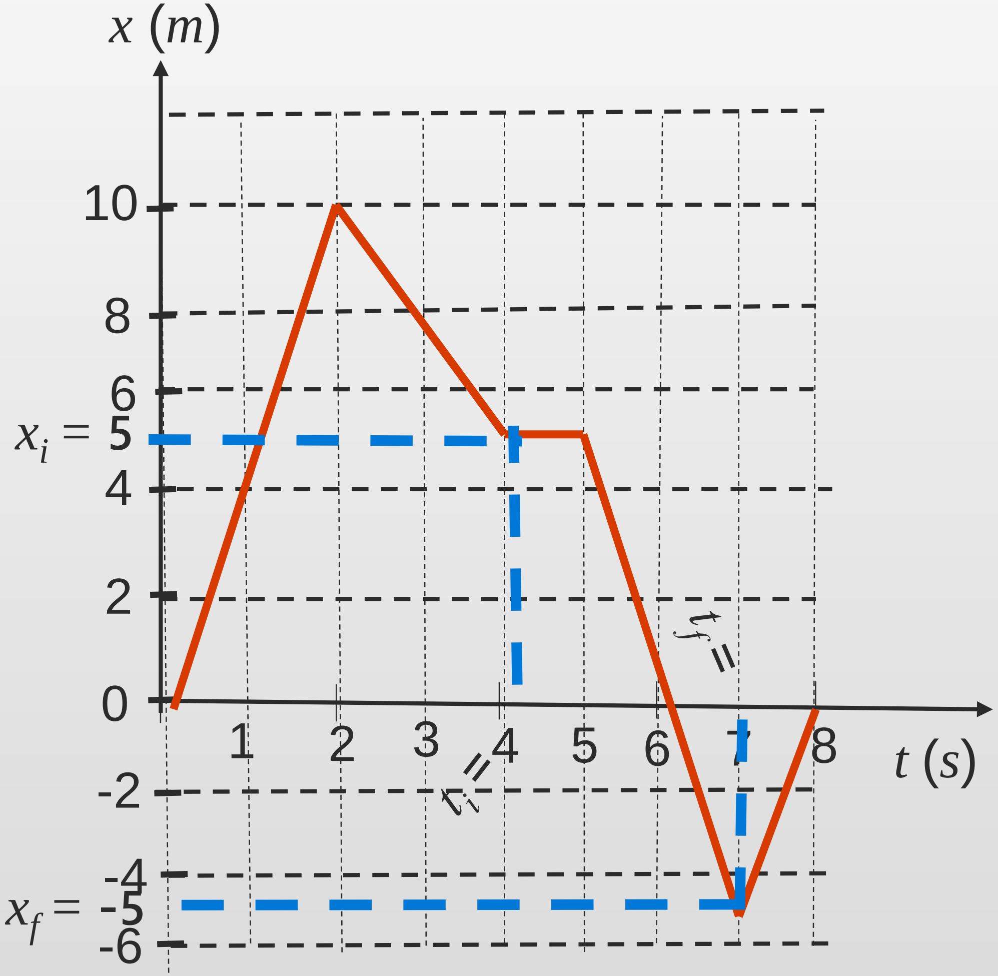
$$v_{avg.} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

(d) From $t_i = 4\ s$ to $t_f = 7\ s$:

$x_i = 5\ m$, $x_f = -5\ m$

$$v_{avg.} = \frac{-5m - 5m}{(7-4)s} = -3.33 m/s$$

, or 3.33 m/s due west



Finding Average Velocity from a Given Graph:

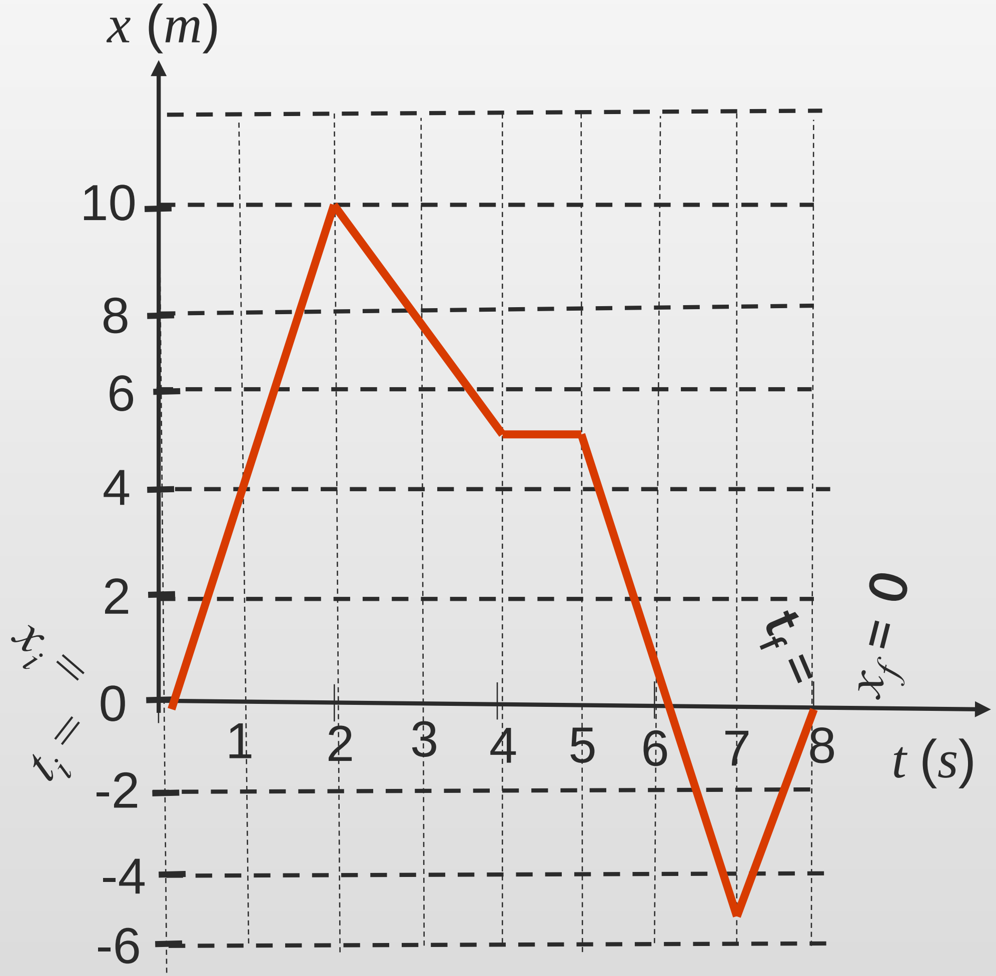
Solution:

$$v_{avg.} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

(e) From $t_i = 0$ to $t_f = 8\ s$:

$x_i = 0\ ,\qquad x_f = 0$

$$v_{avg} = \frac{0-0}{(8-0)s} = 0$$



Finding Average Velocity from a Given Graph:

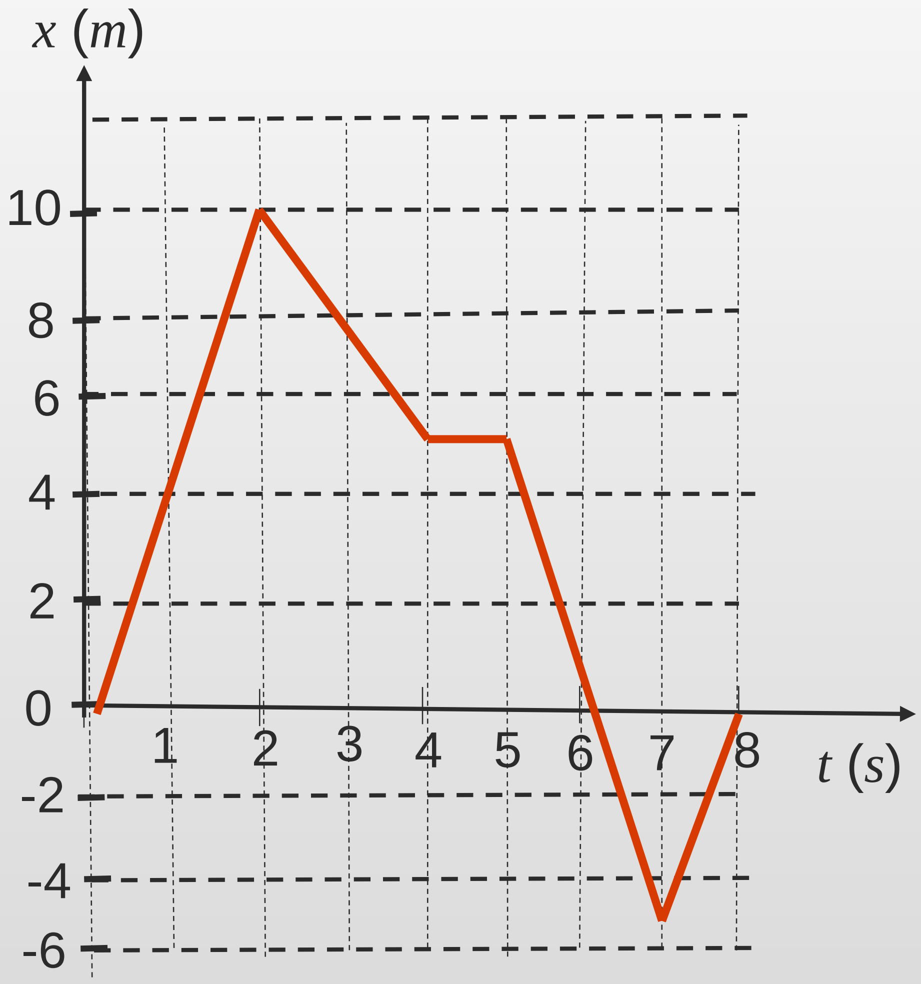
Exercise:

Find average velocity in the time intervals

(f) $t_i = 4\ s$ to $t_f = 5\ s$

(g) $t_i = 5\ s$ to $t_f = 7\ s$

(h) $t_i = 7\ s$ to $t_f = 8\ s$



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One Dimensional Motion: Instantaneous Velocity

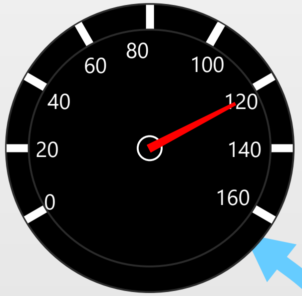
Definition (in3-D): $$\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$$

$$(\vec{v} = v_x \hat{i} + v_y \hat{j} + v_z \hat{k})$$

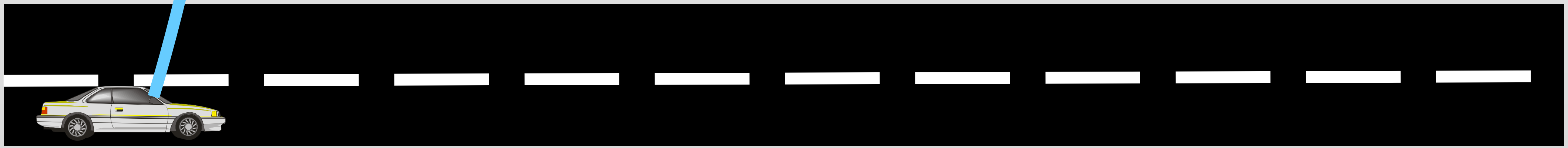
In 1-D its magnitude is simply written as follows:

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

The direction of velocity is along x-axis (Due east in the shown case)

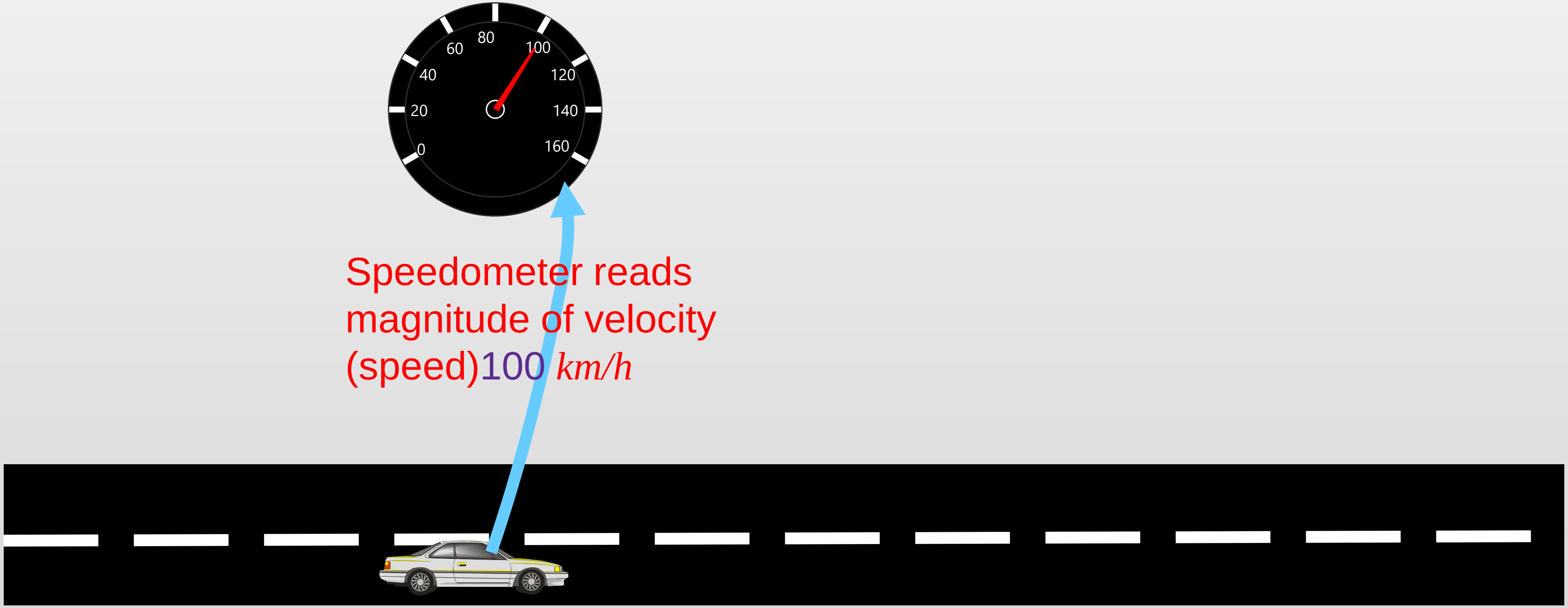


Speedometer reads magnitude of velocity (speed)120 *km/h*



One Dimensional Motion: Instantaneous Velocity

Instantaneous Velocity $v = v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$



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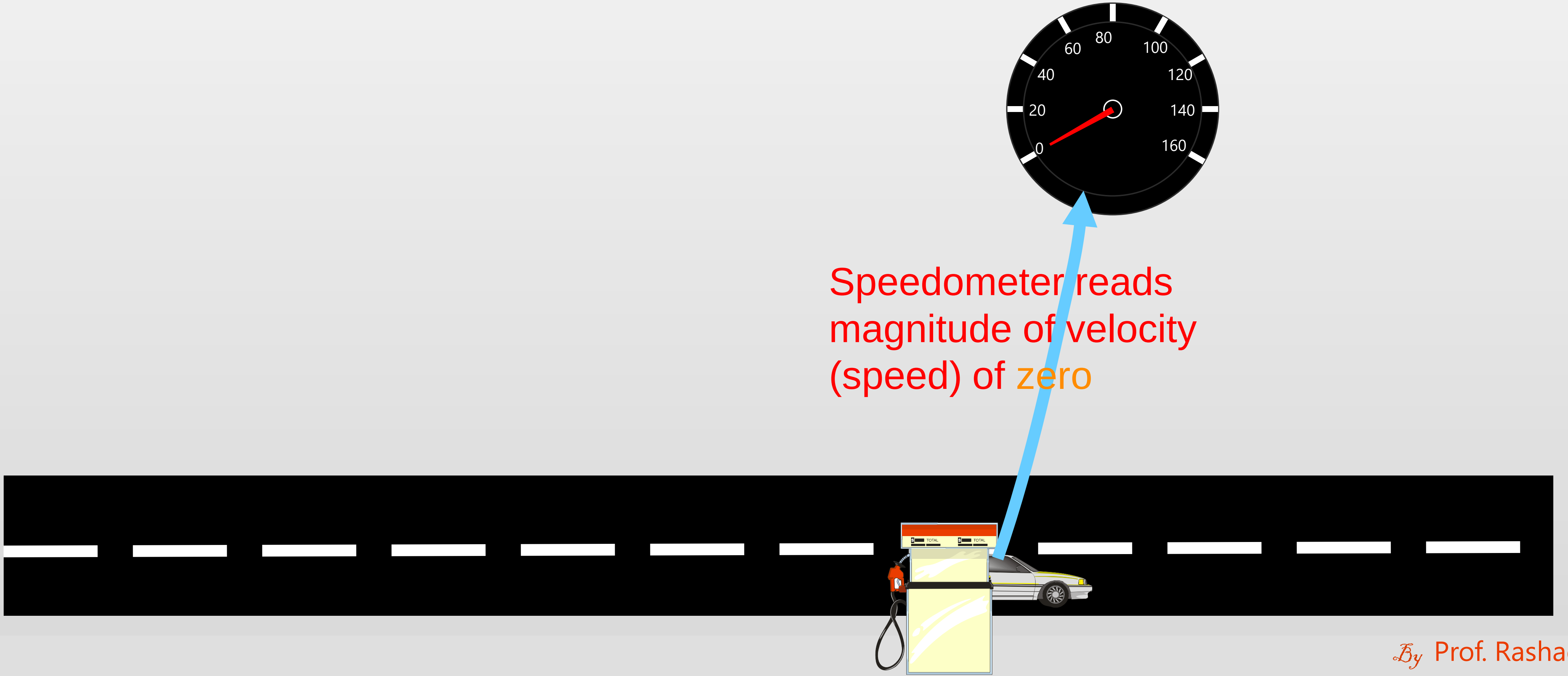
One Dimensional Motion: Instantaneous Velocity

Instantaneous Velocity $v = v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$



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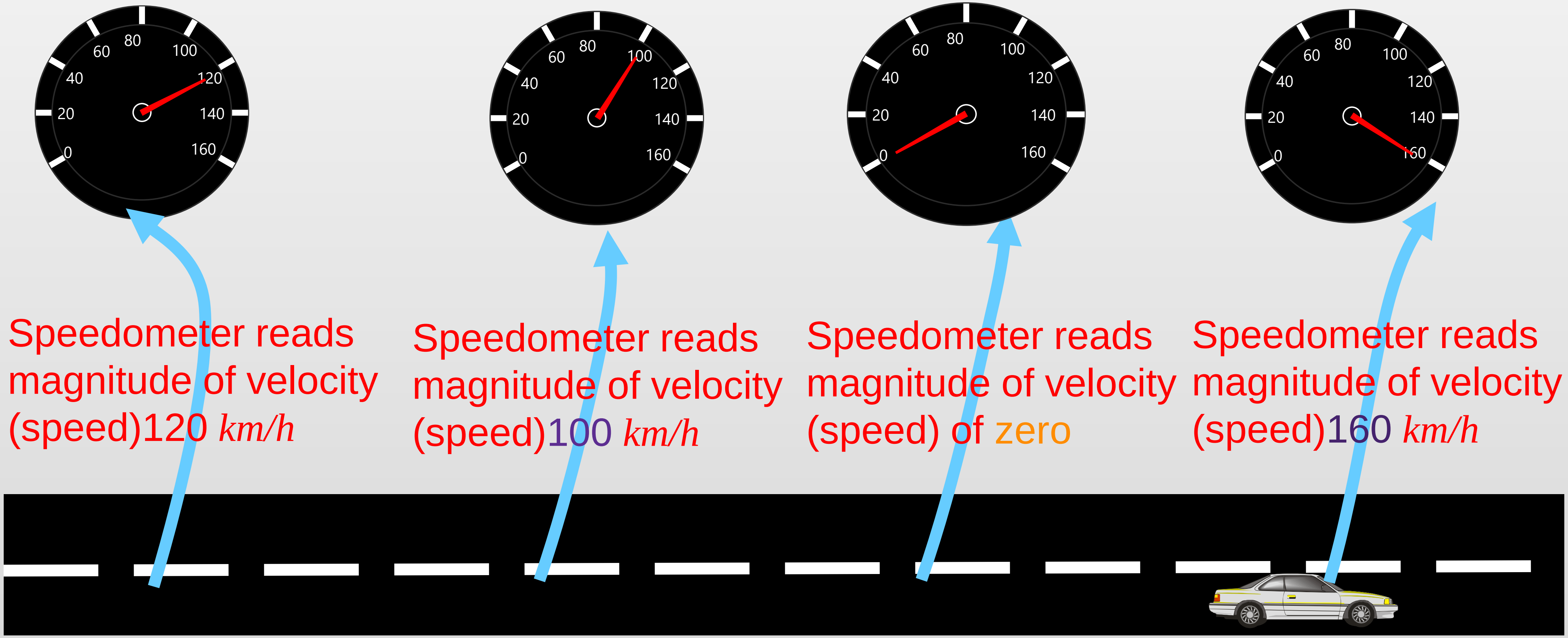
One Dimensional Motion: Instantaneous Velocity

Instantaneous Velocity $v = v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$

One Dimensional Motion: Instantaneous Velocity

Different Instantaneous Velocities



Speedometer reads magnitude of velocity (speed)120 *km/h*

Speedometer reads magnitude of velocity (speed)100 *km/h*

Speedometer reads magnitude of velocity (speed) of zero

Speedometer reads magnitude of velocity (speed)160 *km/h*

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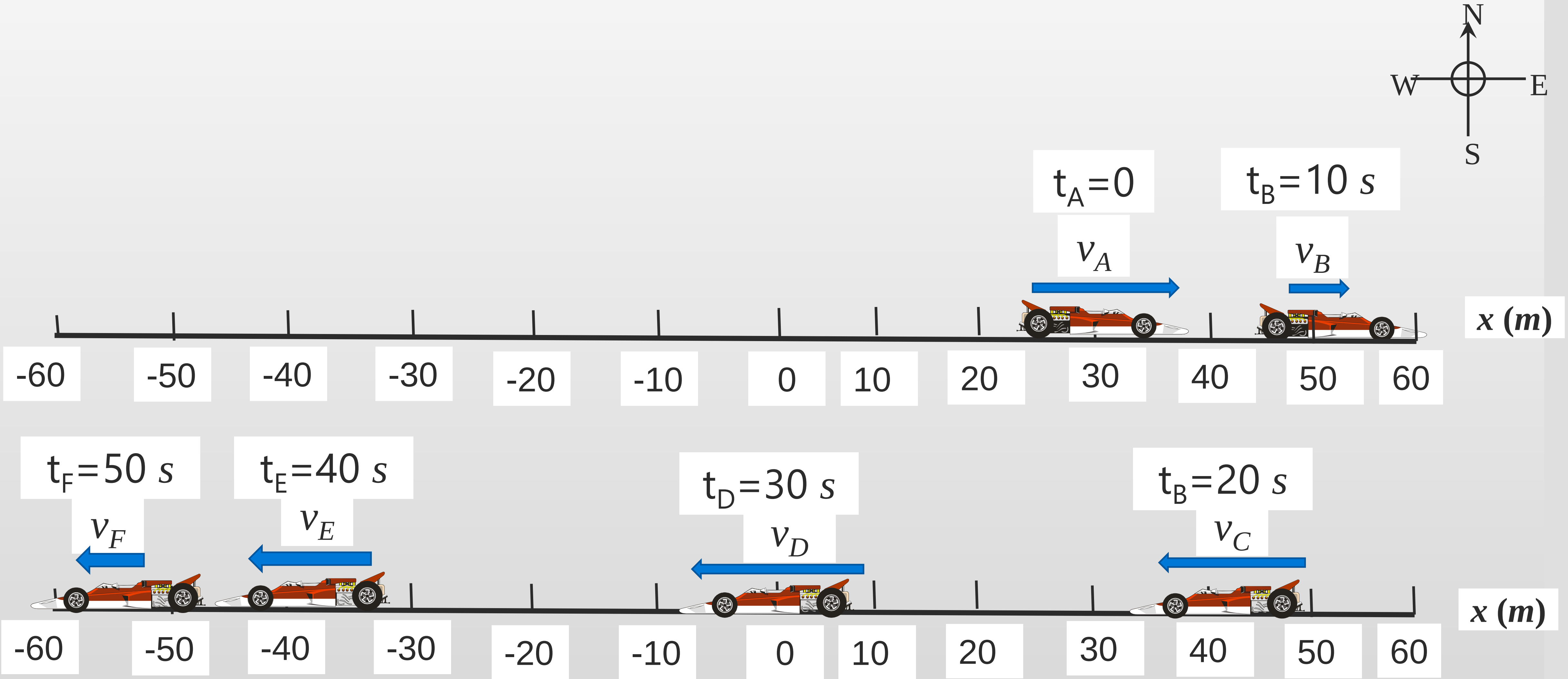
NonUniform Motion: Velocities of the car at different times



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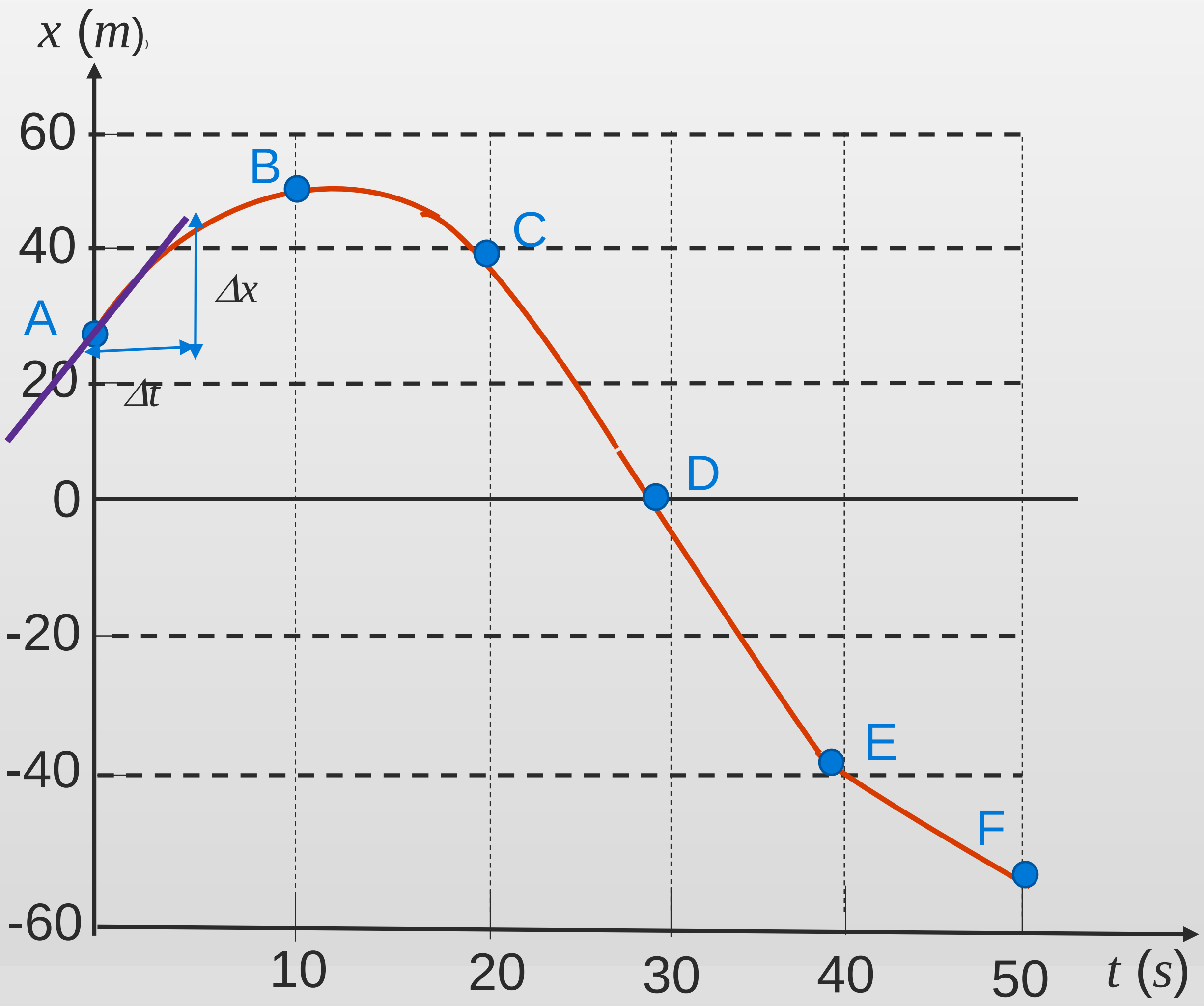
One Dimensional Motion: NonUniform Motion

Determining velocity from a graph

Position	*x-t* graph	Particle's Motion
A	Large positive slope ($\Delta x/\Delta t$) $v_x > 0$	Moving fast in +*ve* *x*-direction



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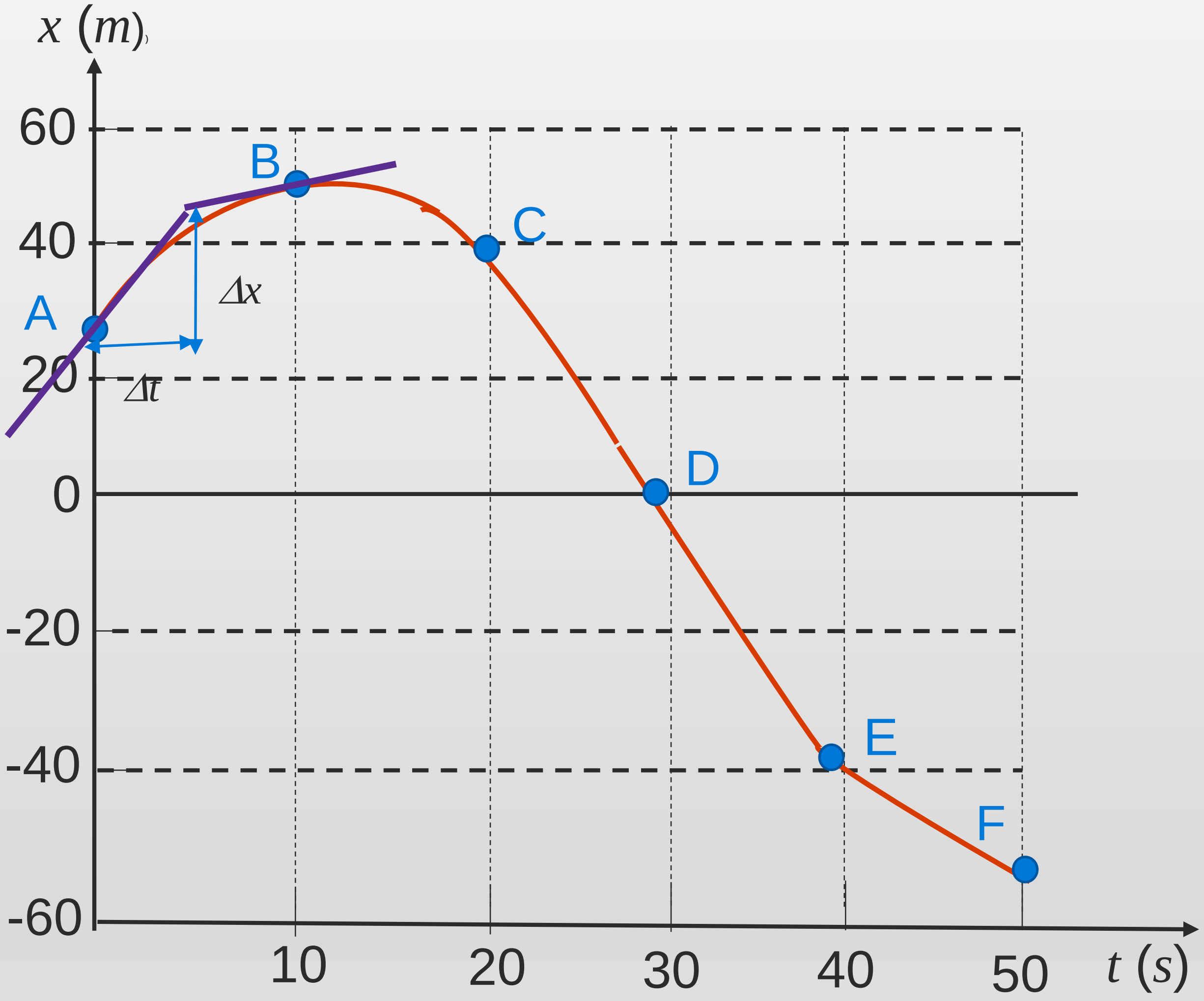
One Dimensional Motion: NonUniform Motion

Determining velocity from a graph

Position	*x-t* graph	Particle's Motion
A	Large positive slope ($\Delta x/\Delta t$) $v_x > 0$	Moving fast in $+ve$ x-direction
B	small positive slope $v_x > 0$	moving in $+ve$ x-direction slower than A



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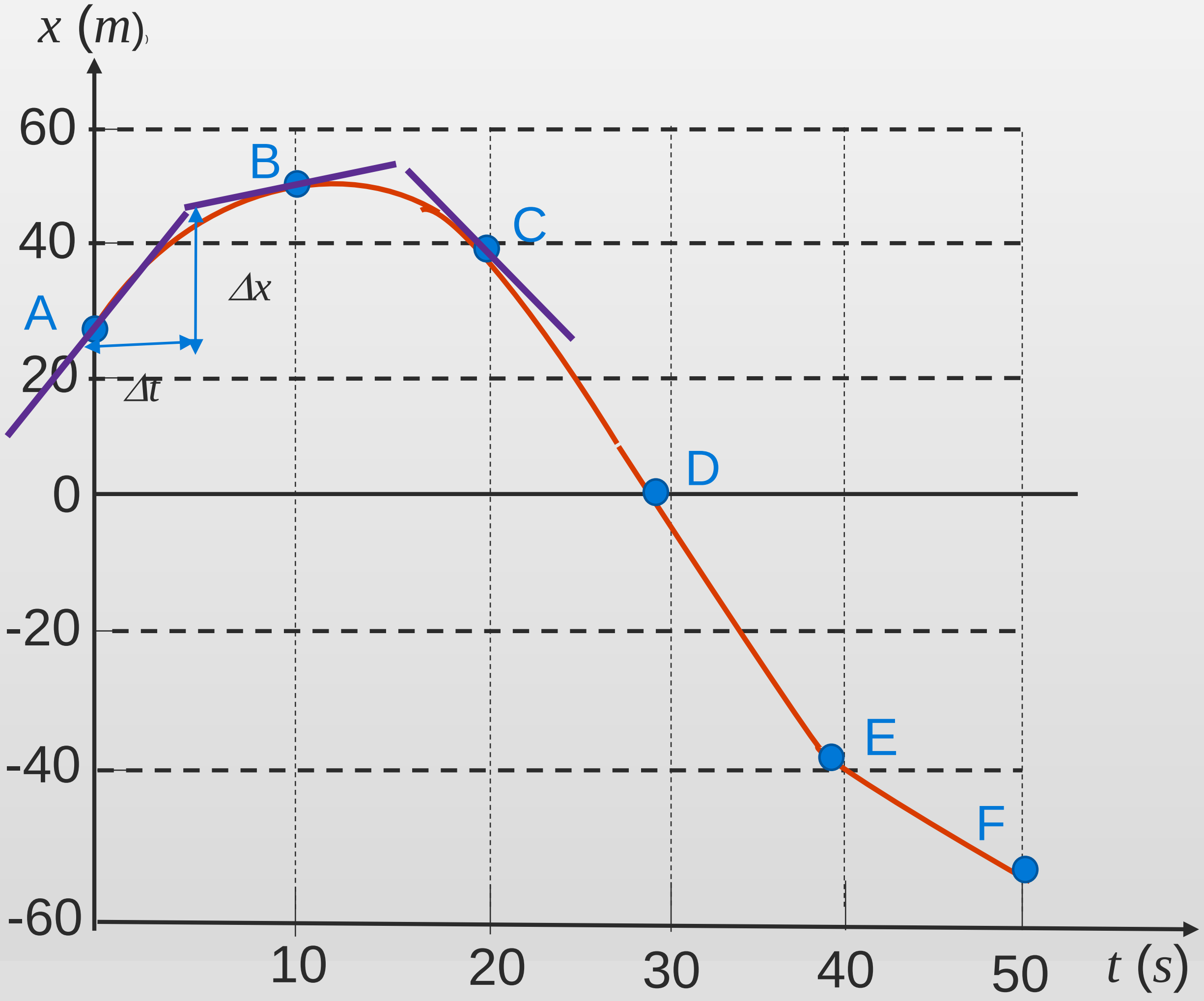
One Dimensional Motion: NonUniform Motion

Determining velocity from a graph

Position	x-t graph	Particle's Motion
A	Large positive slope $(\Delta x/\Delta t)$ $v_x > 0$	Moving fast in $+ve$ x-direction
B	small positive slope $v_x > 0$	moving in $+ve$ x-direction slower than A
C	negative slope $v_x < 0$	moving in $-ve$ x-direction



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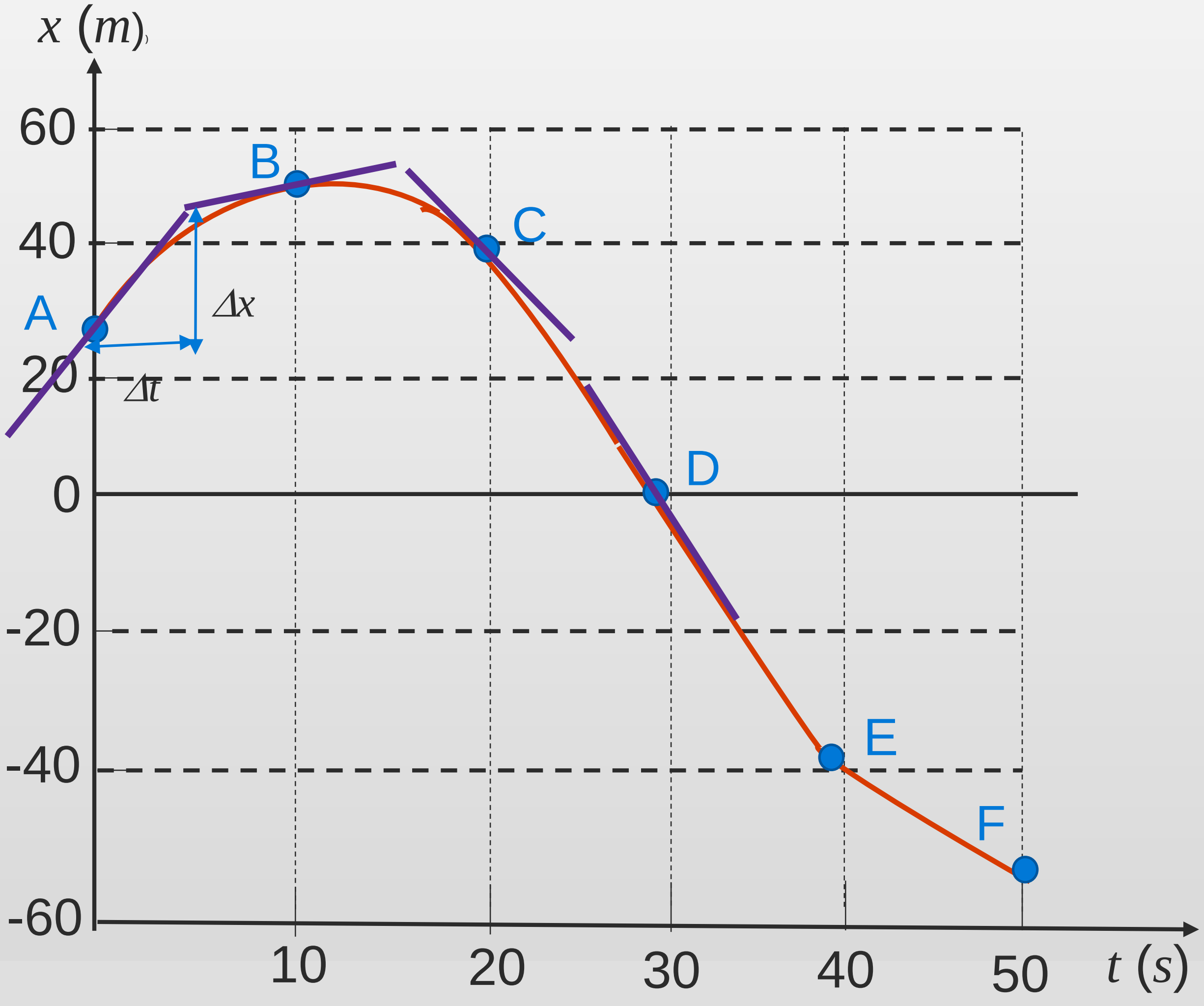
One Dimensional Motion: NonUniform Motion

Determining velocity from a graph

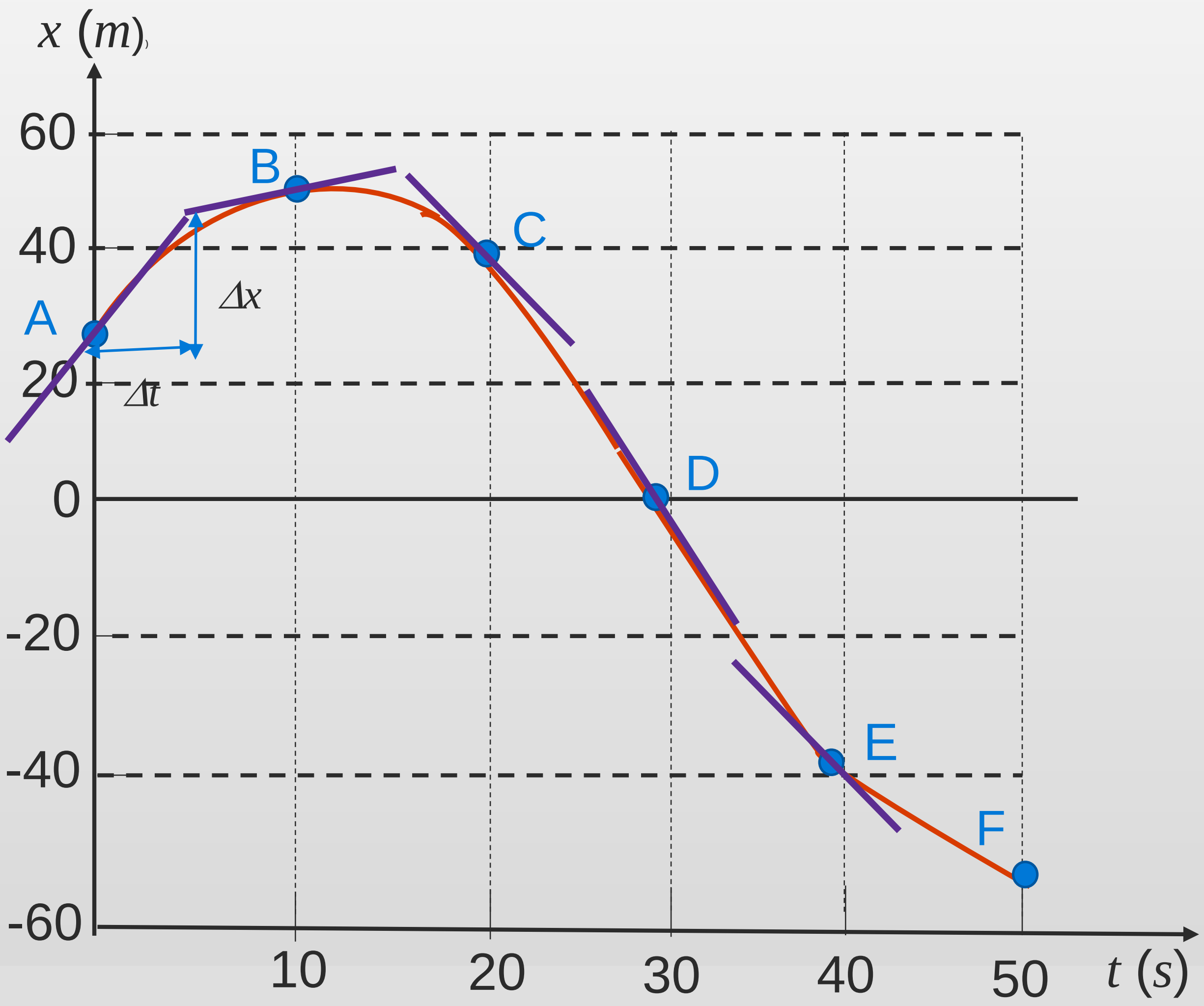
Position	x-t graph	Particle's Motion
A	Large positive slope ($\Delta x/\Delta t$) $v_x > 0$	Moving fast in $+ve$ x-direction
B	small positive slope $v_x > 0$	moving in $+ve$ x-direction slower than A
C	negative slope $v_x < 0$	moving in $-ve$ x-direction
D	Larger negative slope $v_x < 0$	moving in $-ve$ x-direction faster than C



One Dimensional Motion: NonUniform Motion

Position	*x-t* graph	Particle's Motion
A	Large positive slope $(\Delta x/\Delta t)$ $v_x > 0$	Moving fast in +*ve x*-direction
B	small positive slope $v_x > 0$	moving in +*ve x*-direction slower than A
C	negative slope $v_x < 0$	moving in -*ve x*-direction
D	Larger negative slope $v_x < 0$	moving in -*ve x*-direction faster than C
E	negative slope $v_x < 0$	moving in -*ve x*-direction slower than D

Determining velocity from a graph



One Dimensional Motion: NonUniform Motion

Determining velocity from a graph

Position	x-t graph	Particle's Motion
A	Large positive slope ($\Delta x/\Delta t$) $v_x > 0$	Moving fast in +*ve* x-direction
B	small positive slope $v_x > 0$	moving in +*ve* x-direction slower than A
C	negative slope $v_x < 0$	moving in -*ve* x-direction
D	Larger negative slope $v_x < 0$	moving in -*ve* x-direction faster than C
E	negative slope $v_x < 0$	moving in -*ve* x-direction slower than D
F	Smaller negative slope $v_x < 0$	moving in -*ve* x-direction slower than E