

Section 1.4: Graphing Uniform Motion

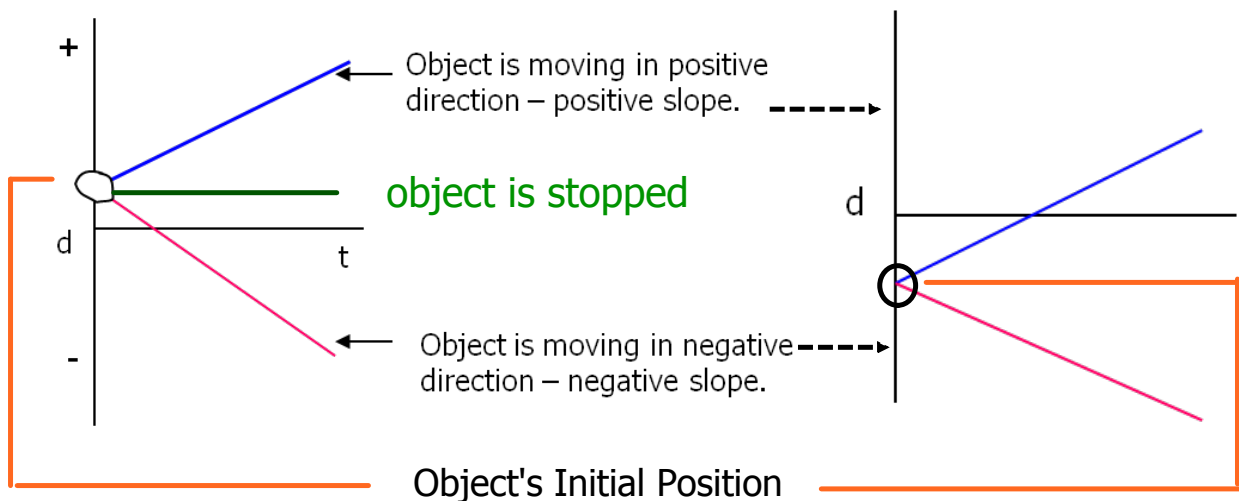
In this lesson you will

- construct $\vec{d}-t$ and $\vec{v}-t$ graphs for an object undergoing uniform motion.
- determine the starting position and the average velocity of an object undergoing uniform motion given its displacement-time graph
- determine the average velocity and the displacement of an object undergoing uniform motion given its velocity-time graph

Motion Graphs with Direction

I) Uniform Motion

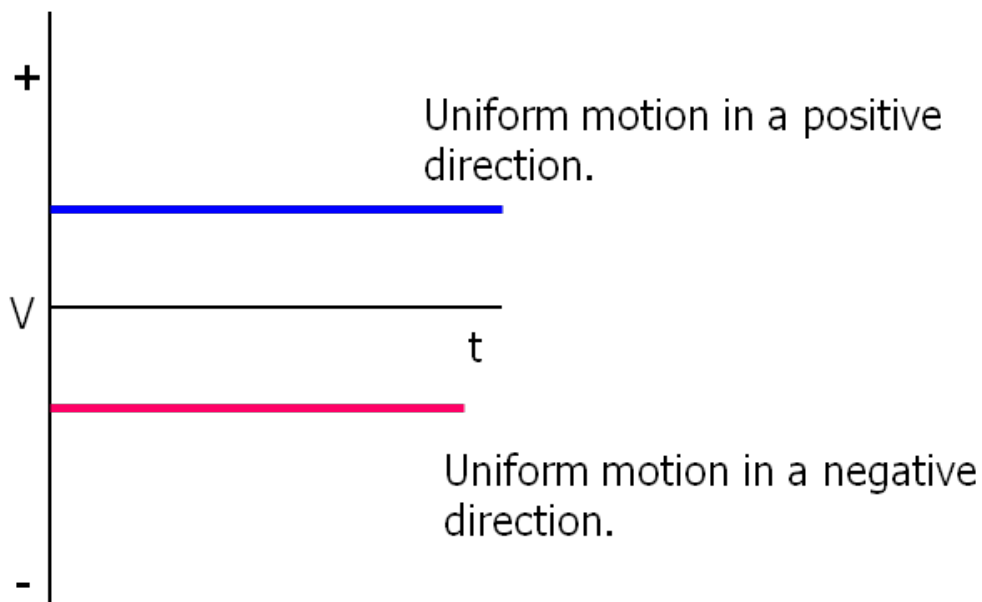
A) Displacement - Time Graphs



On $\vec{d}-t$ graphs

- **slope** represents **velocity**. (ie speed & direction)
 steeper slope - greater speed.
 positive slope - motion to the right or up [E or N]
 negative slope - motion to the left or down [W or S]

B) Velocity - Time Graphs



On $\vec{v} - t$ graphs,

- **velocity** is indicated by the **y-intercept**.
positive y-intercept - motion to the right or up [E or N]
negative y-intercept - motion to the left or down [W or S]
- **displacement** is the **area** "under" the graph (between the graph and the time axis).

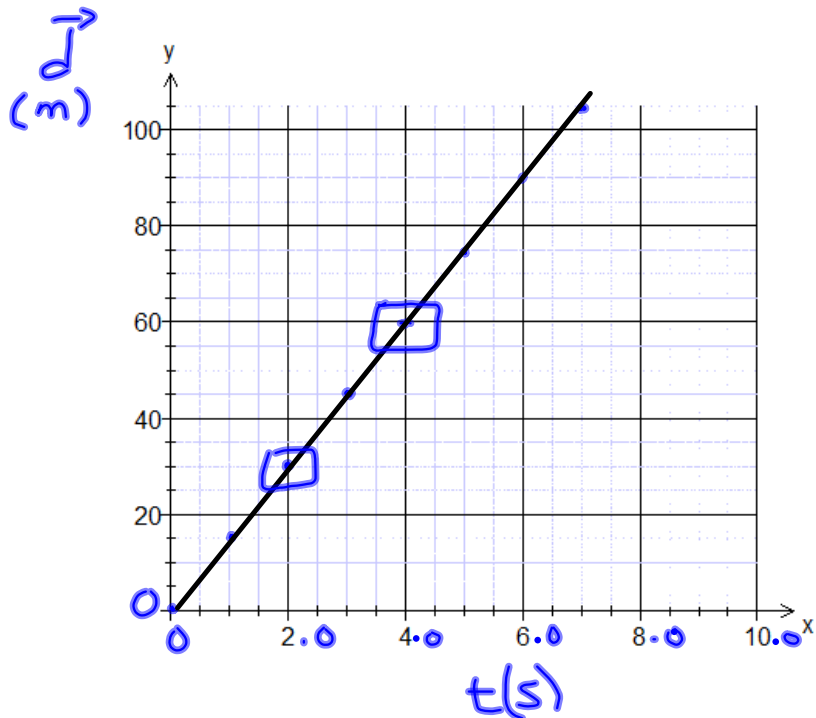
Displacement-Time and Velocity-Time Graphs

	$\vec{d}-t$ graphs	$\vec{v}-t$ graphs	Velocity	Acceleration	Example
Stopped			$\vec{v} = 0$	$\vec{a} = 0$	
			$\vec{v} = 0$	$\vec{a} = 0$	
Constant velocity			$\vec{v} > 0$	$\vec{a} = 0$	
			$\vec{v} < 0$	$\vec{a} = 0$	

Examples

1. a) Graph a position-time graph for the following data.

Time (s)	Position (m)
0	0
1.0	15
2.0	30
3.0	45
4.0	60
5.0	75
6.0	90
7.0	105



- b) Find the velocity of the object.

$$\vec{V} = \text{Slope} = \frac{60\text{ m} - 30\text{ m}}{4.0\text{ s} - 2.0\text{ s}} = 15\text{ m/s}$$

- c) Describe the motion of the object.

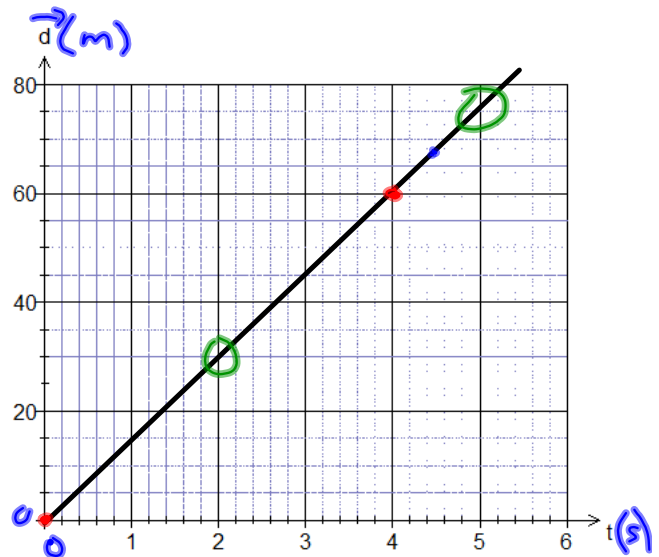
The object is moving to the right at 15 m/s.

2. a) What is the position of the object at 4.5s?
b) What is the object's displacement between 2.0 s and 5.0 s?
c) What is the velocity of the object?

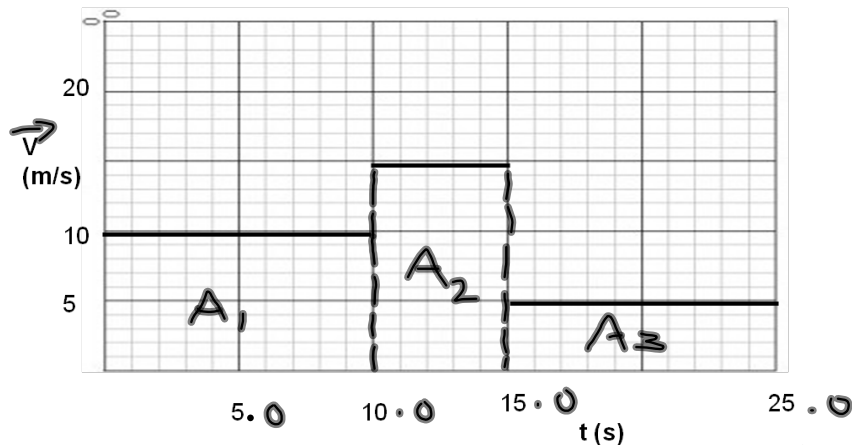
a) 68m

b) $75\text{m} - 30\text{m}$
 45m

c) $\vec{v} = \frac{60\text{m}}{4.0\text{s}} = 15\text{m/s}$



3. Compute the total displacement. Compute the average velocity.



a) To find displacement - find area "under" the graph

$$A_1 = l \times w = (10 \text{ s}) \left(10 \frac{\text{m}}{\text{s}} \right) = 100 \text{ m}$$

$$A_2 = l \times w = (5 \text{ s}) \left(15 \frac{\text{m}}{\text{s}} \right) = 75 \text{ m}$$

$$A_3 = (10 \text{ s}) \left(5 \frac{\text{m}}{\text{s}} \right) = 50 \text{ m}$$

$$\boxed{\text{Total } \vec{d} = 225 \text{ m}}$$

$$(b) v_{AV} = \frac{d_T}{t_T} = \frac{225 \text{ m}}{25 \text{ s}} = 9.0 \text{ m/s}$$

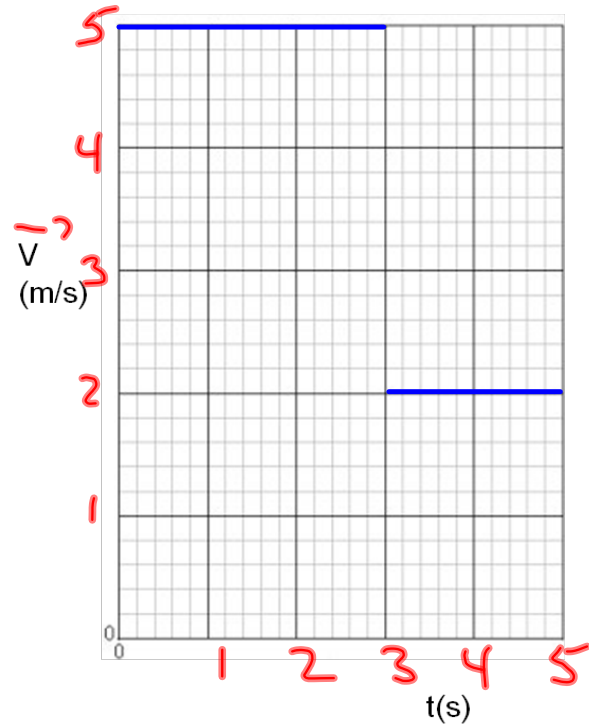
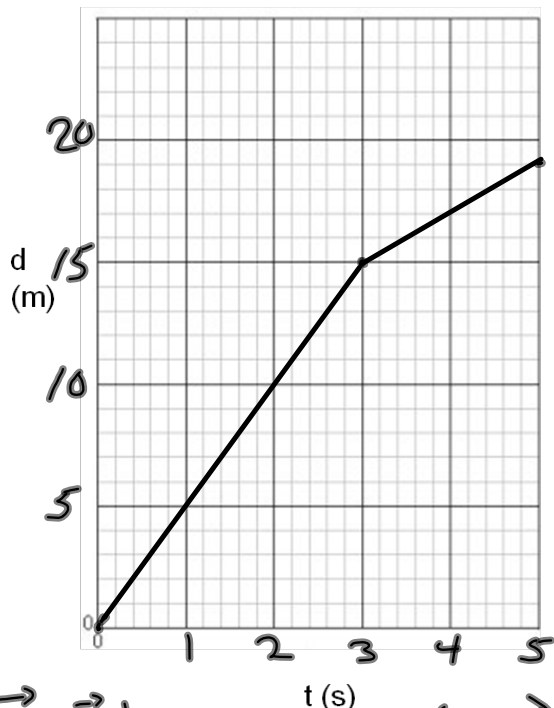
Describe the motion of the object.

0-10 s - object is moving at 10 m/s to the right.

10-15 s - " " " " 15 m/s " " "

15-25 s - " " " " 5 m/s " " "

4. A cyclist paddles her bike at 5m/s for 3 seconds and then at 2 m/s for 2 seconds. Produce both a \vec{d} - t and a \vec{v} - t graph of the motion.



$$\vec{d} = \vec{v}t = (5\text{ m/s})(3\text{ s}) = 15\text{ m}$$

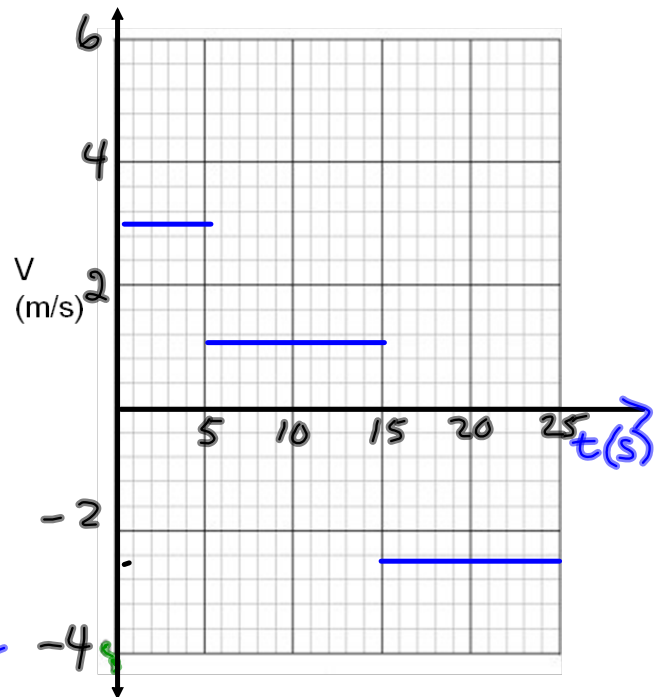
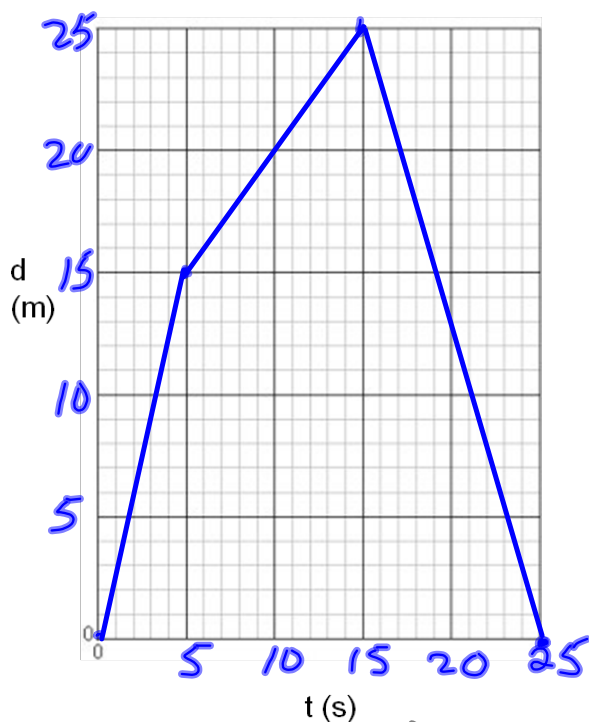
$$\vec{d} = (2\text{ m/s})(2\text{ s}) = 4\text{ m}$$

↑
These are displacements.

t (s)	Position (m)
0	0
3	15
5	19

+2 sec } +4 m

5. Draw a position-time and velocity-time graph for a runner who moves at 3.0 m/s for 5.0 s, then 1.0 m/s for 10.0 s and finally -2.5 m/s for 10.0 s.



$$d = vt = (3 \text{ m/s})(5 \text{ s}) = 15 \text{ m}$$

$$d = (1 \text{ m/s})(10 \text{ s}) = 10 \text{ m}$$

$$d = (-2.5 \text{ m/s})(10 \text{ s}) = -25 \text{ m}$$

t	Position
$5 < 0$	$0 > 15$
$10 < 5$	$15 > 15$
$15 < 15$	$25 > 10$
$10 < 25$	$0 > -25$