VELOCITY-TIME GRAPHS

Goal:

- to be able to read velocity-time graphs

- to be able to calculate vector and scalar quantities using v-t graphs (displacement, distance, velocity, speed and acceleration)

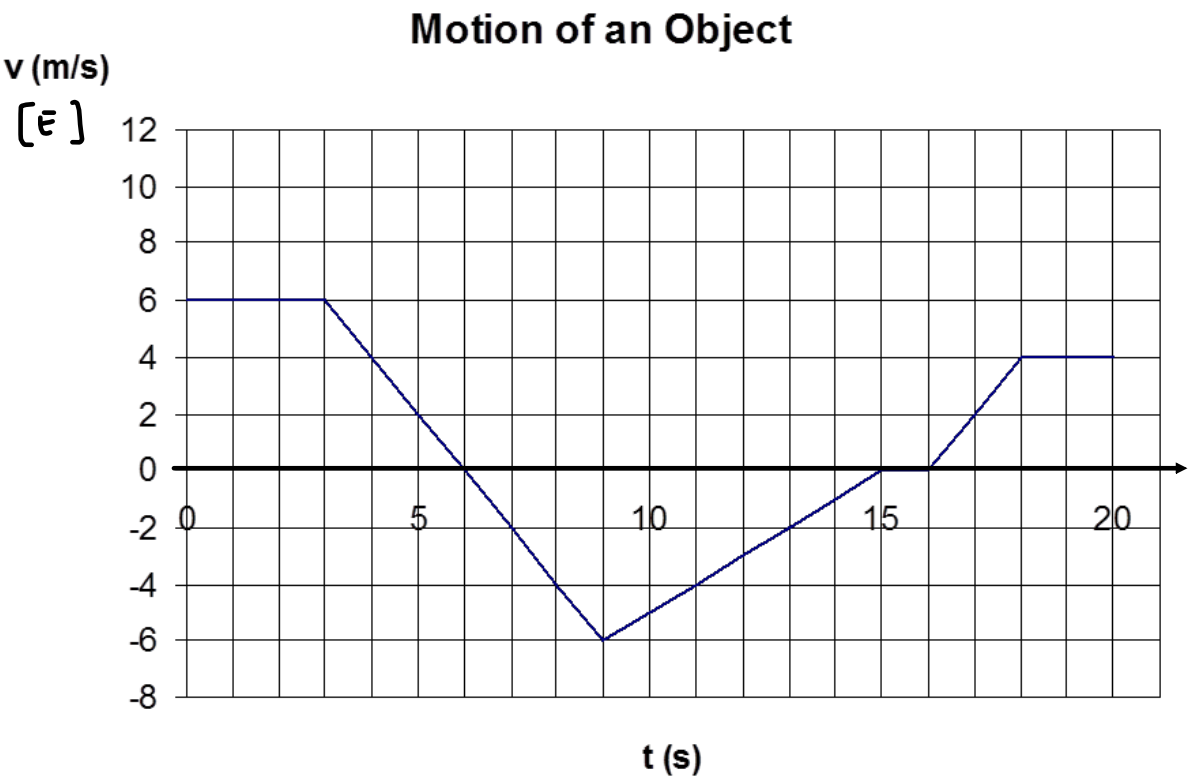
On a V-T Graph:

acceleration = slope

a+ v+ or a- v- speed up

a+ v- or a- v+ slow down

displacement = area (between function and x-axis)



At what time(s) is the object at rest?

6 s and [15, 16] s

What is the velocity of the object at 5 s?

2 m/s [E]

During what time interval(s) is the object speeding up?

[6, 9] s and [16, 18] s

moving away from x-axis

During what time interval(s) is the object slowing down?

[3, 6] s and [9, 15] s

moving towards x-axis

What is the acceleration of the object at 2 s?

$\vec{a} = 0$ velocity is constant

What is the acceleration of the object at 11 s?

$$\vec{a} = \frac{\vec{\Delta v}}{\Delta t} = \frac{0 - (-6\ m/s)}{15\ s - 9\ s} = \frac{6\ m/s}{6\ s} = 1\ m/s^2\ [E]$$

slowing down

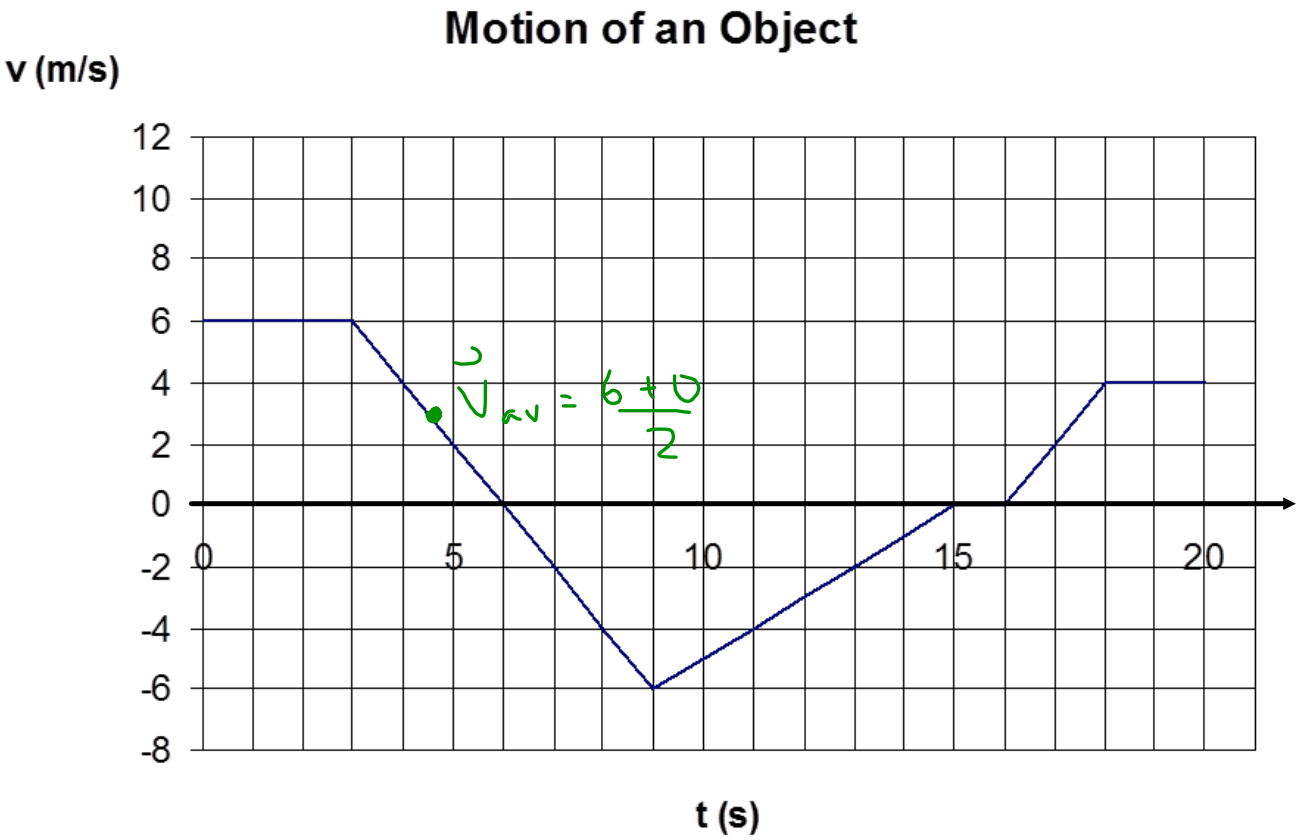
objects slow down when the acceleration is in the opposite direction of velocity.

What is the average acceleration of the object from 2 s to 13 s?

$$\vec{a} = \frac{\vec{\Delta v}}{\Delta t} = \frac{(-2m/s - 6m/s)[E]}{13s - 2s} = \frac{-8\ m/s\ [E]}{11\ s}$$

$$= -0.73\ m/s\ [E]$$

$$= 0.73\ m/s^2\ [W]$$


Motion of an Object
v (m/s)
12
10
8
6
4
2
0
-2
-4
-6
-8
0
5
10
15
20
t (s)
$v_{av} = \frac{6+0}{2}$

What is the displacement of the object from 0 s to 3 s?

$\vec{v} = \frac{\vec{\Delta d}}{\Delta t}$ $\quad 6\ m/s\ [E] = \frac{\vec{\Delta d}}{3\ s}$

$\vec{\Delta d} = 6\ m/s\ [E]\ (3\ s) = 18\ m\ [E]$

What is the displacement of the object from 3 s to 6 s?

$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t}$ $\quad \vec{v}_{av} = \frac{6+0}{2} = 3\ m/s\ [E]$ midpoint b/c $\vec{a}$ is constant

$3\ m/s\ [E] = \frac{\vec{\Delta d}}{3s}$ $\quad \vec{\Delta d} = 9\ m\ [E]$

What is the displacement of the object from 6 s to 9 s?

$\vec{v}_{av} = \frac{-6\ m/s + 0}{2} = -3\ m/s\ [E] = 3\ m/s\ [W]$

$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t}$

$3\ m/s\ [W] = \frac{\vec{\Delta d}}{3s}$

$\vec{\Delta d} = 9\ m\ [W]$

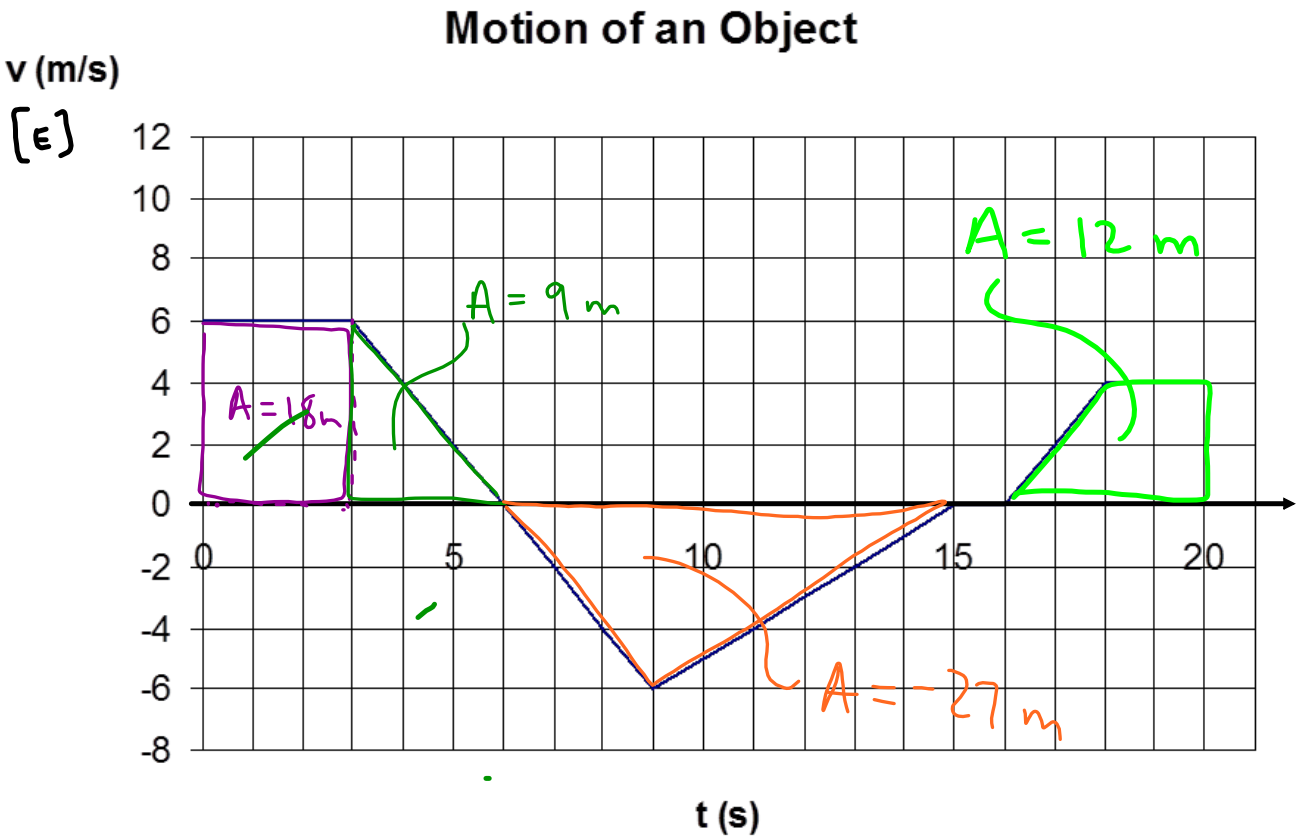
What is the displacement of the object from 9 s to 15s?

$\vec{v}_{av} = \frac{-6\ m/s\ (E) + 0}{2} = -3\ m/s\ [E] = 3\ m/s\ [W]$

$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t}$

$3\ m/s\ (W) = \frac{\vec{\Delta d}}{6s}$

$\vec{\Delta d} = 18\ m\ [W]$


Motion of an Object
v (m/s)
[ε]
12
10
8
6
4
2
0
-2
-4
-6
-8
0
5
10
15
20
t (s)
A = 18 m
A = 9 m
A = 12 m
A = -27 m

What is the average velocity of the object from 0 s to 20 s?

$$\vec{v}_{av} = \frac{\vec{\Delta d}}{\Delta t} = \frac{18\text{m} + 9\text{m} - 27\text{m} + 12\text{m}\ [E]}{20\text{s}}$$

$$= \frac{12\text{m}\ [E]}{20\text{s}}$$

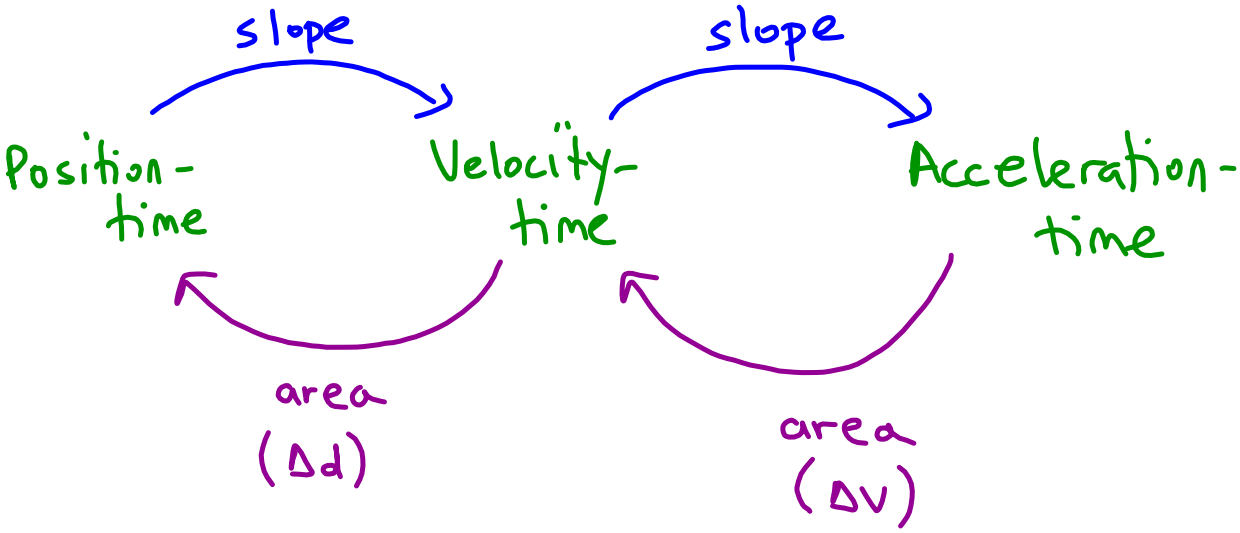
$$= 0.6\text{m/s}\ [E]$$

What is the average speed for the entire 20 s?

$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{|18m| + |9m| + |-27m| + |12m|}{20s}$$

$$= \frac{66\ m}{20\ s}$$

$$= 3.3\ m/s$$


slope
slope
Position-time
Velocity-time
Acceleration-time
area
(Δd)
area
(Δv)