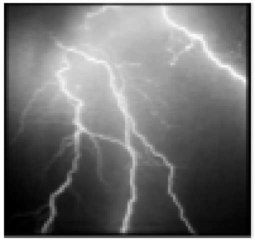
Science 10 Unit B: Physics

Acceleration

Review:

ex) A bolt of lightning is observed and the thunder is heard 5.25 s later. Given that the speed of sound is 343 m/s, how far away was the lightning bolt?



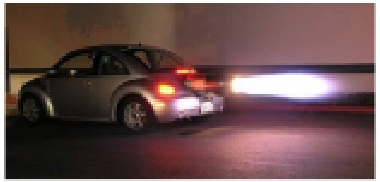
Secret Lightning Thing

***Rearrange your formula first!**

ex) Two cars compete in a 1000 m race. Car A travels at 175 m/s, car B at 182 m/s. When the faster car finishes, how far behind, in m, is the slower car?

*Draw a diagram.

* $t_A = t_B$



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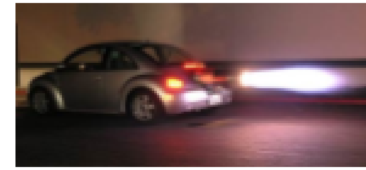


Secret Rocket-Beetle Thing

$d_B = 1000\,m$

$d_A = ?$

$V_B = 182\,\frac{m}{s}$

$V_A = 175\,\frac{m}{s}$

$t_A = ?$

$t_B = ?$

$$t_B = \frac{d_B}{V_B} = \frac{1000\,m}{182\,m/s}$$

$$= 5.49\,s$$

$$t_A = 5.49\,s$$

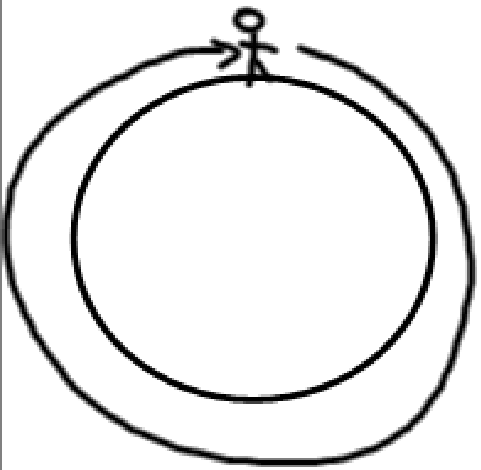
$$d_A = V_A t_A = 175\,\frac{m}{s}(5.49\,s)$$

$$= 961\,m$$

$$d_{between} = 1000\,m - 961\,m = 38.5\,m$$

Ans: [redacted]

ex) Given that the diameter of the Earth is 12.7×10^6 m, how fast is the planet rotating (in m/s)?



Secret Earth Thing

***The Earth rotates once per day.**

***C = πd**

$$C = \pi d$$

$$= \pi (12.7 \times 10^6 m)$$

$$t = 24h \times \frac{3600s}{h}$$

$$= 86\,400s$$

$$V = \frac{C}{t} = \frac{\pi (12.7 \times 10^6 m)}{86\,400s}$$

$$= 462 \frac{m}{s}$$

Non-uniform motion = accelerated motion

We have talked about uniform motion (a body at rest or moving at a constant velocity). But what happens if the velocity changes? We get an acceleration.

Acceleration

-While we can not sense a constant velocity, we can sense a change in velocity.

Acceleration is the rate of change of velocity.

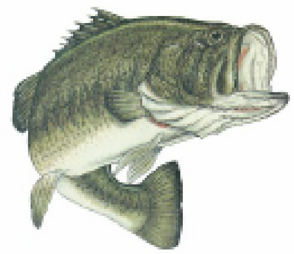
$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

Where:

$\vec{a}$ = acceleration
$\vec{v}$ = velocity
t = time

The unit of acceleration is metre per second squared (m/s^2)

ex) A bass begins to swim left at 5.00 m/s. 5.0 minutes later, the bass has increased its velocity to 7.00 m/s. What was the fish's acceleration over this time?



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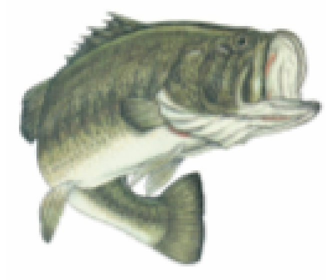


$t = 5.0\,\text{min}$
$= 300\,\text{s}$

$\vec{v}_1 = 5.00\,\frac{m}{s}$ left

$\vec{v}_2 = 7.00\,\frac{m}{s}$ left

$$\vec{a} = \frac{\Delta \vec{v}}{t} = \frac{\vec{v}_2 - \vec{v}_1}{t} = \frac{7.00\,\frac{m}{s} - 5.00\,\frac{m}{s}}{300\,s}$$

$$= \frac{2.00\,m/s}{300\,s} = 6.7 \times 10^{-3}\,\frac{m}{s^2}$$

left

Ans: [redacted]

ex) While driving at 100 km/h, I spied a student on the road and hits the brakes. It takes 98 m to stop my car. What was the acceleration of the car?

$$\vec{a} = \frac{\vec{v}}{t} \qquad \vec{v} = \frac{\vec{d}}{t}$$

*Convert to m/s from km/h by dividing by 3.6!

$\vec{v}_1 = 100 \frac{km}{h}$

$\vec{d} = 98 m$

$\vec{a} = ?$

$\vec{v}_2 = 0 \frac{km}{h}$

$\vec{t} = ?$

$$t = \frac{\vec{d}}{\Delta \vec{v}} = \frac{0.098 km}{0 \frac{km}{h} - 100 \frac{km}{h}}$$

$$= \frac{0.098 km}{-100 \frac{km}{h}}$$

$$= -0.00098 h$$

$$\vec{a} = \frac{-100 \frac{km}{h}}{0.00098 h}$$

$$= 102\,041 \frac{km}{h^2}$$

$$= -1.0 \times 10^5 km/h^2$$

deceleration

Ans: [redacted]

More Acceleration Problems:

We often use the form:

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t}$$

As we often deal with the final and initial velocities of an object.

This form can be manipulated as follows:

$$t = \frac{\vec{v}_f - \vec{v}_i}{\vec{a}} \qquad \vec{v}_f = \vec{v}_i + \vec{a}t \qquad \vec{v}_i = \vec{v}_f - \vec{a}t$$

ex) An insect buzzes at 3.0 m/s, then accelerates for 4.75 s at 1.25 m/s^2. What is the insect's final velocity?

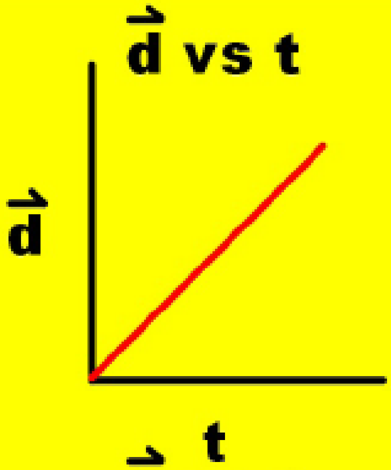
Ans: 8.9 m/s

ex) An electron has a final velocity of 3.0×10^6 m/s after accelerating for 25 s at 1.5×10^4 m/s^2. What was the electron's initial velocity?

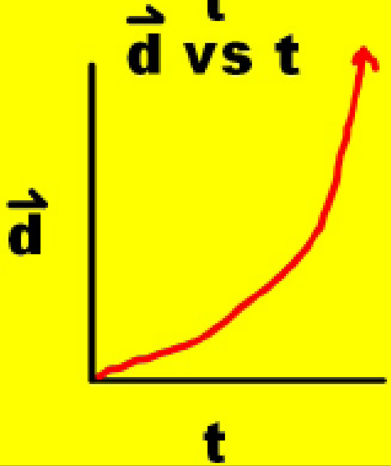
Ans: 2.6×10^6 m/s

Graphing Acceleration using $\vec{d}$ vs t

Note that in a displacement vs. time graph for acceleration, we have a curved line graph.



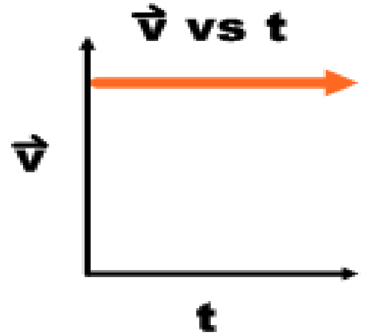
- graph of constant velocity (no acceleration)



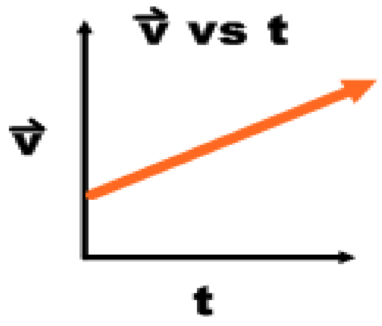
- graph of accelerated motion

Graphing Acceleration

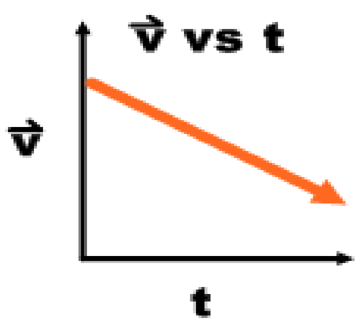
Acceleration can be found from the slope of a velocity vs. time graph.



-This represents zero acceleration, or constant velocity, as the slope is zero.



- This represents a constant acceleration. Velocity increases at a constant rate as time increases.



-This represents a deceleration, as the slope of the line is negative.

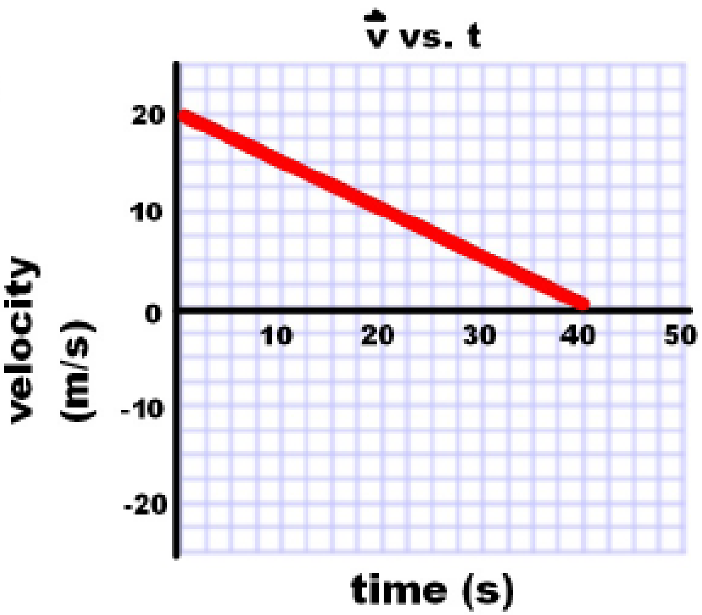
ex) A beetle, starting from rest, increases his speed to 8.0 m/s forwards in 4.0 seconds. He continues at this speed for 5.0 seconds, then slows down to 2.0 m/s in 2.0 seconds. Finally, he comes to a stop in 4.0 s.

a) Sketch a velocity vs. time graph of this beetle's movement.

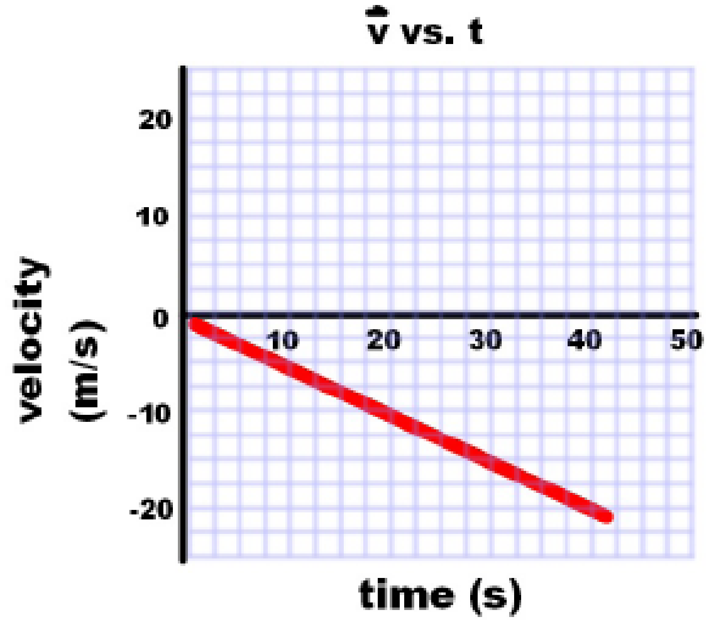
b) Calculate the beetle's accelerations.

ex) Examine the graph. Describe in words the motion of the object producing each graph.

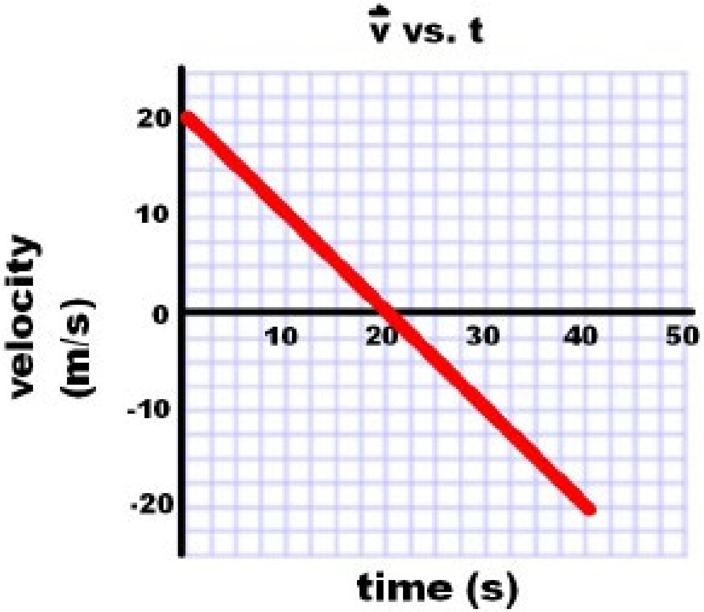
a)



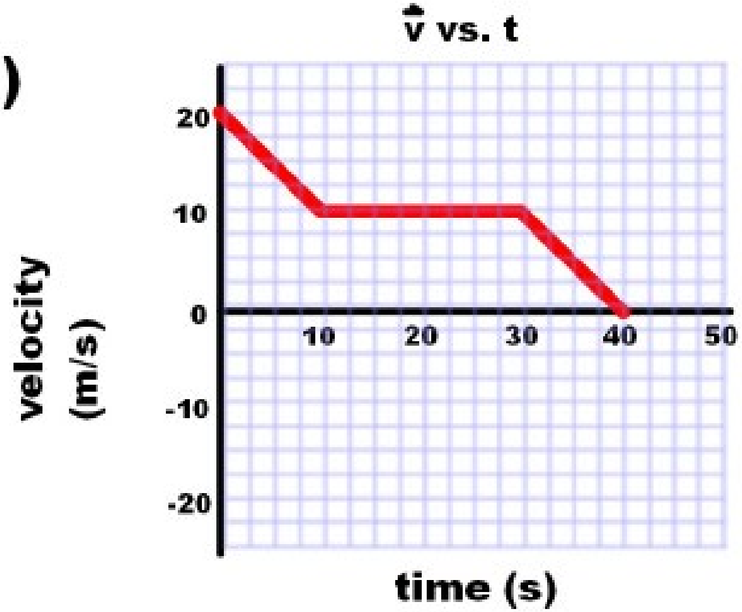
b)



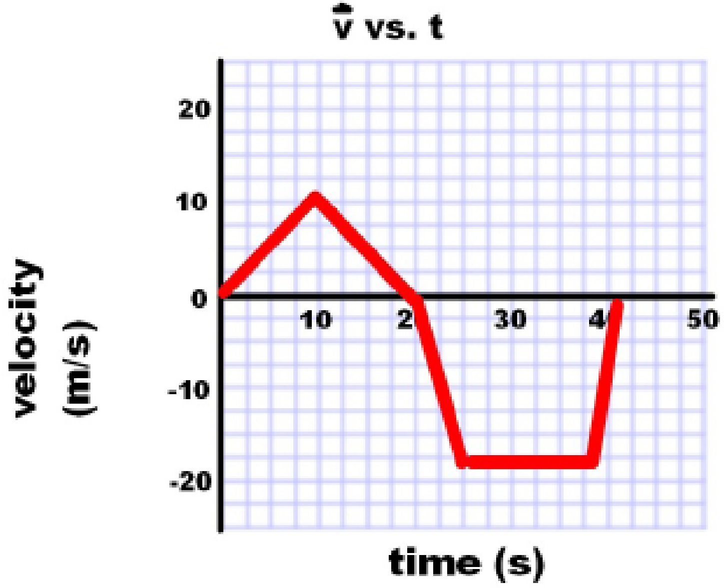
c)


v vs. t
20
10
0
-10
-20
10
20
30
40
50
velocity (m/s)
time (s)

d)


v vs. t
20
10
0
-10
-20
10
20
30
40
50
velocity (m/s)
time (s)

e)



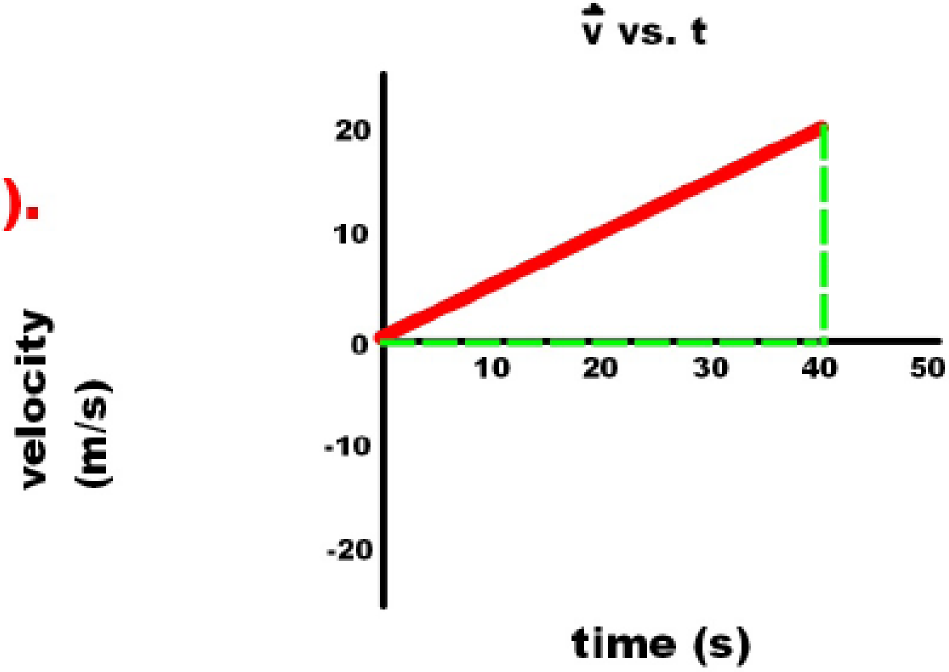
Whoa.

*Note: we only have straight lines on velocity vs. time graphs in Science 10!

Finding Displacement from a Velocity vs. Time graph

Another important and totally radical property of $\vec{v}$ vs. t graphs is what happens if you find the area underneath of them:

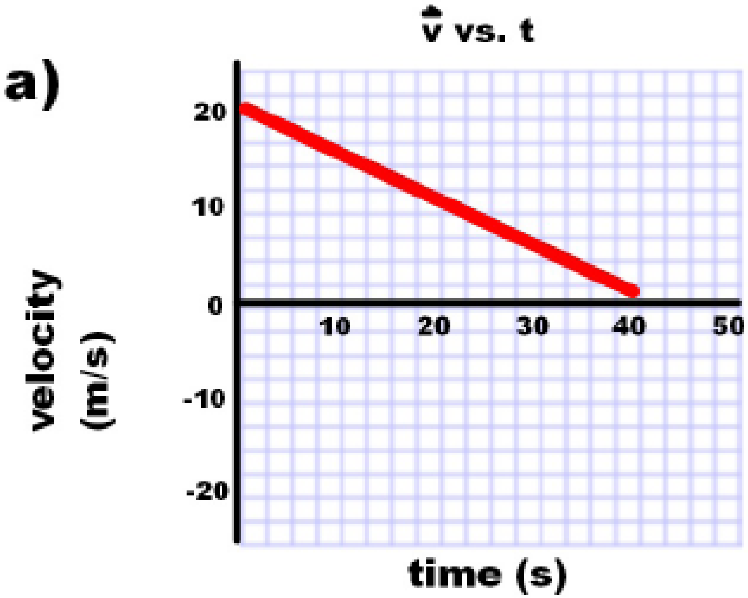
ex) Find the area under the curve (include units).



As you have just discovered, **finding the area underneath of a velocity vs. time graph will give displacement**.

ex) Find the displacement.

a)



b)