Section 1.4: Graphing Uniform Motion

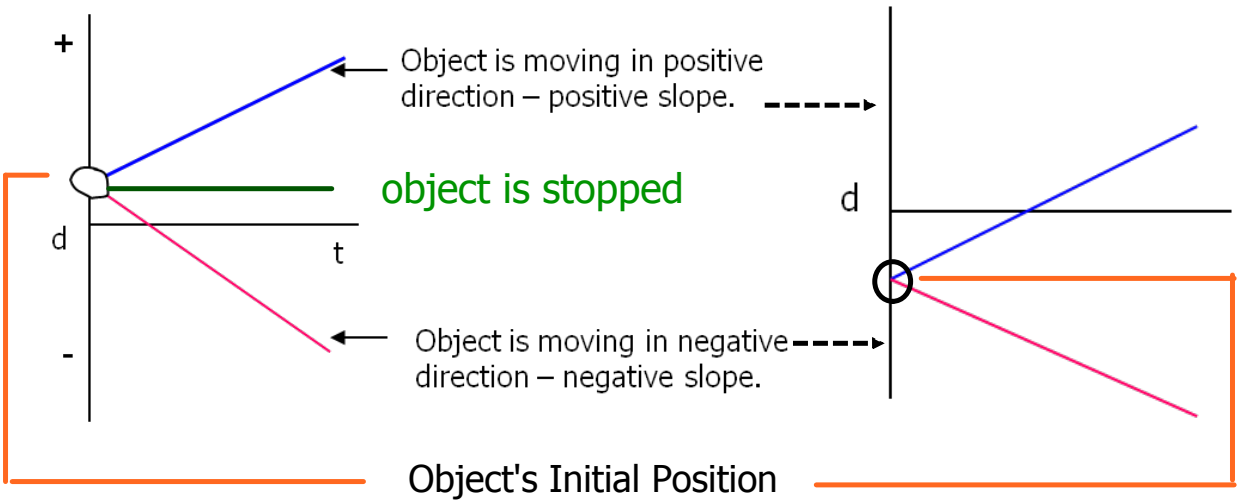
In this lesson you will

- 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 it velocity-time graph

Motion Graphs with Direction

I) Uniform Motion

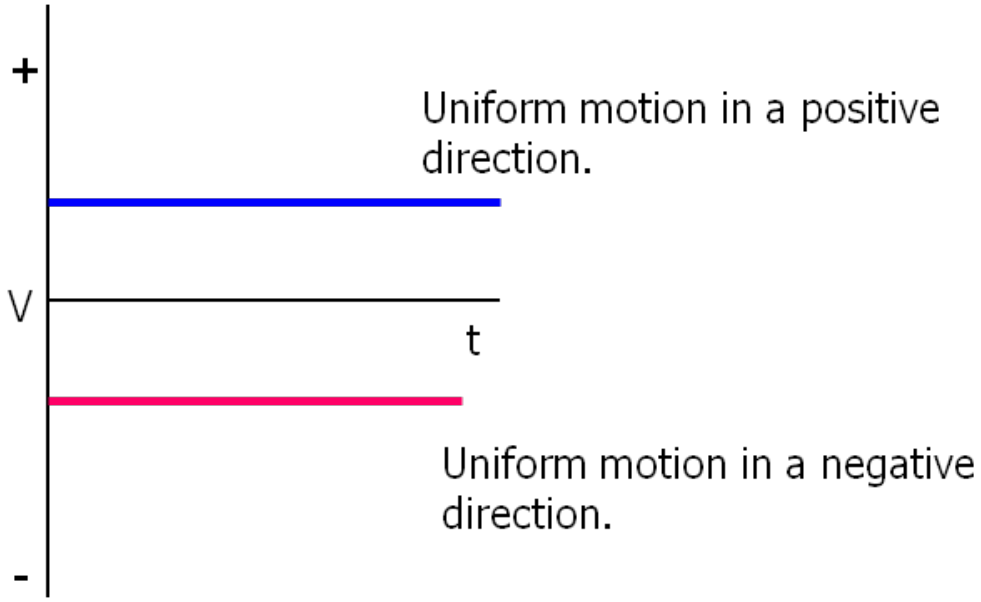
A) Displacement - Time Graphs



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

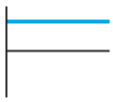
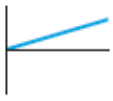
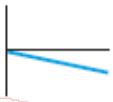
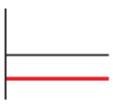


On $\vec{v} - t$ graphs,

- **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).

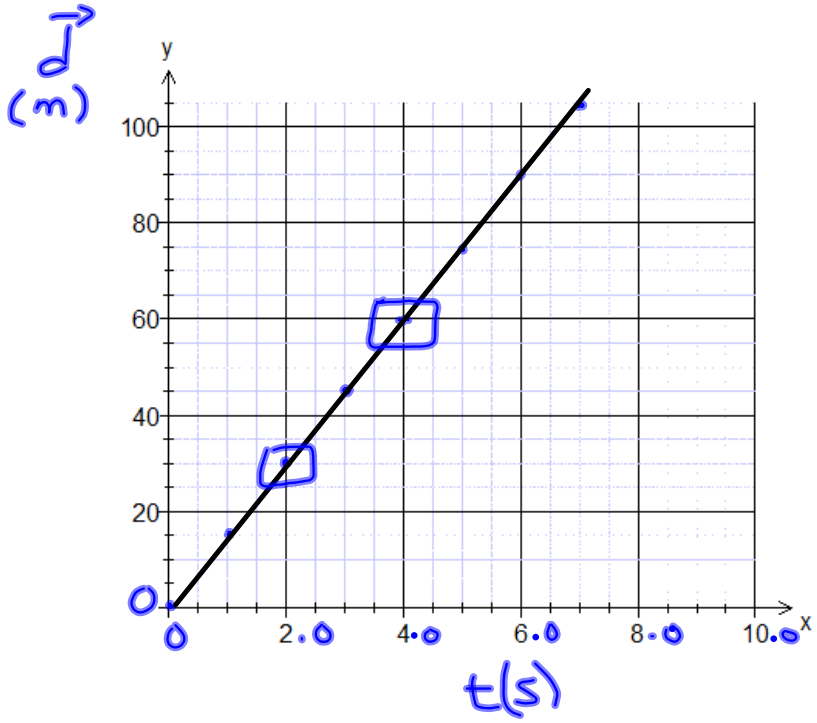
Displacement-Time and Velocity-Time Graphs

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

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.

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

c) Describe the motion of the object.

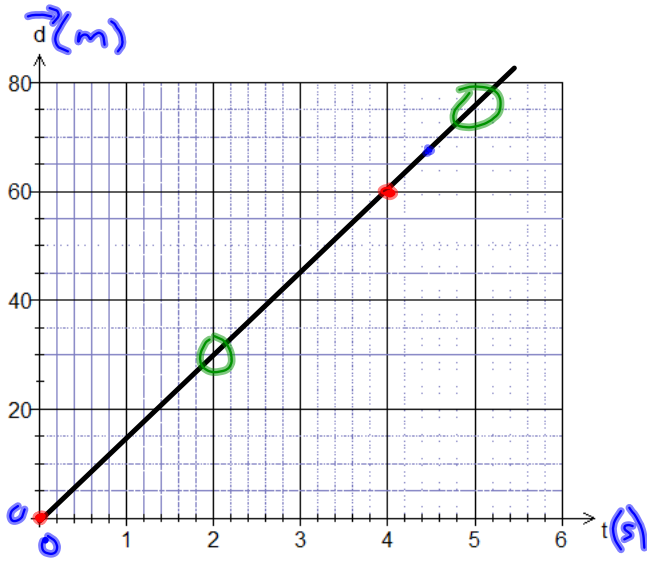
The object is moving to the right at 15 m/s.

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?

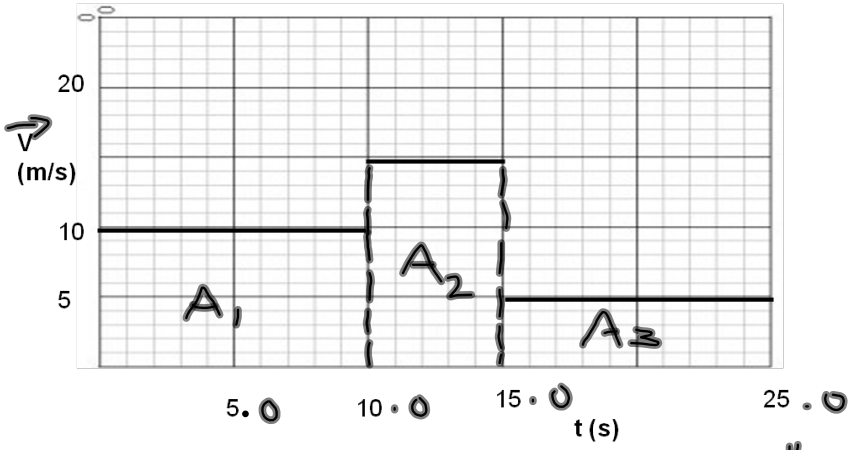
a) 68m

b) 75m − 30m
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

$A_1 = l \times w = (10s)(10\,m/s) = 100m$

$A_2 = l \times w = (5s)(15\,m/s) = 75m$

$A_3 = (10s)(5\,m/s) = 50m$

Total $\vec{d} = 225m$

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

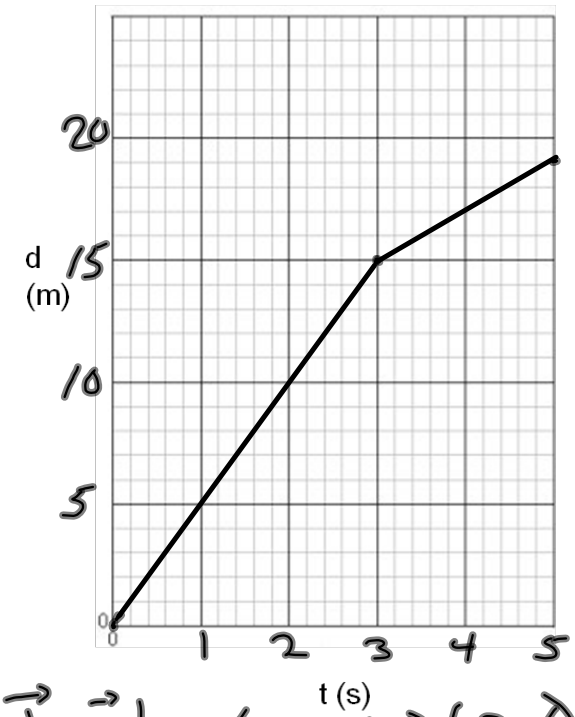
Describe the motion of the object.

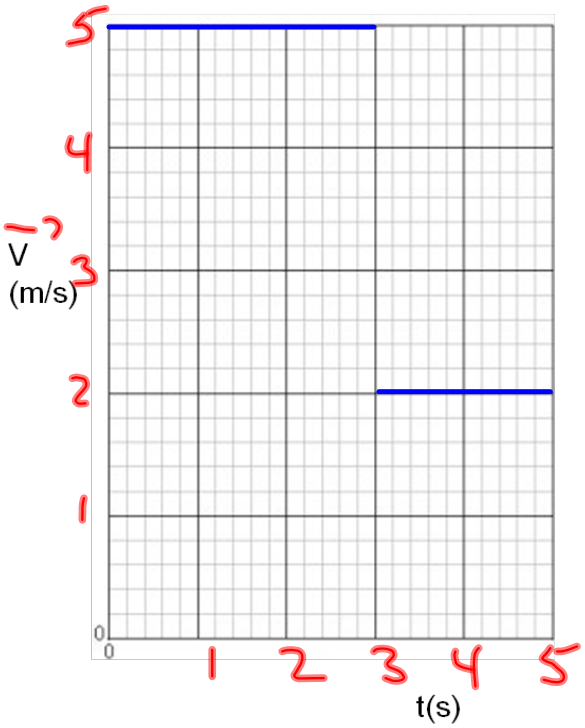
0-10 s – object is moving at 10 m/s to the right.

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 d-t and a v-t graph of the motion.





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

$= 15\text{ m}$

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

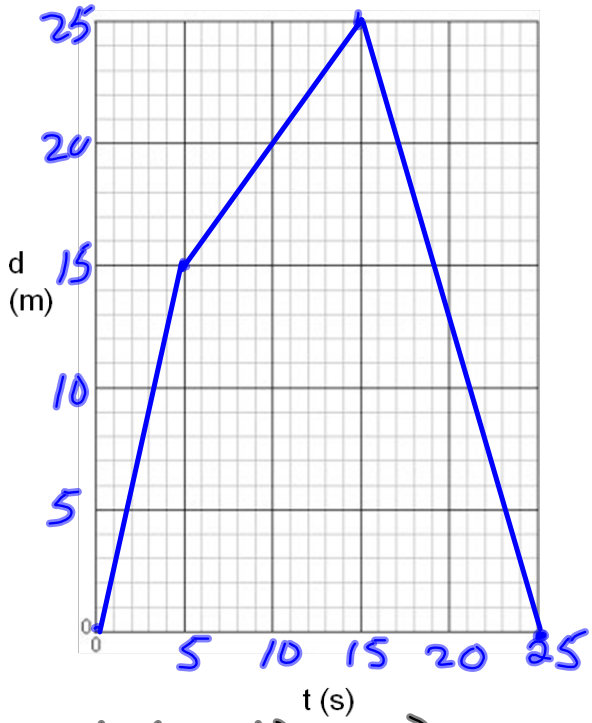
$= 4\text{m}$

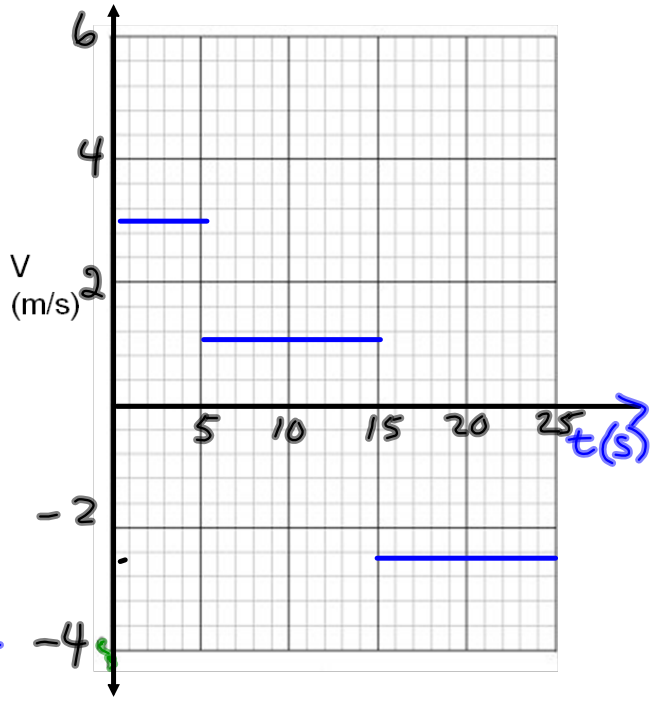
These are displacements.

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

+2sec → +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.





$d = vt = (3\,m/s)(5\,s) = 15\,m$

$d = (1\,m/s)(10\,s) = 10\,m$

$d = (-2.5\,m/s)(10\,s) = -25\,m$

t	Position
0	0
5	15
15	25
25	0

5 > 10 > 10 > 15

15 > 10 > -25