NAME:__________________________

U1:L4 Velocity

SPEED	VELOCITY
The rate that you cover a distance	The rate that you change position (displacement).
SCALAR	VECTOR
$v = \frac{\Delta d}{\Delta t}$	$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$
$\Delta d =$ distane (m) $\Delta t =$ time interval (s) v = average speed (m/s)	$\Delta \vec{d} =$ displacement (m) $\Delta t =$ time interval (s) $\vec{v} =$ average velocity (m/s)
$v = \frac{d_f - d_o}{t_f - t_o}$	$\vec{v} = \frac{d_f - d_o}{t_f - t_o}$
5 m/s	5 m/s [North]

- average speed is the speed an object moves at on average, over a period of time. Similarly, average velocity is the velocity an object moves, on average, over a period of time.

...For instance, your average speed driving to school may have been 50 km/h. During this drive, however, you were likely stopped at some point, and at some points may have been going above or below 50 km/h.

- instantaneous Speed is the speed you are travelling at one instant in time. Similarly, instantaneous velocity is the velocity you are travelling at one instant in time

For example, exactly 100 seconds into your drive to school, you were travelling at 44 km/h.

EXAMPLES:

Sally Jo runs around a 400m track in 50 seconds. What was Sally Jo's average speed?

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

$$v = \frac{400\,m}{50\,s} = \frac{400-0}{50-0}$$

$$v = 80\,m/s$$

What is the average velocity of a truck which drove 500km [North] in 4 hours?

$$\frac{500\,km}{4\,h} \times \left[\frac{1000\,m}{1\,km}\right] \times \left[\frac{1\,h}{3600\,s}\right] = 34.7\overline{2}\,m/s\,[N]$$

How long (in hours) would it take a cyclist riding at 4 m/s to travel 100m?

$$\frac{4\,m}{1\,s} = \frac{100\,m}{\Delta t}$$

$$\Delta t \times 4\,m = 100\,m \times 1\,s$$

$$\frac{\Delta t\,(4\,m)}{4\,m} = \frac{100\,m\,(s)}{4\,m}$$

$$\Delta t = 25\,s$$

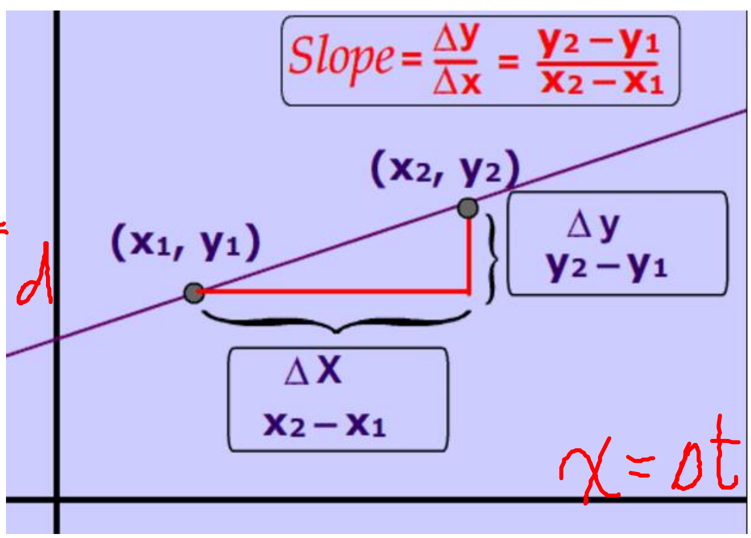
$$25\,s \times \left[\frac{1\,h}{3600\,s}\right] = 0.00694\,h$$

Velocity on Position-Time Graphs

VELOCITY
change of position in an interval of time
$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$

SLOPE
the measure of STEEPNESS of a line
$m = \frac{rise}{run} = \frac{\Delta y}{\Delta x}$

$y = \Delta d$



SLOPE (V) $= \frac{\Delta d}{\Delta t}$

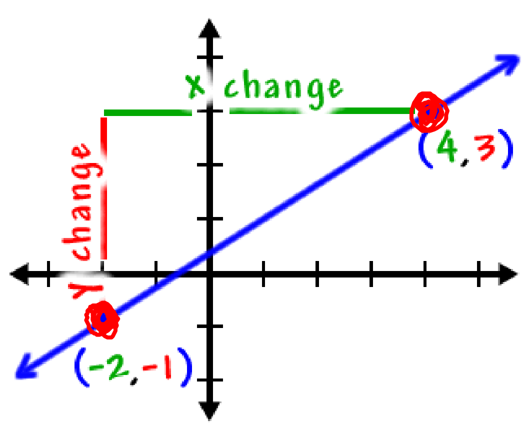
EXAMPLE:

$m = \frac{\Delta y}{\Delta x} = \frac{3-(-1)}{4-(-2)} = \frac{4}{6}$

(x, y)
(−2, −1)
(4, 3)

$V = \frac{\Delta d}{\Delta t} = \frac{d_f - d_o}{t_f - t_o} = \frac{m}{s}$

$\frac{4m}{6s} = 0.\overline{6}\ m/s$

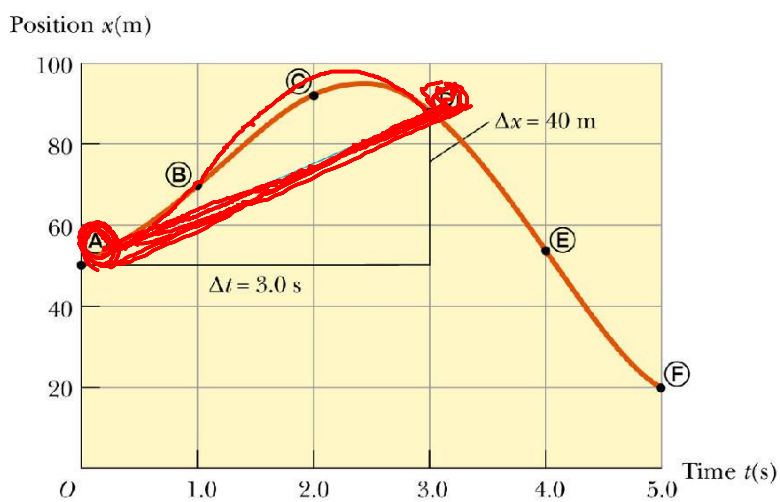


Determining the SLOPE of the line, on a position-time graph, determines the velocity of the object.

AVERAGE VELOCITY
SLOPE = total displacement over an INTERVAL of time

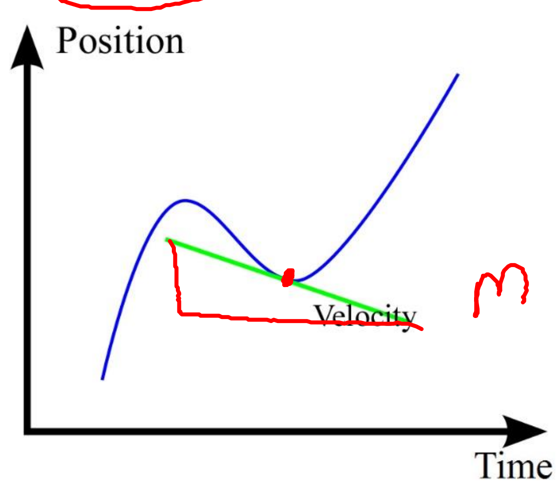
Therefore, average velocity can be found by determining the slope between two points on a Position-Time graph.

Slope of line = average speed

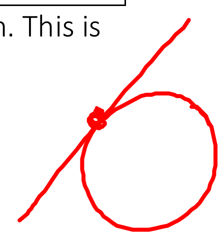


INSTANTANEOUS VELOCITY
@ a specific INSTANT.

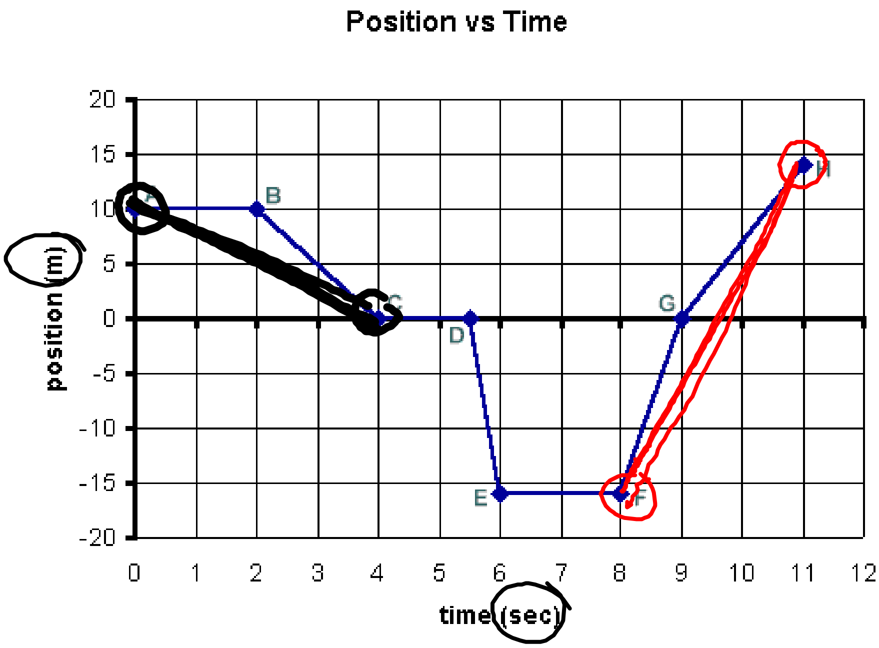
Therefore, instantaneous velocity must be found through a specific instant on the graph. This is done by finding the slope of a tangent line.



m



crosses @ ONLY 1 point



What is the average speed of the object between point A and C (graph above)?

$$V = \frac{\Delta d}{\Delta t} = \frac{10}{4} = 2.5 \, m/s$$

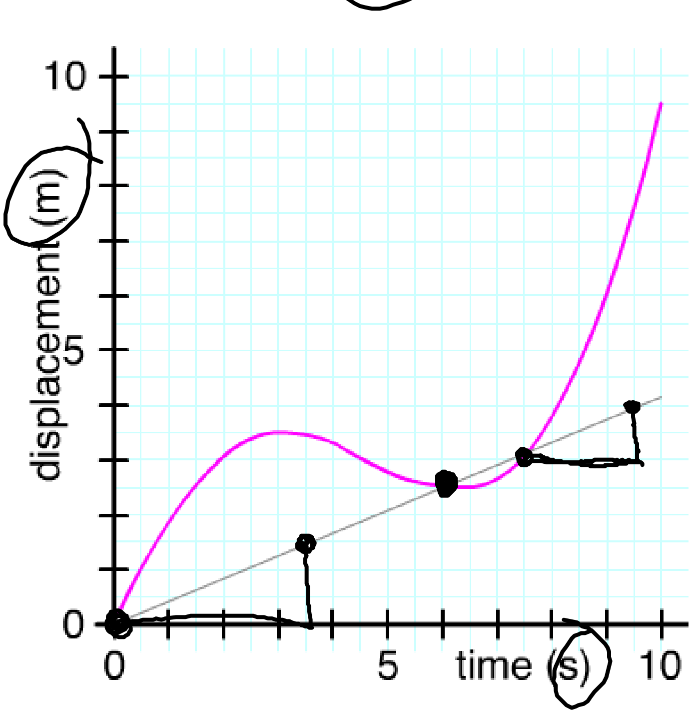
What is the average speed for the object between point F and H (graph above)?

$$V = \frac{\Delta d}{\Delta t} = \frac{30}{3} = 10 \, m/s$$

What is the instantaneous speed of the object at 6 seconds (graph below)?

$$V = \frac{\Delta d}{\Delta t} = \frac{2}{4} = 0.5$$

$$0.5 \, m/s$$



Acceleration

Acceleration is a__________________quantity that is defined as…

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*An object is only accelerating if it is changing its velocity.

Time	Velocity
0 s	0 m/s, No
1 s	10 m/s, No
2 s	20 m/s, No
3 s	30 m/s, No
4 s	40 m/s, No
5 s	50 m/s, No

Is this object accelerating?

YES NO

IS it constant acceleration?

YES NO

____________________________ is when an object accelerates at the same rate each second.

**An object with a constant acceleration should not be confused with an object with a constant velocity.*

**Don't be fooled! If an object is changing its _______________ -whether by a constant amount or a varying amount - then it is an _____________________ object.*

**And an object with a _______________________________ is __________accelerating.*

Accelerating Objects are Changing Their Velocity ...

... by a constant amount each second ...

Time (s)	Velocity (m/s)
0	0
1	4
2	8
3	12
4	16

...in which case, it is referred to as a constant acceleration.

... or by a changing amount each second ...

Time (s)	Velocity (m/s)
0	0
1	1
2	4
3	5
4	7

...in which case, it is referred to as a non-constant acceleration.

Finding an equation for acceleration:

Can you find the acceleration of a falling object from the following information?

Time Interval	Velocity Change During Interval	Ave. Velocity During Interval	Distance Traveled During Interval	Total Distance Traveled from 0 s to End of Interval
0 – 1.0 s	0 to ~10 m/s	~5 m/s	~5 m	~5 m
1.0 – 2.0 s	~10 to 20 m/s	~15 m/s	~15 m	~20 m
2.0 – 3.0 s	~20 to 30 m/s	~25 m/s	~25 m	~45 m
3.0 – 4.0 s	~30 to 40 m/s	~35 m/s	~35 m	~80 m

Units for acceleration are a bit bizarre – but we can find the units to use based on our equation for acceleration…

Since acceleration is a vector quantity, it has a _____________ associated with it. The direction of the acceleration vector depends on two things:

- whether the object is ____________________ or __________________
- whether the object is moving in the ____________ or_______________ direction

The general principle for determining the acceleration is:

If an object is __________________, then its acceleration is in the ____________________direction of its motion.

Calculate the acceleration of the following situations:

Example A

Time (s)	Velocity (m/s)
0	0
1	2
2	4
3	6
4	8

Example B

Time (s)	Velocity (m/s)
0	-8
1	-6
2	-4
3	-2
4	0

These are both examples of positive acceleration.

Example C

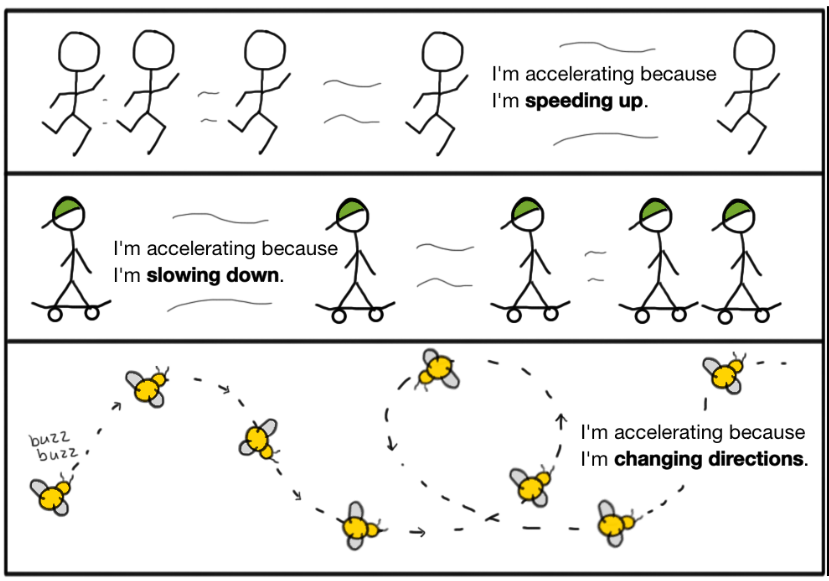
Time (s)	Velocity (m/s)
0	8
1	6
2	4
3	2
4	0

Example D

Time (s)	Velocity (m/s)
0	0
1	-2
2	-4
3	-6
4	-8

These are both examples of negative acceleration.

Explain the following situations:



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