SCIENCE 1206 Unit 3

"Good morning, and welcome to The Wonders of Physics."

Physical Science – Motion

Introduction

- Motion is a common theme in our everyday lives: birds fly, babies crawl, and we, run, drive, and walk.

- ***Kinematics** is the study of how objects move.*

Sign Convention

- In physics we will use a standard set of signs and directions.
- Up, right, east and north are positive directions. (+)
- Down, left, west, and south are negative directions. (-)

Types of Measures

1 **Scalar** – any description of motion that has size (magnitude) and a unit. **NO DIRECTION** is given !

ex. **Distance** between LC and HVGB is 580 km.
The **speed** of a frightened goose is 60 km / h

2 **Vector** – descriptions that have size (magnitude), units, AND include a direction written inside square brackets at the end

Ex. A car's **velocity** is 80 km / h [E]

5 N of **force** pulling [up]
The **displacement** of me at home, to me at work is 1.3 km [ESE]

Distance and Displacement

- Distance (d) is a **scalar measure** of the actual path between two locations.
- It has a magnitude and a unit. (just a #)
- Ex: 50 m, 2.5 hrs.

d = distance →

$d_T = d_1 + d_2$ ..

trip 1 distance

trip 2

* If calculating distance all natural (+ve) #'s

Distance cont'd....

* Always end story problem with statement

It is the length of an object's trip regardless of direction. It is the combined total of all movement. Usually measured in metres or kilometres.

Ex. The odometer on a vehicle records distance travelled

Ex. If I leave Lab City, head to the Ashuanipi camp for the weekend, and come back on Sunday....my distance travelled is roughly 90 km.

Distance

Ex.1 Ted walked 2 km [N] and then 5 km [S]. Find the total distance Ted travelled.

Always write your givens!

Given....

$$\vec{d}_1 = 2\,km\,[N]$$

$$\vec{d}_2 = 5\,km\,[S]$$

don't need for distance please write in anyways

Total distance would be...

T means Total

$$d_T = d_1 + d_2$$

Always write down formulas!

$$d_T = 2\ km + 5\ km$$

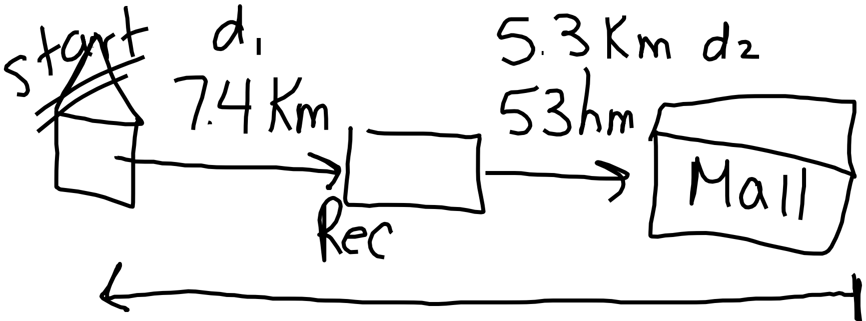
Substitute in #'s

$$d_T = 7\ km$$

$\frac{1}{2}$ mark original answer, + $\frac{1}{2}$ sig fig answer!

Ted's total distance is 7 km

Colden walks 7.4 Km [S] to Rec Centre, gets tired and hitches a ride to mall with Ashton 53 hm. Ashton feels sorry for Colden + brings him home. What is Coldens total distance?



$7.4 + 5\,3 = 12\,7$

d_3

G _ _ M _ _ Kdda

<u>Given</u>

$d_1 = 7.4\text{ Km}$

$d_2 = 53\text{ hm} = 5.3\text{ Km}$

$d_3 = 7.4\text{ Km} + 5.3\text{ Km} = 12\,7\text{ Km}$

$d_T = d_1 + d_2 + d_3$

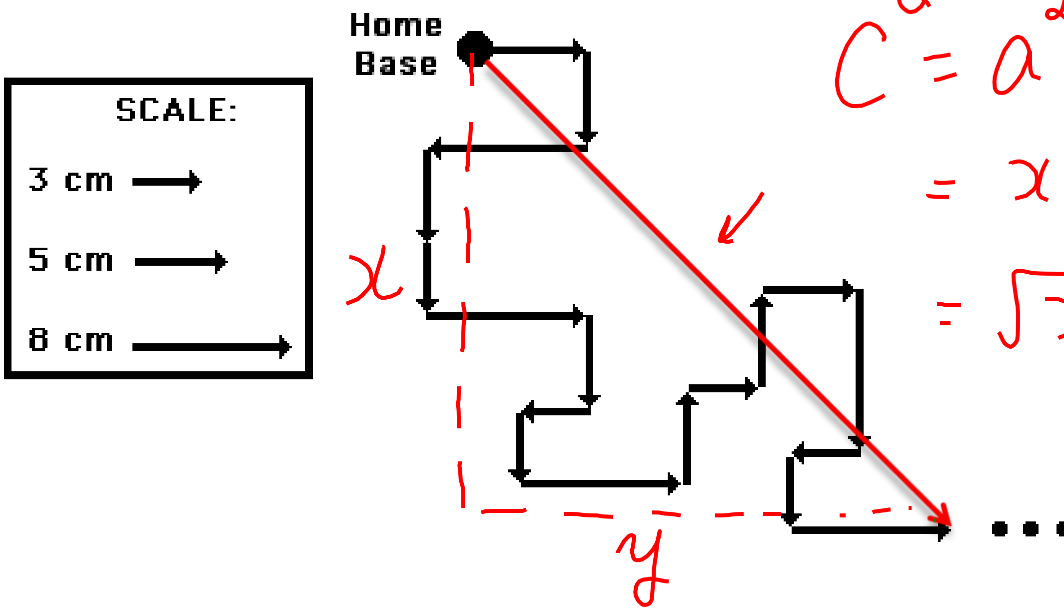
$= 7\,4 + 5.3 + 12.7$

$= \underline{25}4\text{ Km} = \boxed{25\text{ Km}}$

He walked 25 Km

- Vectors are **always** added tip to tail.

The resultant or net vector goes from the start of the first vector to the tip of the last vector.



$$c^2 = a^2 + b^2$$
$$= x + y$$
$$= \sqrt{x+y}$$

The black lines represents the **<u>distance</u>** traveled to get from the home base to the destination(path actually taken)

The red line represents the **<u>displacement</u>** from the home base to the destination (the shortest distance from the start point to the end point)

Displacement

- Displacement ($\vec{d}$) is a **vector measure** of the change in position measured in a straight line from a starting reference point.
- It has a magnitude, unit and direction. * Not using a graph
- Ex: 5 m [W] $\vec{d}_T = \vec{d}_1 + \vec{d}_2$. etc

On position-time graph. displacement formula changes..

It is the difference between where an objects starts from (initial position), and where it stops at (final position). Usually measured in metres or kilometres.

To calculate it, **"Final position" - "initial position"** (only use this formula if you are given positions. This is usually used with graphs.

$$\vec{d}_T = \vec{d}_f - \vec{d}_i$$

Displacement cont'd….

If an object's trip happens to be in one direction, then it moves in the opposite direction. we'll have to add the two opposite vectors (directions) together.

If you are given actual displacements, then use

Hint: draw a vector diagram

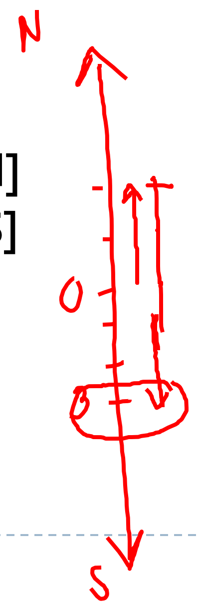
Example 1:

Ted Walks 2 km [N] and then 5 km [S]. Find his total displacement.

<u>Givens</u>

$\vec{d}_1$ = 2 km [N]

$\vec{d}_2$ = 5 km [S]



$$\vec{d}_T = \vec{d}_1 + \vec{d}_2$$

$$= 2\,Km\,[N] + 5\,Km\,[S]$$

$$\boxed{= 3\,Km\,[S]}$$

His displacement is 3 Km [S] of his starting point.

*Remember Sig. Figs

Example ~~1~~ 2

P. 416 # 1, 4, 5, 6 + 13

A person started from the zero position, moved 3.0 *km East (or to the right), then moved backward 4.0 km West (or to the left).*

A) What is the distance

B) What is the displacement

Givens

$\vec{d}_1 = 3.0\text{ Km [E]}$

$\vec{d}_2 = 4.0\text{ Km [W]}$

A) $d_T = d_1 + d_2$

$= 3.0\text{ Km} + 4.0\text{ Km}$

$= 7\text{ Km} = \boxed{7.0\text{ Km}}$

Person travelled 7.0 Km.

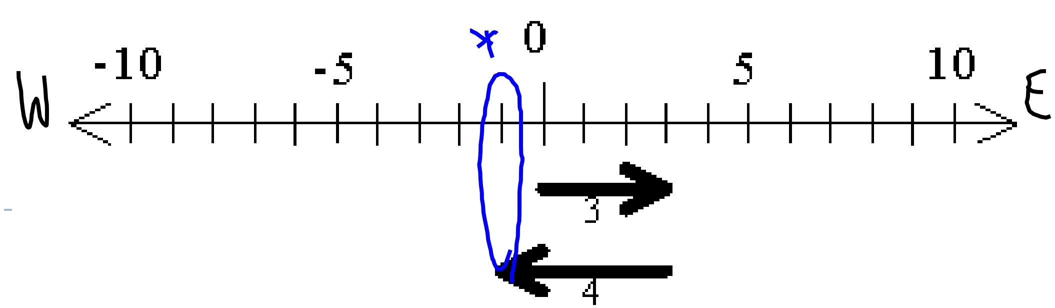
B.) $\vec{d}_T = \vec{d}_1 + \vec{d}_2$

$= 3.0\text{ Km [E]} + 4.0\text{ Km [W]}$

$= 1\text{ Km [W]}$

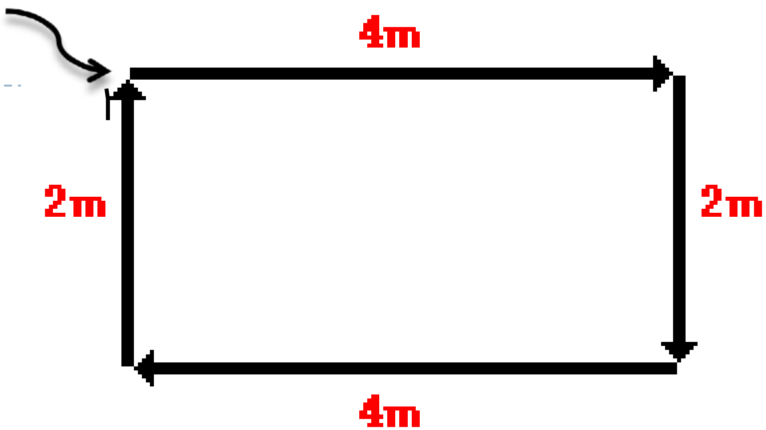
$\boxed{= 1.0\text{ Km [W]}}$

Persons displacement is 1.0 Km [W].



Example ~~2~~ 3

A person started from the zero position, and moved as shown in the diagram.
A)What is the distance traveled?
B) What is the displacement?



Givens

$\vec{d}_1 = 4\text{ m [E]}$

$\vec{d}_2 = 2\text{ m [S]}$

$\vec{d}_3 = 4\text{ m [W]}$

$\vec{d}_4 = 2\text{ m [N]}$

Distance – total trip

$d_{total} = d_1 + d_2 + d_3 + d_4$

$d_{total} = 2m + 4m + 2m + 4m$

$d_{total} = 12\text{ m}$

A) $d_T = 4m + 2m + 4m + 2m$

$\boxed{= 12\text{ m}}$

The person travelled 12 m.

Displacement – change in position

$\vec{d}_{total} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3 + \vec{d}_4$

$d_{total} =$

B) $\vec{d}_T = \vec{d}_1 + \vec{d}_2 + \vec{d}_3 + \vec{d}_4$

$= 4\text{m [E]} + 2\text{m [S]} + 4\text{m [W]} + 2\text{m [N]}$

$= (4\text{m [E]} + 2\text{m [N]}) + (4\text{m [W]} + 2\text{m [S]})$

$\boxed{= 0\text{ m}}$

$\vec{d}$ is 0 m

Displacement

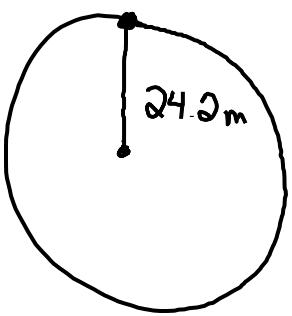
When you return back to your original starting point,

P.416 # 1,4,5,6+13.

Ex. Returning to the same house after a weekend at the camp means my displacement is zero....I returned to the exact same place from where I started. No direction is necessary.

Example: A goat is tied on a leash in a backyard Its leash is 24.2 m long. What would the goats total distance and displacement if it travelled In 1 full rotation?

Hint: draw diagram



For a circular Path use circumference.

$C = 2\pi r$

$C = \pi d$

Givens

$r = 24.2$

A) $C = 2\pi r$

$= 2 \times 3.14 \times 24.2\,m$

$= 152.053084\,m$

$\doteq 152\,m$

Distance travelled is 152m.

B) $\vec{d} = 0\,m$

Displacement is 0m.

Seatwork/homework: Chapter 11 in Textbook

Read P. 414-416

Complete Questions: P. 416-417 # 1,4,5,6,13

Distance and displacement worksheet

Speed

- **Speed is a measure of the distance traveled in a given period of time;**

Memorize

$$\Delta = \text{Change In}$$

$$\Delta d = \text{Change in distance}$$

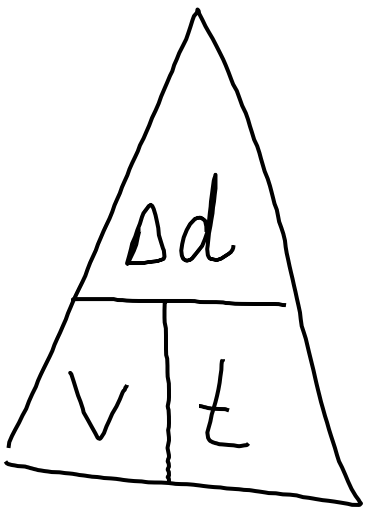
$$t = \text{Time}$$

$$V = \text{Speed}$$

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

Rearrange Speed Formula

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



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

$$d = v \cdot t$$

$$v * t$$

$$(v)(t)$$

$$vt$$

hint: put finger over over what you are asked to find.

Instantaneous Speed

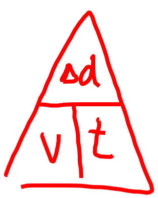
- **Instantaneous speed** is speed at any instant in time.
- A speedometer measures speed in ‘real time’ (the instantaneous speed).

Mrs. Cranford walked her dog, Dakota, at 2.0 m/s for 4.0 s. How far did Mrs. Cranford walk her dog?

Givens

$V = 2\ 0\ m/s$

$t = 4\ 0\ s$



$$d = vt$$

$$= 2.0\frac{m}{\cancel{s}} \times 4.0\cancel{s}$$

$$= 8\ m$$

$$= \boxed{8.0\ m}$$

They walked 8 0m

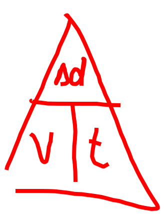
The world's fastest car, travelled 567.7 m at an average speed of 341 m/s. What is the length of time travelled in ~~k~~m/h?

Givens

$d = 567.7\ m$

$V = 341\ m/s$

$t = ?$



$$t = \frac{d}{V}$$

$$= \frac{567.7\ \cancel{m}}{341\ \cancel{m}/s}$$

$$= 1.664809384\ s$$

*

$$\boxed{= 1.66\ s}$$

Convert to hours

$$1.66\cancel{s} \times \frac{1\ \cancel{min}}{60\ \cancel{s}} \times \frac{1\ h}{60\ \cancel{min}}$$

$$= \frac{1.66}{3600} = 0.00046111$$

$$\boxed{= 0.000461\ h}$$

It took 0.000461 h.

Average Speed

- When we are dealing with uniform motion that has different speeds at different times, you **cannot** determine the overall average speed by averaging the speeds of the different parts

- **Average speed** is the average of all instantaneous speeds; found simply by a total distance/total time ratio
- The average speed of a trip:

$$\text{average speed} = \frac{\text{total distance}}{\text{elapsed time}}$$

$$V_{(av)} = \frac{d_T}{t_T} = \frac{d_1 + d_2 + d_3 \ldots}{t_1 + t_2 + t_3 \ldots}$$

Average

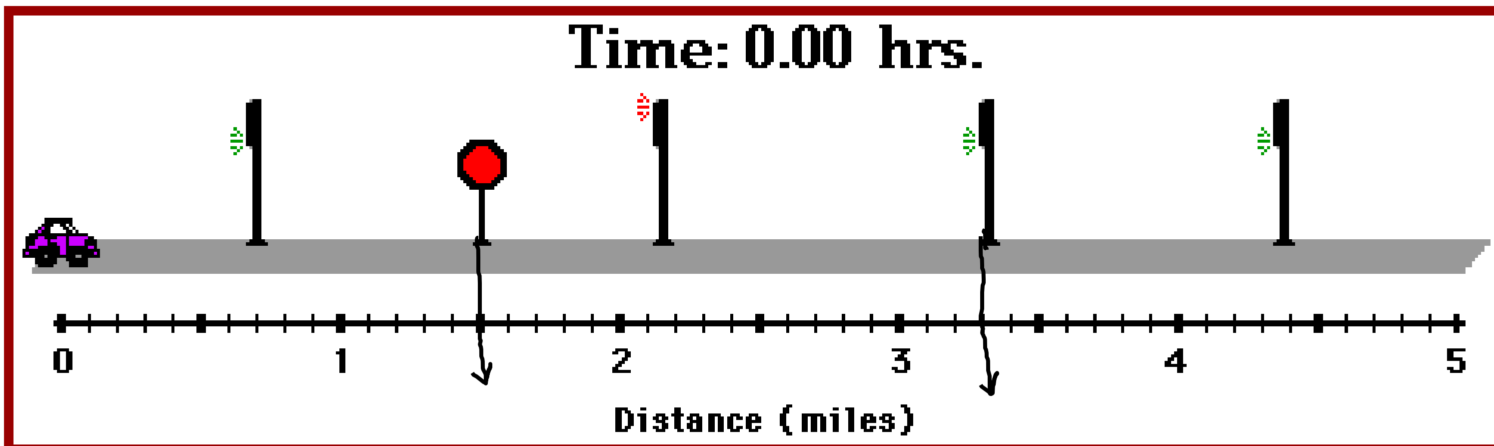
Total

Average Speed

Average is 30 mi/h

Ex 1. Car video..

$$V(av) = \frac{d_1+d_2+d_3}{t_1+t_2+t_3} = \frac{1.5+1.8+1.7}{0.06+0.10+0.04} = \frac{5\ mi}{0.20\ h} = 25\ \frac{mi}{h} = \boxed{30\ \frac{mi}{h}}$$



$0.20 - 0.16 = 0.04$

Givens

$d_1 = 1.5\ mi$
$t_1 = 0.06h$

$0.16 - 0.06 = 0.10$

$3.3 - 1.5$

$d_2 = 1.8\ mi$
$t_2 = 0.10\ h$

$5 - 3.3 = 1.7\ mi$

$d_3 = 1.7\ min$
$t_3 = 0.04\ h$

Example 2:

Suppose that during your trip to school, you traveled a distance of 1002 m and the trip lasted 300 seconds. What is your average speed?

What is the average speed of the car?

Givens

$d_T = 1002\,m$

$t_T = 300\,s$

* Answer 1 SF

$$V_{(av)} = \frac{d_T}{t_T} = \frac{1002\,m}{300\,s} = 3.34\,\frac{m}{s} = \boxed{3\,\frac{m}{s}}$$

Average Speed of car is 3 m/s.

Example 3 :

You go out for some exercise in which you run 12.0 km in 2 hours, and then bicycle another 20.0 km in 1 more hour.

What was your average speed for the entire marathon?

Givens

$d_1 = 12.0\,Km$

$d_2 = 20.0\,Km$

$t_1 = 2\,h$

$t_2 = 1\,h$

$SF = 1*$

$$V_{(av)} = \frac{d_1 + d_2}{t_1 + t_2} = \frac{12.0 + 20.0}{2 + 1} = \frac{32\,Km}{3\,h} = 10.6\,\frac{Km}{h}$$

$$\boxed{= 10\,\frac{Km}{h}}$$

Average Speed for marathon was about 10 Km/h.

Ex. 4

A plane travelling non-stop travels at a speed of 750 km/h in 2.0 hours and then 500.0 km/h for the remaining 5.0 hours. What is its average speed?

Read

Reminder.... to find the average speed, you would first need to find the total distance AND then total time. To find total distance, you need to find d_1 and d_2. You must determine the distance covered during each "leg" of the trip.....which means you need to perform 2 calculations, and add the two distances together before completing the question.

(1) **Givens:**

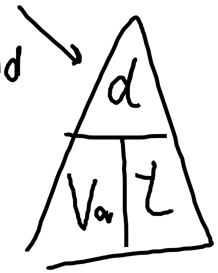
$v_1 = 750\,km/h$

$v_2 = 500.0\,km/h$

$t_1 = 2.0\,h$

$t_2 = 5.0\,h$

need to find



$t_T = 2.0\,h + 5.0\,h = 7.0\,h$

Step 3 (3)

$$v_{AV} = \frac{d_T}{t_T}$$

$$v_{AV} = \frac{1500\,km + 2500\,km}{7.0\,h} = 571.4\,\frac{Km}{h}\ *$$

$$v_{AV} = \boxed{570\,km/h} \quad (2\ sig\ figs)$$

(2) find 2 distances

$d_1 = v_1 t_1$

$d_T = (750\,km/h)(2.0\,h)$

$d_T = 1500\,km$

$d_2 = v_2 t_2$

$d_2 = (500\,km/h)(5.0\,h)$

$d_2 = 2500\,km$

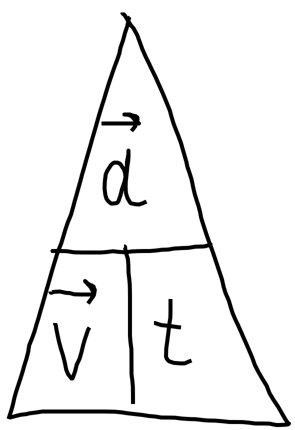
- The planes average speed is 570 km/h

Average speed is 570 Km/h.

Velocity

- Speed in a given direction is velocity (vector).

$$\text{Velocity} = \frac{\text{Change in displacement}}{\text{Change in time}} = \vec{v} = \frac{\Delta \vec{d}}{\Delta t}$$



therefore

$$\vec{d} = \vec{v} \cdot t$$

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

- What is the velocity of a car that travels from Labrador City to Churchill Falls (283Km [W]) in 3.0h?

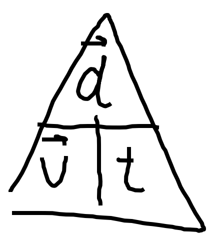
Givens

$\vec{d} = 283\,Km\,[W]$

$t = 3.0\,h$

$\vec{v} = ?$

Answer 2 SF



Think $\vec{d_1} + \vec{d_2}$

Start at 0 go to 283 = $\vec{d} = 283\,Km\,W$

initial final

Start 0h go to 3.0h = $\Delta t = 3.0\,h$

$$\vec{v} = \frac{\vec{d}}{t} = \frac{283\,Km\,[W]}{3.0\,h}$$

$$= \underline{94}\,\overline{3}\ \frac{Km}{h}\,[W]$$

$$= 94\,\frac{Km}{h}\,[W]$$

The velocity is $94\,\frac{Km}{h}\,[W]$.

Ex 2

A marathon runner in training runs 12 km [S] and then 27 km [N]. If this takes 4.2 hours of running altogether, what is the runner's average **velocity** ?

Need to find displacement

Think → **Remember movement in [N] or [E] direction is considered positive, movements [S] or [W] directions is considered negative.**

$\Delta\vec{d}_T$ ← displacement total

$\vec{v}_{AV}$ | t_T ← time total

Givens:

(1)

$$\vec{d}_1 = 12\,km\,[S]$$

$$\vec{d}_2 = 27\,km\,[N]$$

$$t_T = 4.2\,h$$

(2)

$$\vec{d}_T = \vec{d}_1 + \vec{d}_2$$

$$\vec{d}_T = 12\,km\,[S] + 27\,km\,[N]$$

$$\vec{d}_T = -12\,km + 27\,km$$ Think

$$\vec{d}_T = 15\,km$$

$$\vec{d}_T = 15\,km\,[N]$$

$$\vec{v}_{AV} = \frac{\vec{d}_T}{t_T}$$

$$\vec{v}_{AV} = \frac{15\,km\,[N]}{4.2\,h} = \underline{3.5}7^{*}\ \frac{Km}{h}\ [N]$$

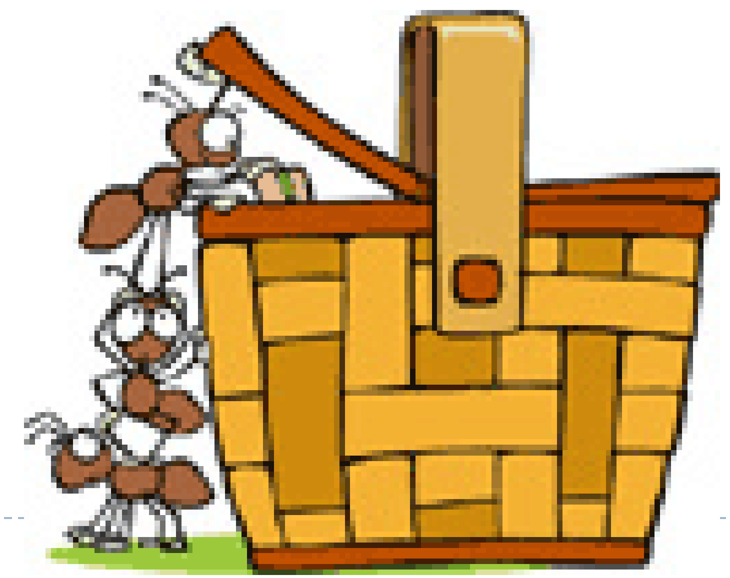
$$\boxed{\vec{v}_{AV} = 3.6\,km\,/\,h\ \ [N]}$$ (2 sig figs)

Runners average velocity is 3.6 $^{km}/_{h}$ $[N]$.

Practice Examples

Question #1

- An ant on a picnic table walks 130 cm to the right and then 290 cm to the left in a total of 40.0 s. Determine the ant's distance covered, displacement from original point, average speed, average velocity.



Givens

$\vec{d}_1 = 130\,[R]$

$\vec{d}_2 = 290\,[L]$

$t_T = 40.0\,s$

Solution

$d_1 + d_2$

A) distance = d = total path of the ant = 130 cm + 290 cm = 420 cm
cm

$\vec{d}_1 + \vec{d}_2 = 130\,[R] + 290\,[L] = 160\,[L]$

B) displacement = $\vec{d}$ = change in position of the ant ~~= 130 cm + (−290) cm = −160 cm =~~ ~~160 cm [left] of the starting point~~

c) average speed:

Statements!

d) $v_{av} = \dfrac{d_{total}}{t_{total}} = \dfrac{420\text{ cm}}{40.0\text{ s}} = 10.5 = 11\text{ cm/s}$

e) average velocity:

$\vec{v}_{av} = \dfrac{\vec{d}_{total}}{t_{tot}} = \dfrac{160\text{ cm}}{40.0\text{ s}} = 4.0 = 4.0\text{ cm/s to the left (or West)}$

Question - Bonus

Vectors at 90 degrees. (Pythagorean Theorem $C^2 = a^2 + b^2$)

A crow flies 30.0 km west, then 40.0 km south. The entire trek took 3.0 h.

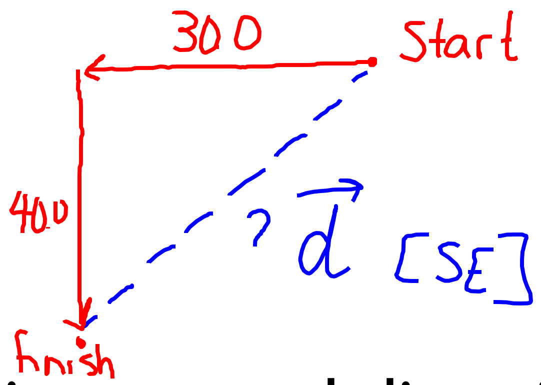
Determine the crow's:

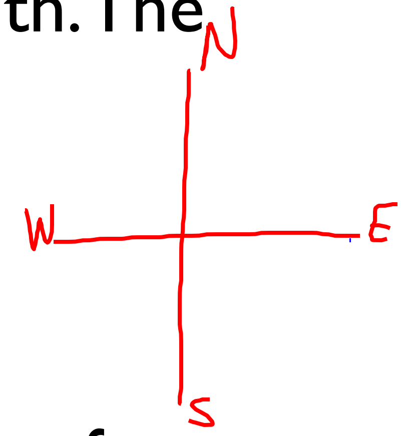
(a) total distance traveled

(b) average speed

(c) displacement (actual distance and direction from where he started) - Hint – Pythagorean theorem

(d) average velocity





Givens

$\vec{d}_1 = 30.0\,Km[W]$

$\vec{d}_2 = 40.0\,Km[S]$

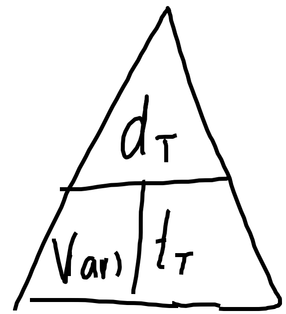
$t = 3.0\,h$

Givens

$\vec{d}_1 = 30.0\ Km\ [W]$

$\vec{d}_2 = 40.0\ Km\ [S]$

$t = 3.0\ h$



A) $d_T = d_1 + d_2 = 30.0\ Km + 40.0\ Km = 70\ Km = \boxed{70.0\ Km}$

Total distance is 70.0 Km.

B) $V_{(av)} = \dfrac{d_T}{t_T} = \dfrac{70.0\ Km}{3.0\ h} = \underline{23}.3\overline{3}\ \dfrac{Km}{h} = \boxed{23\ Km/hr}$

Average Speed is 23 Km/hr.

c) $\vec{d} = a^2 + b^2$

$= 30.0^2 + 40.0^2$

$= 900 + 1600$

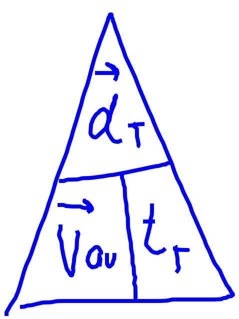
$c^2 = \sqrt{2500}$

$C = 50 \text{ Km}$

$\boxed{= 50.0 \text{ Km}}$

The displacement is 50.0 [SE].

d) $V_{(av)} = \dfrac{\vec{d}_T}{t_T} = \dfrac{50.0 \text{ Km [SE]}}{3.0 \text{ h}} = 16.6\overline{6}\,\dfrac{\text{Km}}{\text{h}} = \boxed{17\,\dfrac{\text{Km}}{\text{h}}}$



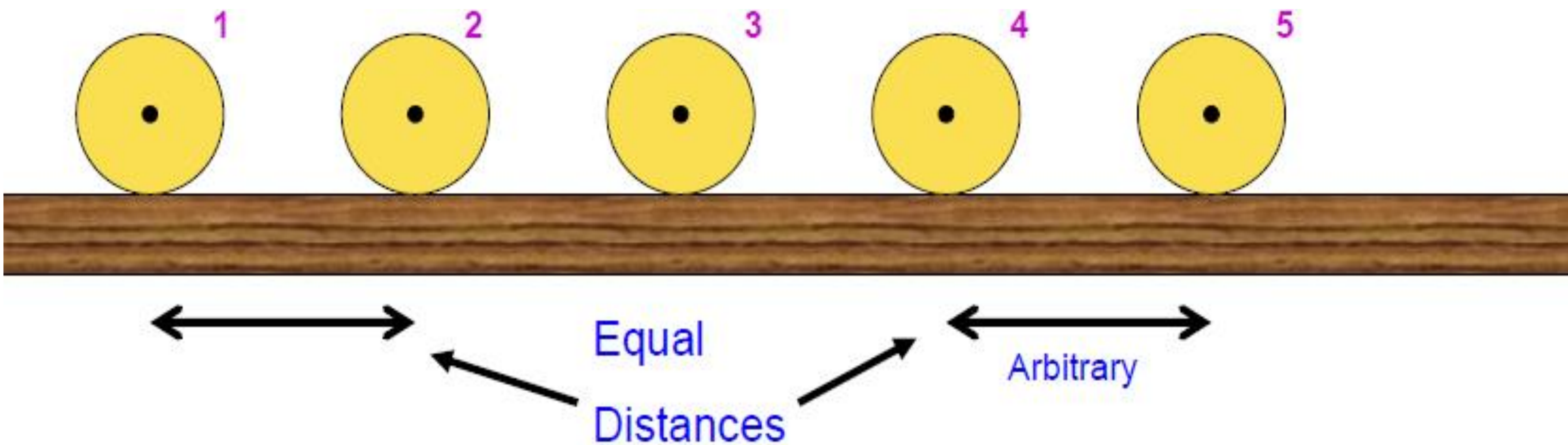
The average velocity is 17 Km/h [SE].

Uniform Motion

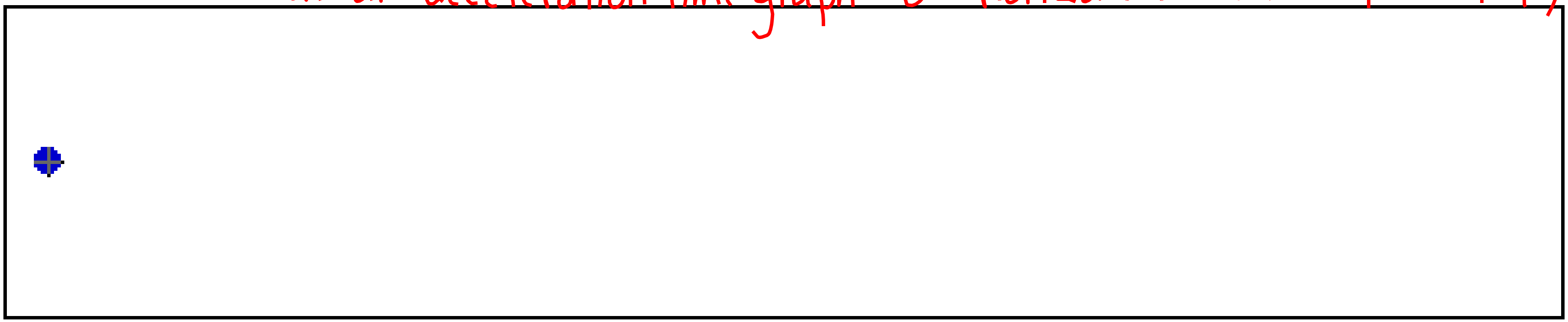
Rolling ball is an example of uniform motion.

1) Speed of the ball is constant (with no friction).

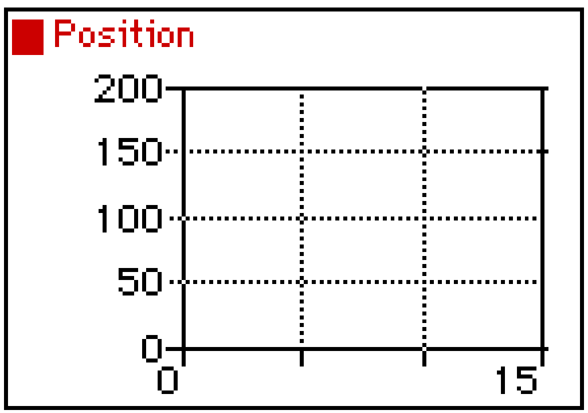
2) In a straight line



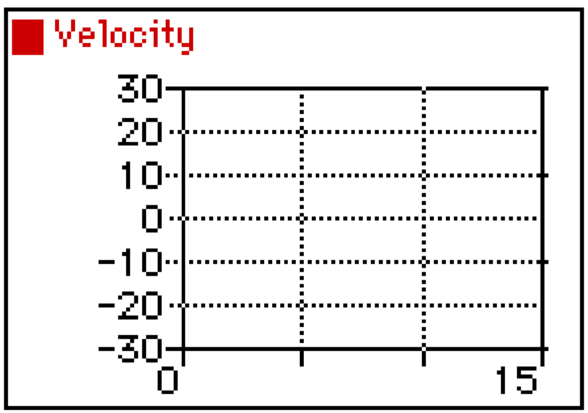
- Uniform motion on a distance-time (d-t) moves at the same rate ∴ Straight line
- " " on a Velocity time graph ($\vec{v}$-t) moves at same speed ∴ horizontal line
- " " on an acceleration time graph - 0 - horizontal line (not Speeding up)



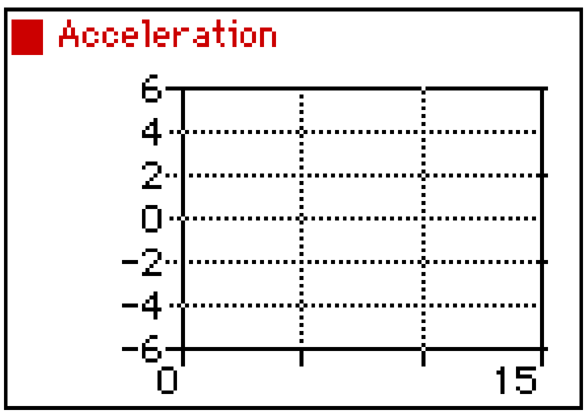
distance
Position-Time Graph



Velocity-Time Graph



Acceleration-Time Graph



Expectations for graphing.

Distance-time graphs

- pencil
- ruler
- arrows + label axis (x, Y)
- Consistant space b/w #'s
- use ⋀⋁ (squiggle) if big jump in #'s
  break

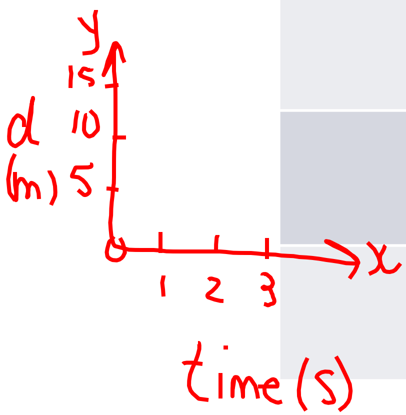
- On your paper, graph the following:

distance- y axis is dependant variable

x axis

time is always independant variable

D(m)	T(sec)
0	0
5	7
10	14
15	21



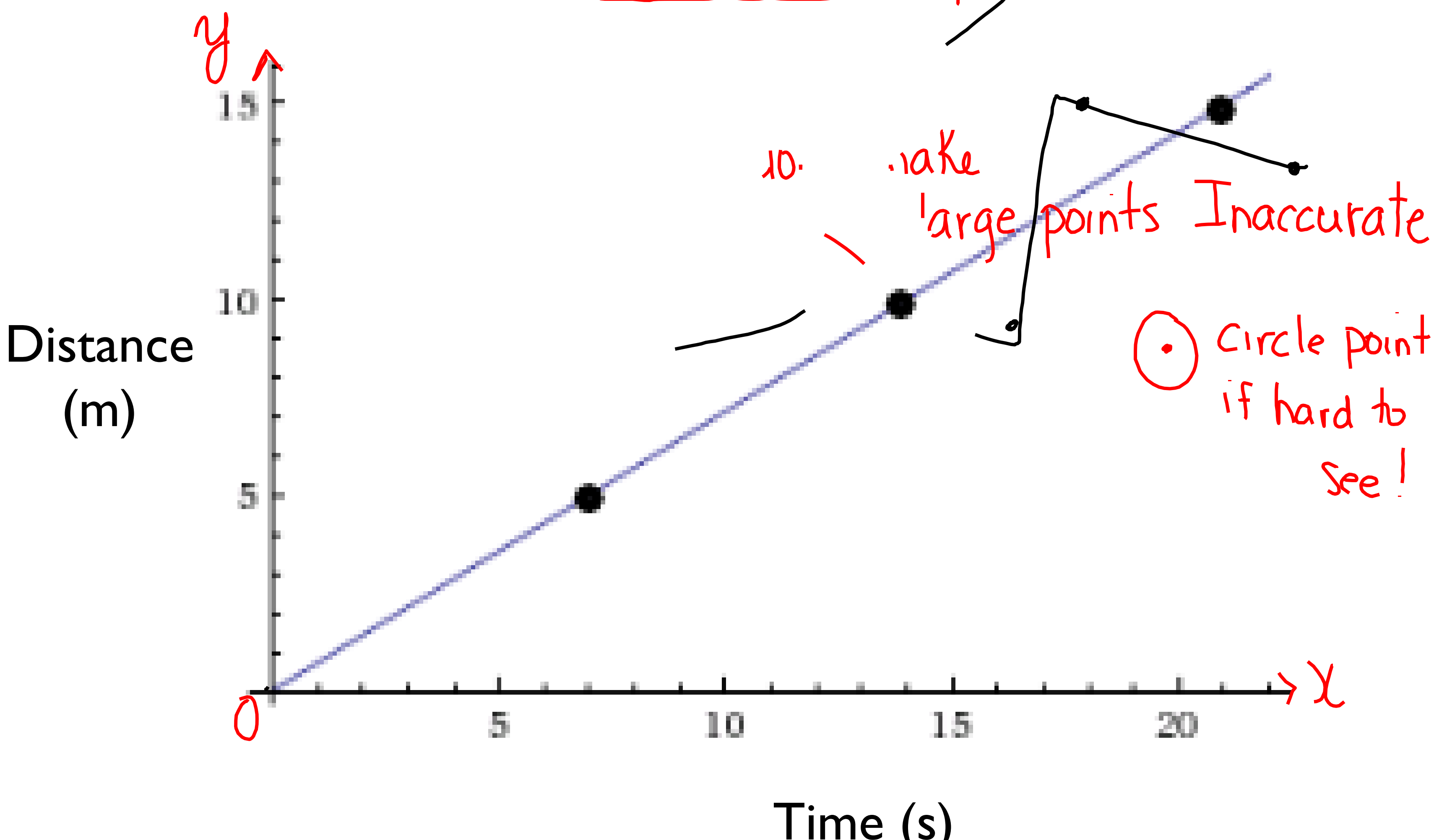
linear relation

→ increase by same amount

Distance – Time Graphs

title has to be Centered + underlined

Distance-time Graph



Was your graph a straight line?

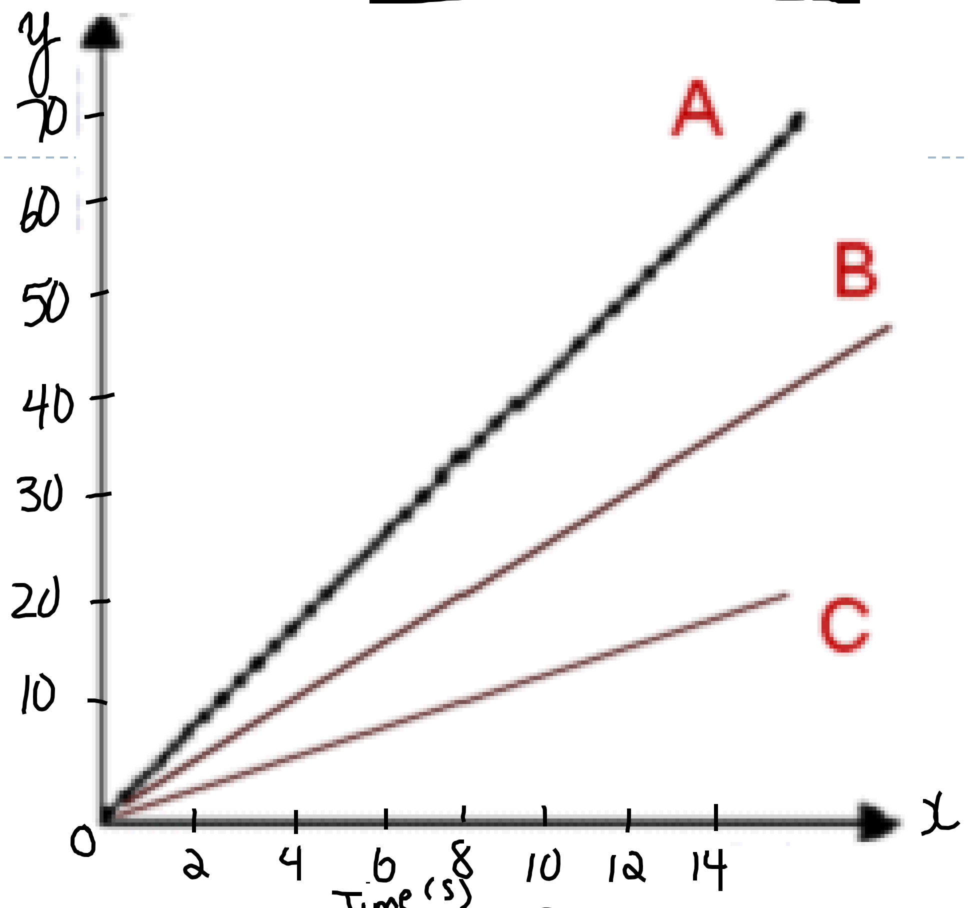
- A distance-time graph which is a straight line indicates constant speed.

- In constant speed, the object does not speed up or slow down. **The acceleration is zero.**

Distance VS Time

Distance (m)

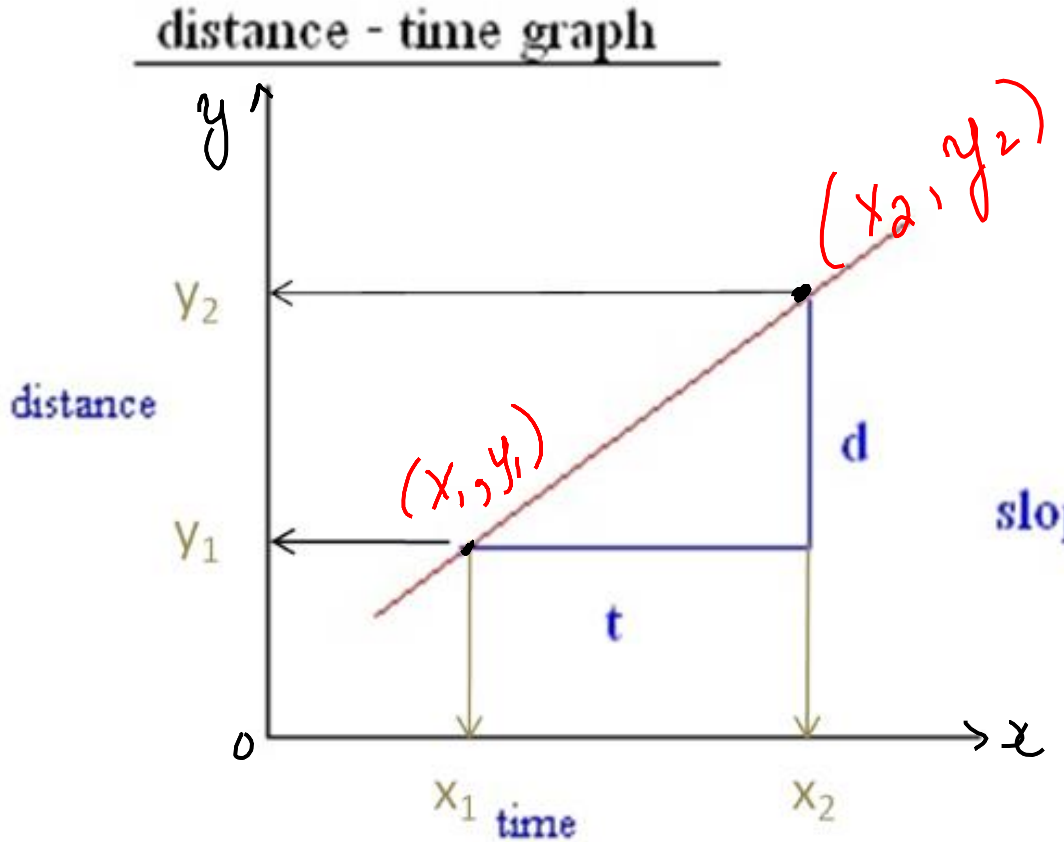
always put in units in label



* line of best fit
• draw line to get closest to majority of points

The Steeper the slope the faster the object is moving.

In this graph *Object A is moving fastest* and *Object C is moving slowest*

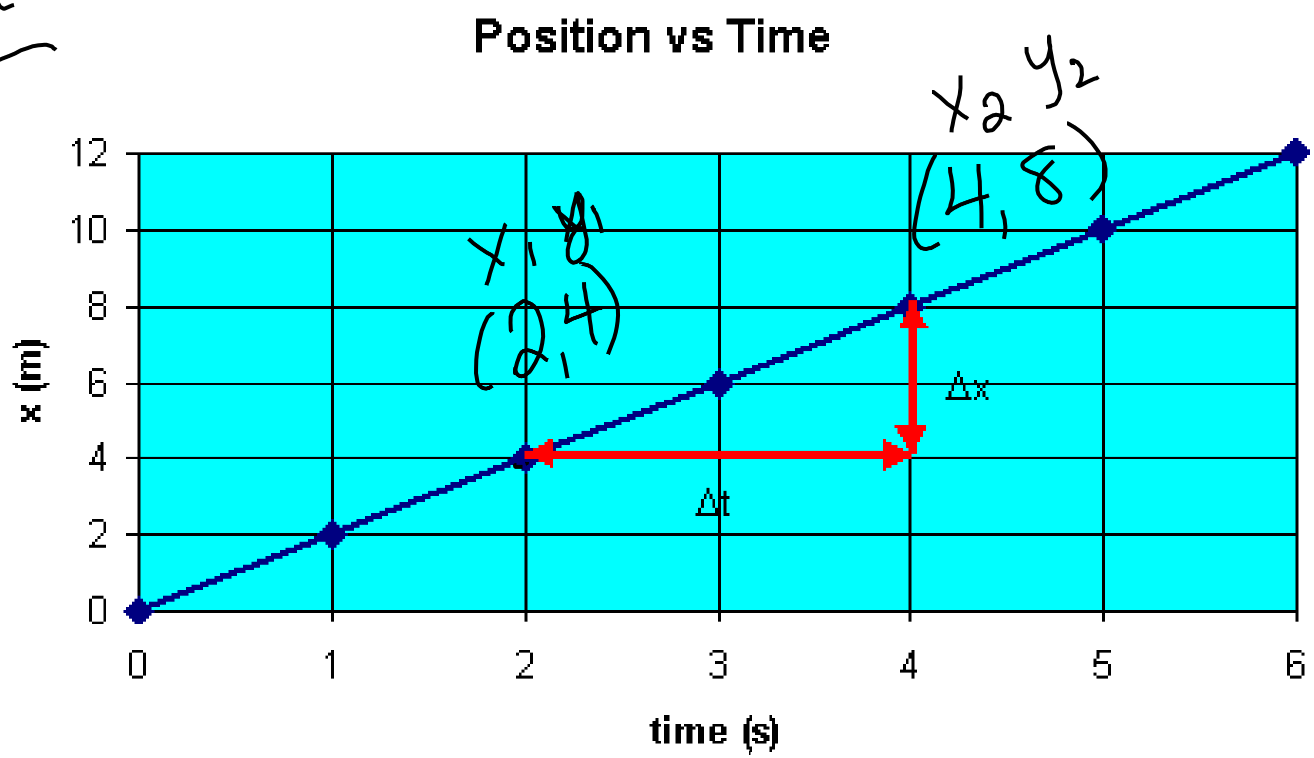


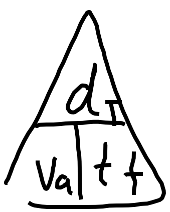
On a distance time graph for uniform motion the slope equals the average speed.

Change in

$$V_{avg} = \frac{\Delta d}{t} = \text{slope} = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{d_2 - d_1}{t_2 - t_1}$$

Example 1





What is the V_{avg} for this graph?

put in units!

$$V_{(av)} = \frac{\Delta d}{\Delta t} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{8-4}{4-2} = \frac{4}{2} = 2\left(\frac{m}{s}\right)$$

$$V_{avg} = Slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{8-4}{4-2} = \frac{4}{2} = 2m/s$$

Displacement Time Graphs

- Like distance time graphs only displacement can be either positive or negative, therefore we need two quadrants.

There are 3 things that you can do with any graph:

- Read the values
- Find the slope
- Calculate the area between the line and the x-axis of the graph

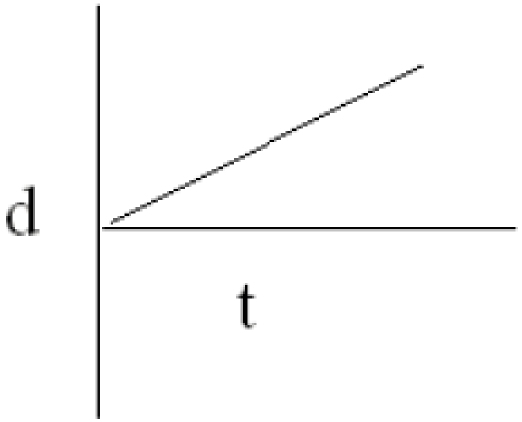
Displacement Time Graphs

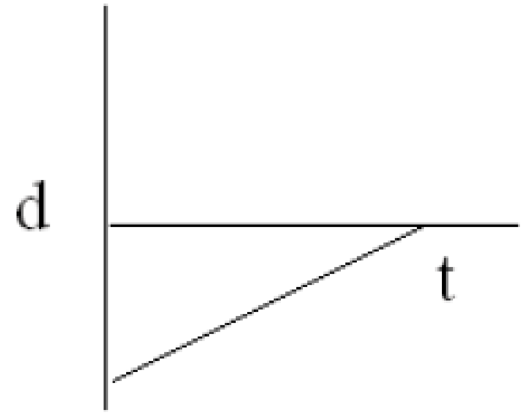
AKA **Position-Time Graphs for Uniform Motion**

Straight line position-time $(\vec{d} - t)$ graphs describe uniform / linear motion.

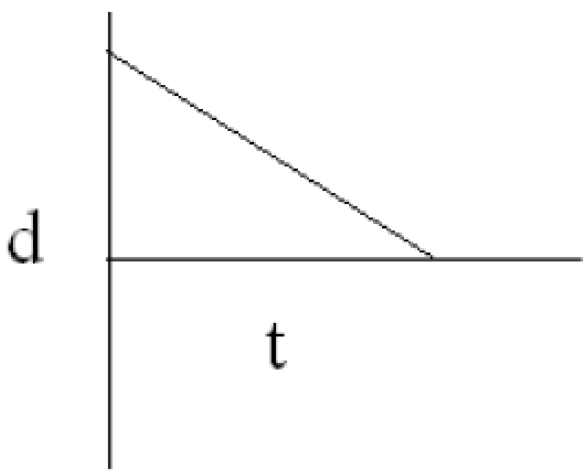
The **slope** is the velocity of the moving object.

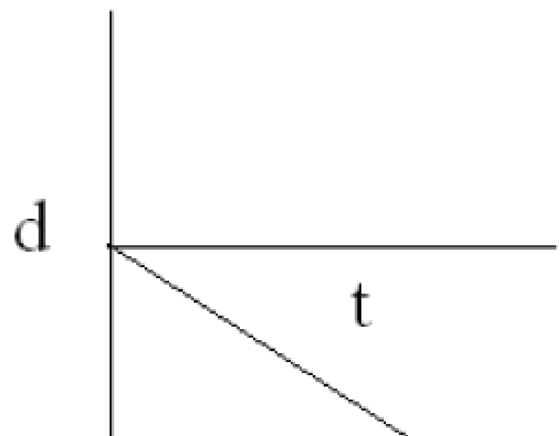
- If the slope is positive: object is moving to the **right** at a constant speed



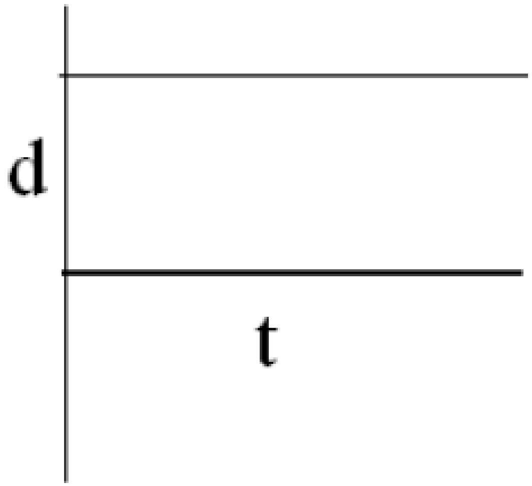


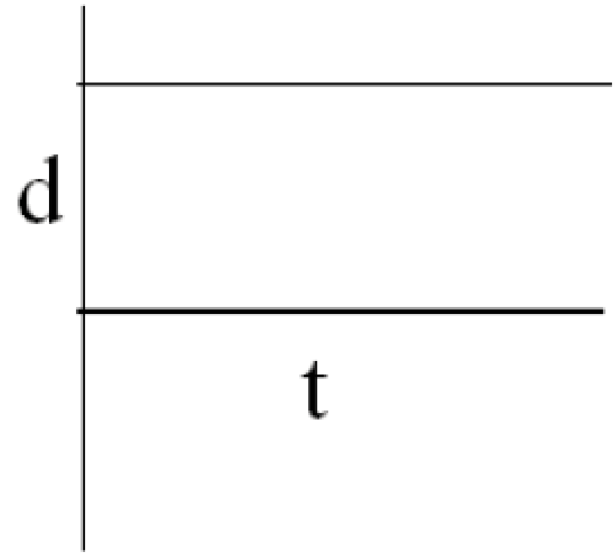
- If the slope is negative: moving to the **left** at a constant speed.





- If the slope is 0 (a horizontal line)the object is stopped (at rest)

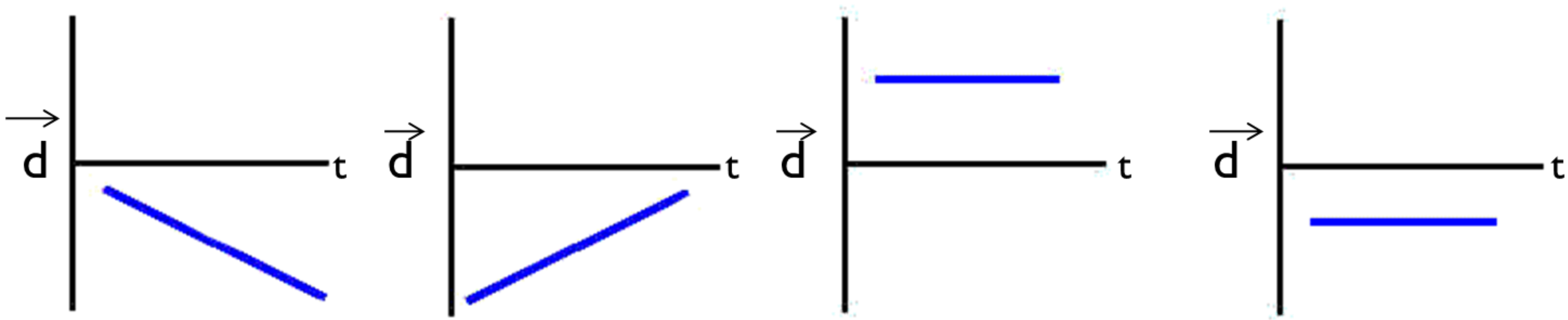




The ***y*-intercept** of the graph is the initial position of the object. (described as being either "right" / "up", or "left" / "down" with respect to the reference point (0).

The object's instantaneous position can be read directly from the graph.

To find the change in an object's displacement you'd have to know where it started (its initial position or d_1) and where it finished (final position d_2)



Moving left away from origin

Moving right toward origin from left

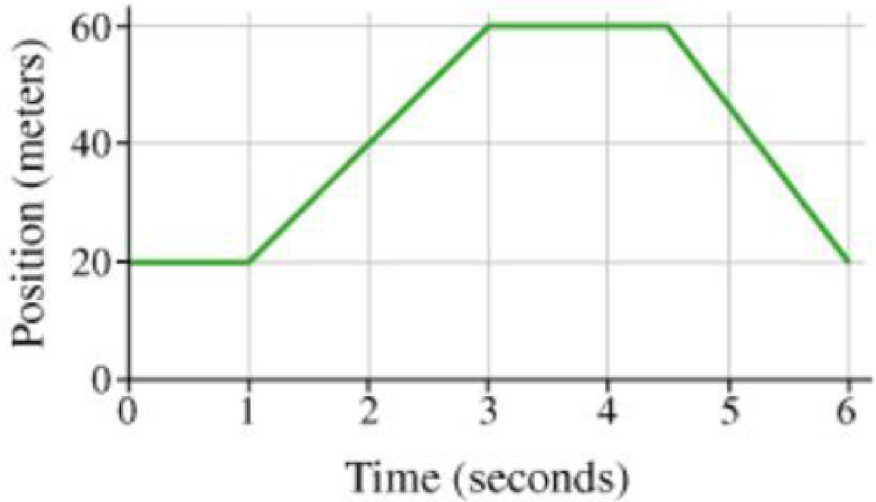
Stopped right of origin

Stopped left of origin

On a graph of displacement vs time, use: $\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$

Area under a d - t graph doesn't give us any useful information, but WILL with other graphs to come.

Ex. Use this graph to answer the following questions....

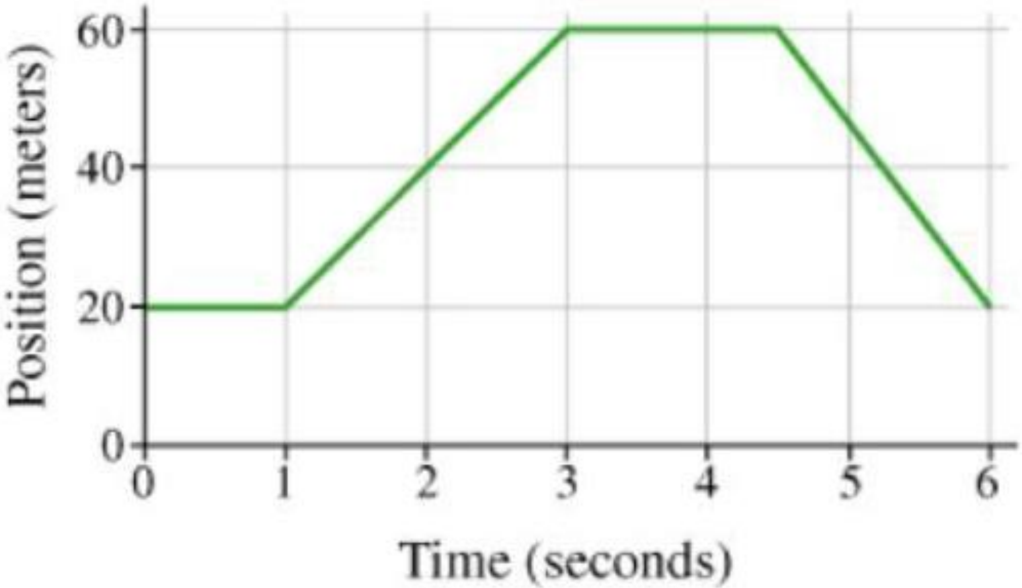


a) What is the object's initial position (d_1) ?

b) What is the object's final position (d_2) ?

c) What was the object's displacement for the 6 s trip ? ($\vec{d} = \vec{d}_2 - \vec{d}_1$)

Note : we always assume that there is a " .0" after each number on the graph axis. If not, you'd be seriously limited to one sig fig when you do any graph related calculation.



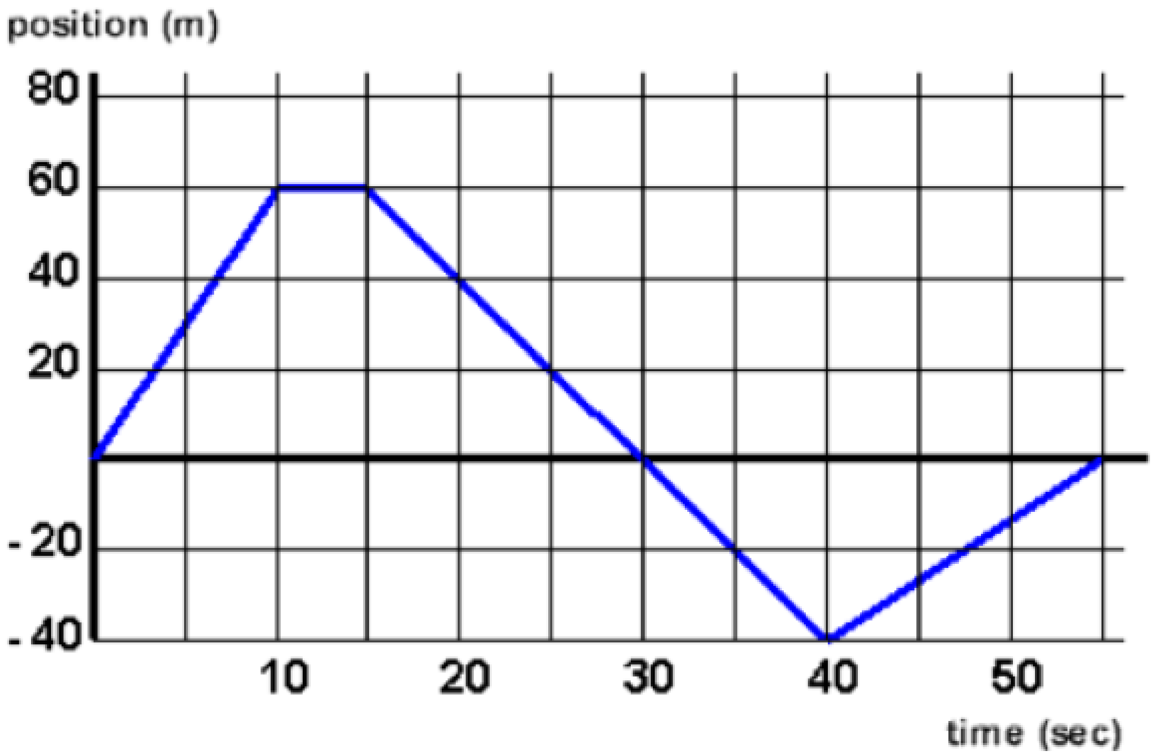
d)What was the total distance (d) the object travelled ?

e) What is the velocity of the object during these time intervals ?

0 to 1 seconds	3. 3 to 4.5 seconds
1 to 3 seconds	4.5 to 6 seconds

f) Describe the motion of the object for the 6 s trip.

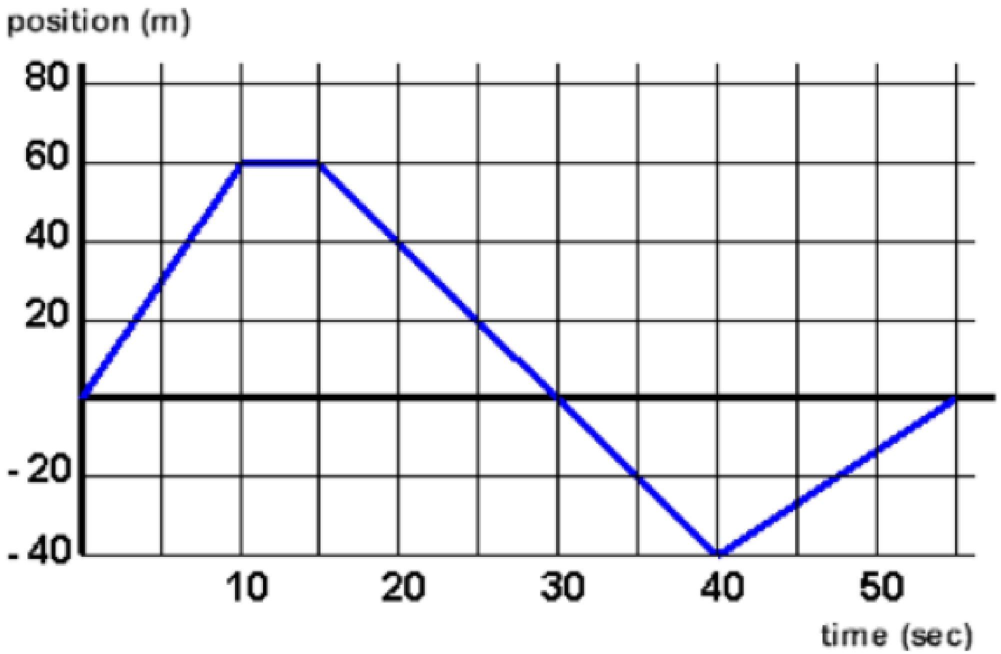
Try the same questions with this one.....



a)What is the object's initial position (d_1) ?

b)What is the object's final position (d_2) ?

c) What was the object's displacement for the 6 s trip ? ($\vec{d} = \vec{d}_2 - \vec{d}_1$)



d)What was the total distance (d) the object travelled ?

e) What is the velocity of the object during these time intervals ?

0 to 1 seconds

1 to 3 seconds

3. 3 to 4.5 seconds

4.5 to 6 seconds

f) Describe the motion of the object for the 6 s trip.

Position-Time Graphs for Non - Uniform Motion

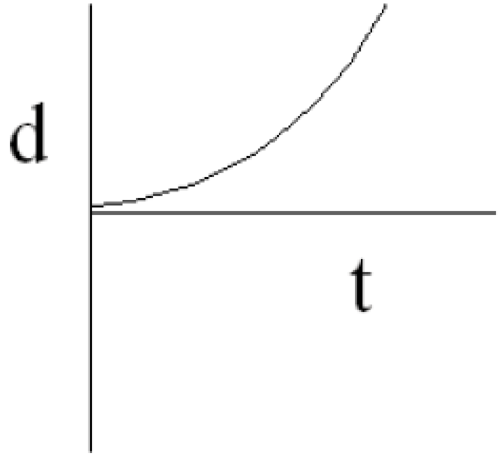
What is non - uniform motion ?

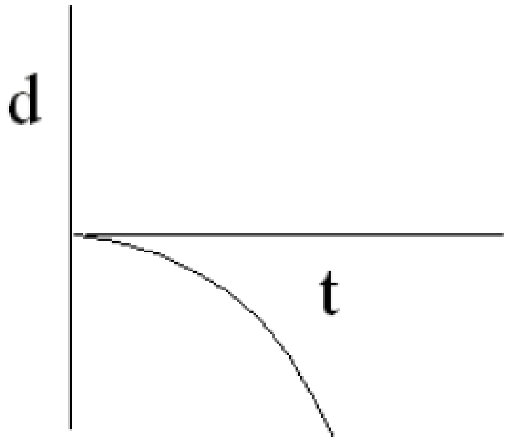
What would a graph of non - uniform motion look like ?

Can a displacement time graph ever contain a vertical line? Why or why not ?

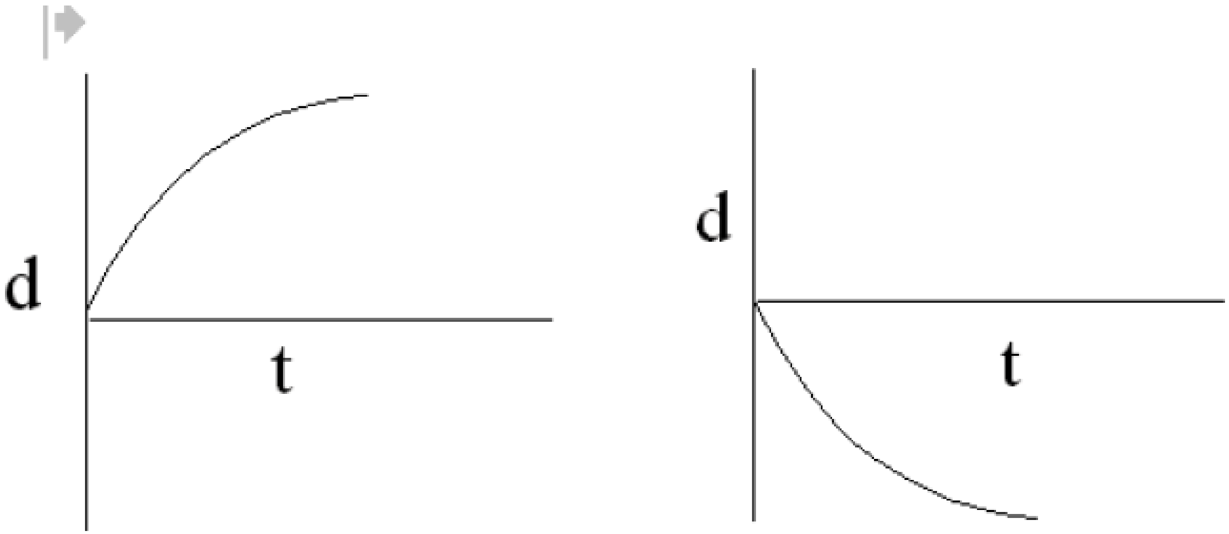
The position-time graph for uniform acceleration is parabolic. (A curve)

Graphs of objects that are speeding up





Graphs of objects that are slowing down



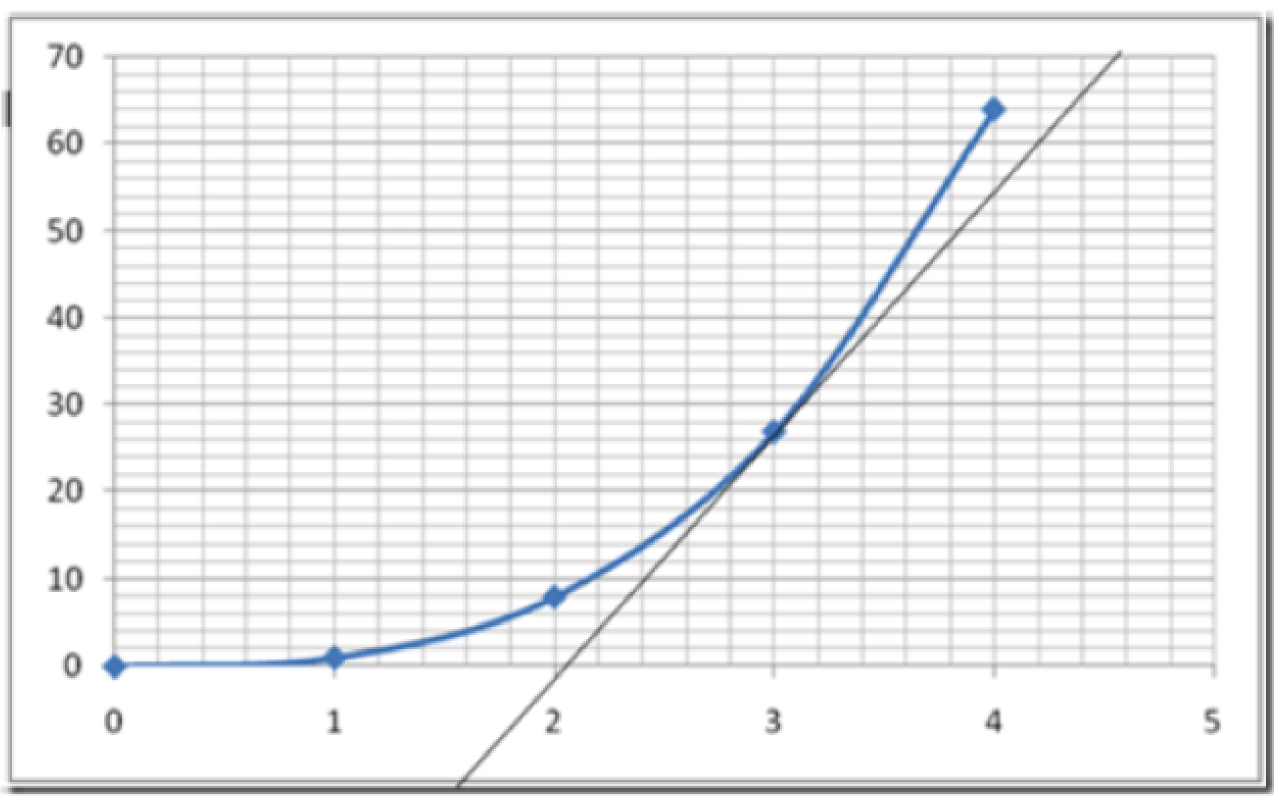
To find the instantaneous velocity at one point on the curve, we'll draw a tangent that touches the curve there. The **slope** of the line tangent to the curve is the instantaneous velocity.

To construct a tangent to a curve:

- Choose a point(s) on the curve (a question may tell what point(s) to use)

- Draw a straight line that touches the curve at that one point only (how to tell if its drawn right : the angles between the curve and the line on either side of the point are equal.

d



Then draw a rise-run triangle and calculate the slope using rise over run. You could also choose two points on your tangent, and use the slope formula to find instantaneous velocity.

$$Slope = m = \frac{y_2 - y_1}{x_2 - x_1}$$

The ***y*-intercept** of the *d*-*t* graph represents the initial position.

- Instantaneous position can be read directly from the graph.
- To find the change in displacement: use $\vec{d} = \vec{d}_2 - \vec{d}_1$

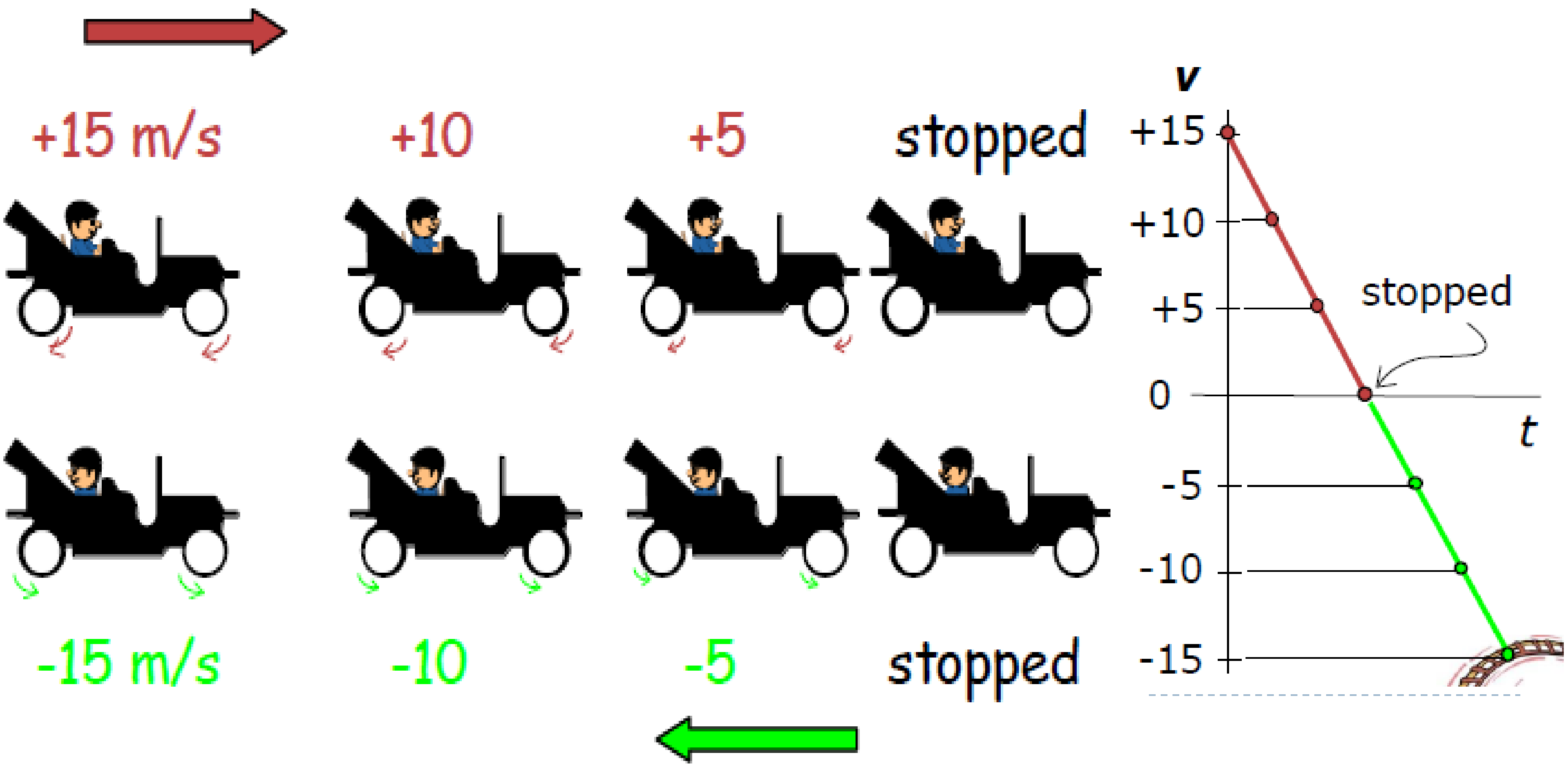
Practice.....

#8 (a) on page 442

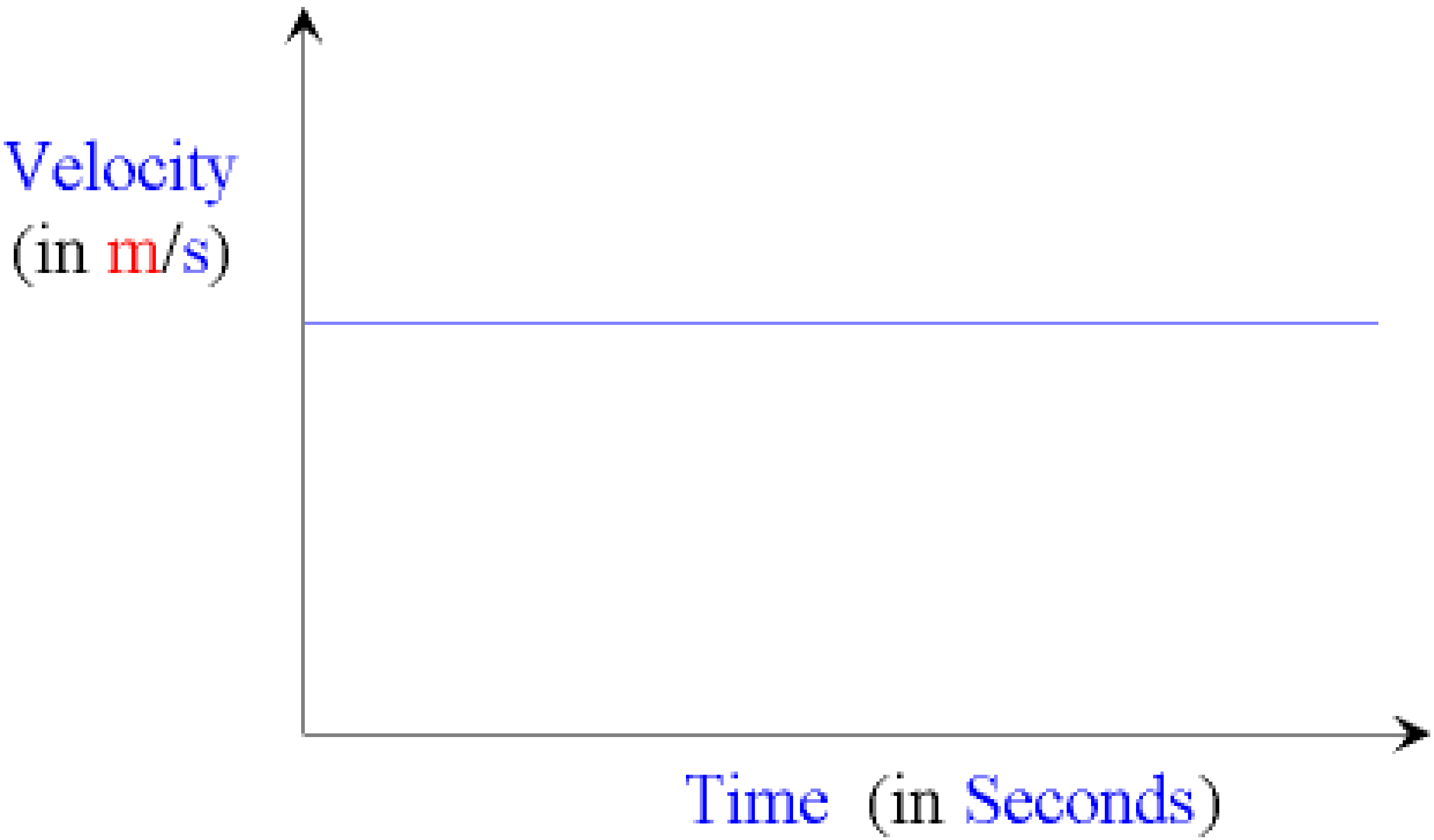
#1, #2, # 3, # 4 (a), a modified # 6 (use "car" and m and s) (a - c) or modified 7 on page 450

- Over the next few slides we will summarize some facts about graphs and motion.

- # Velocity-time Graphs: The basics

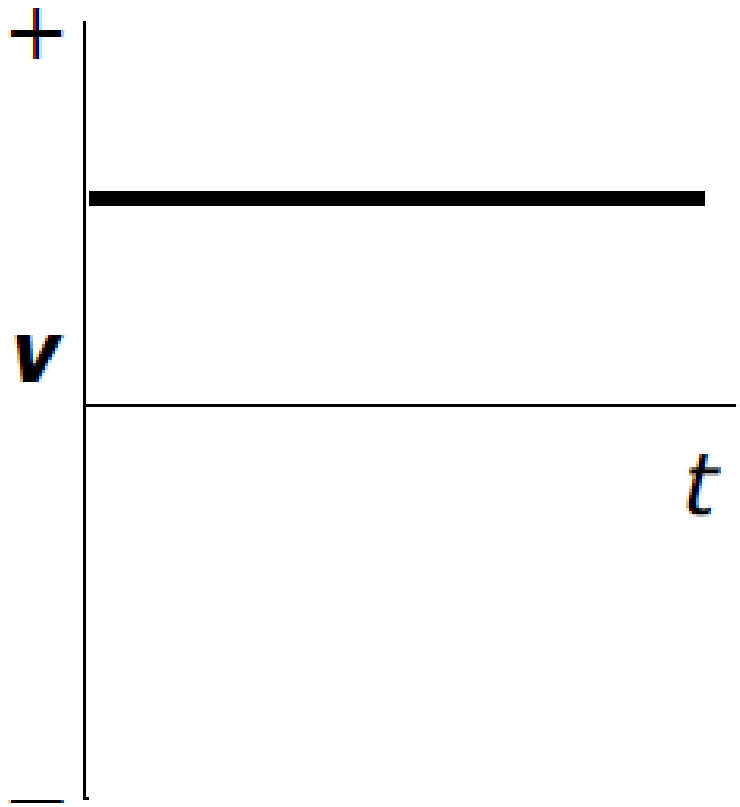


Velocity - Time graph
showing an object with constant velocity.

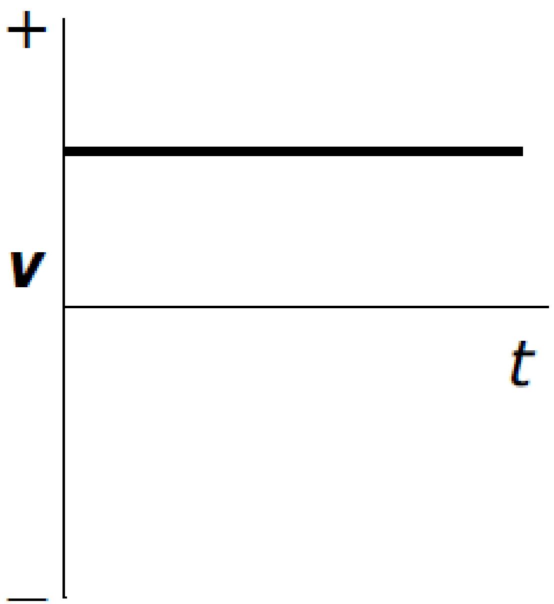


Slope is zero therefore the acceleration is zero.

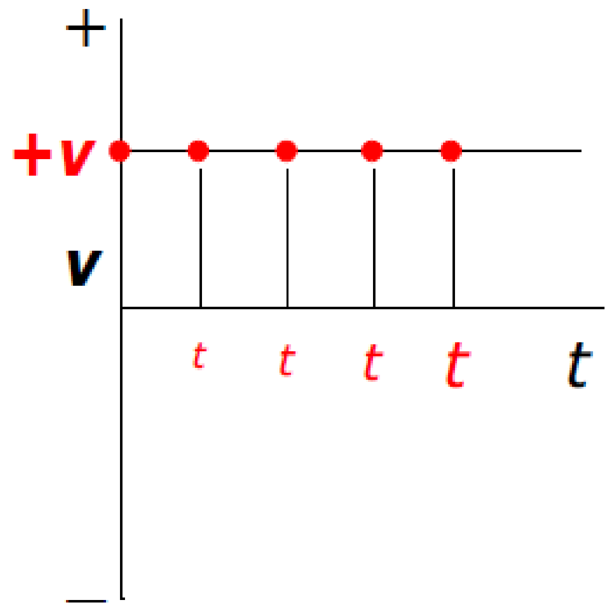
Describe the motion:



Explanation

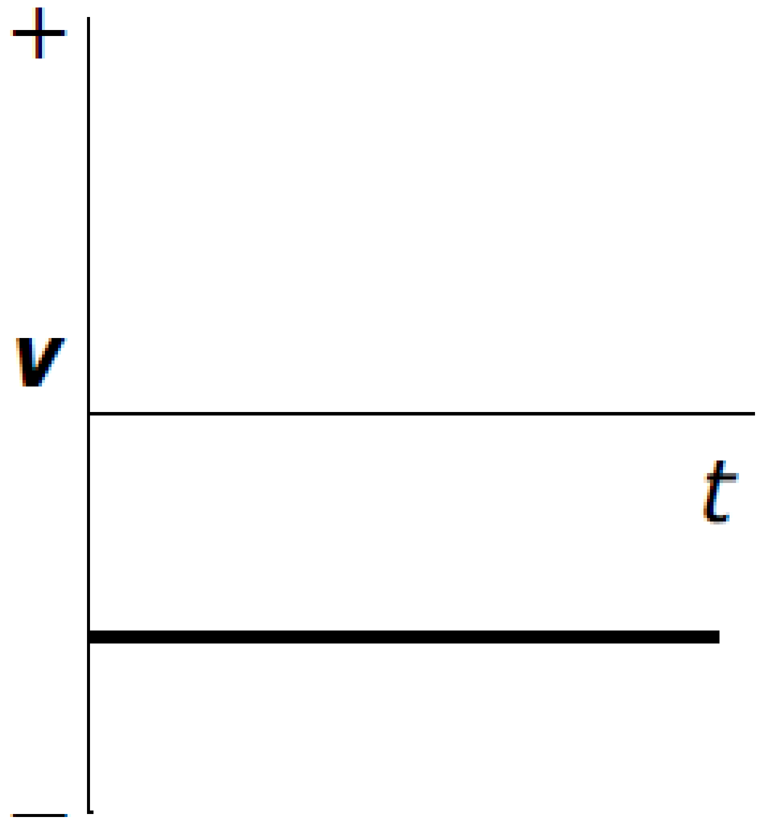


The object is moving at a fixed speed to the right.

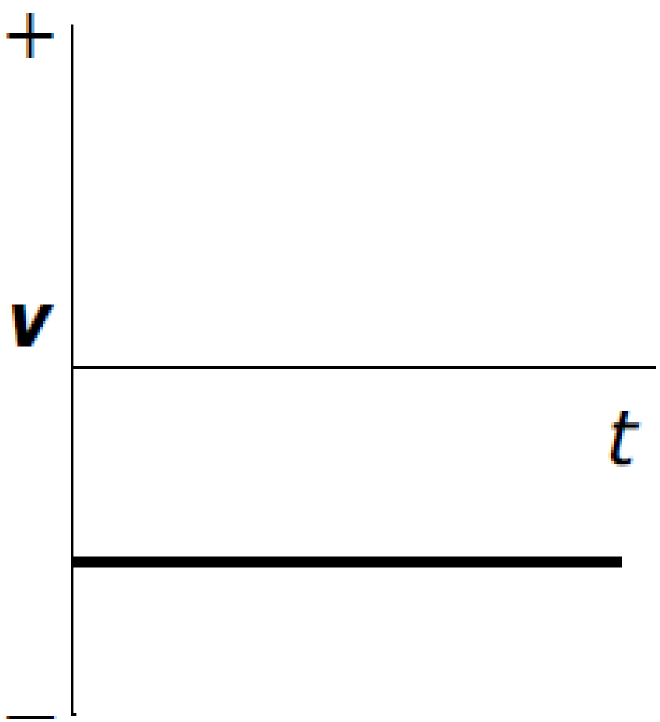


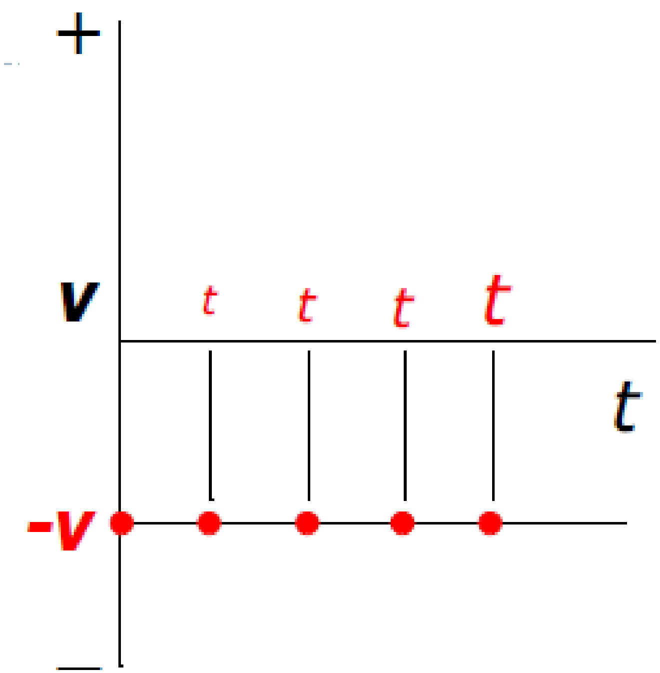
As time goes on, the speed remains constant. All "*v*" values are in the "positive", first quadrant, meaning the object is traveling to the right.

Describe the motion depicted by the ***v-t graph below***



Explanation



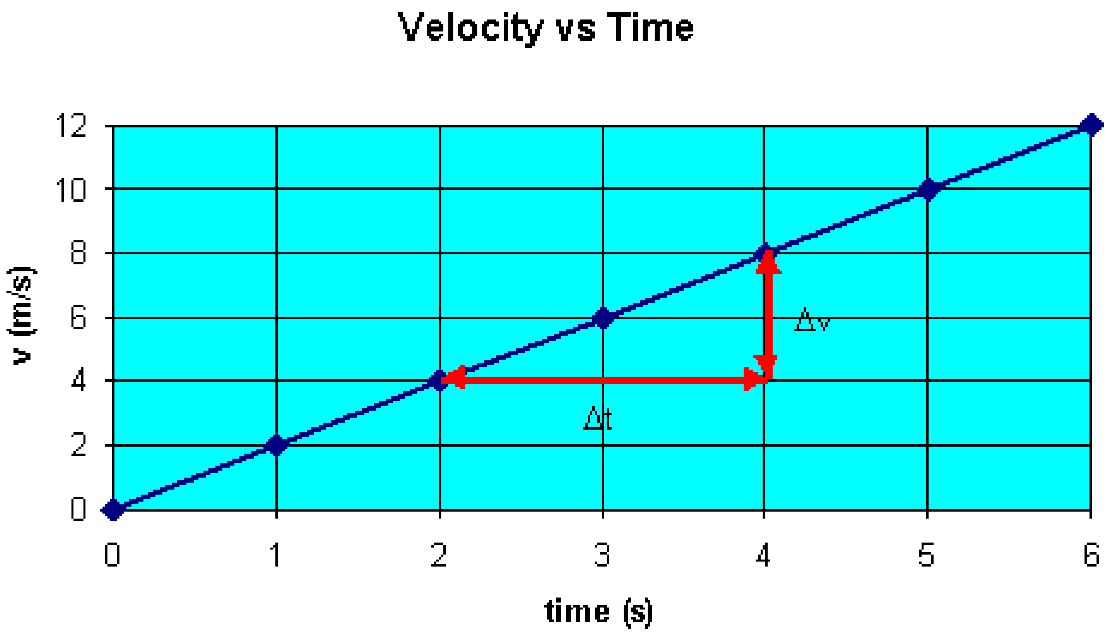


As time goes on, the speed remains constant. All "*v*" *values are in the "negative", fourth quadrant, meaning the object is traveling to the left.*

Answer

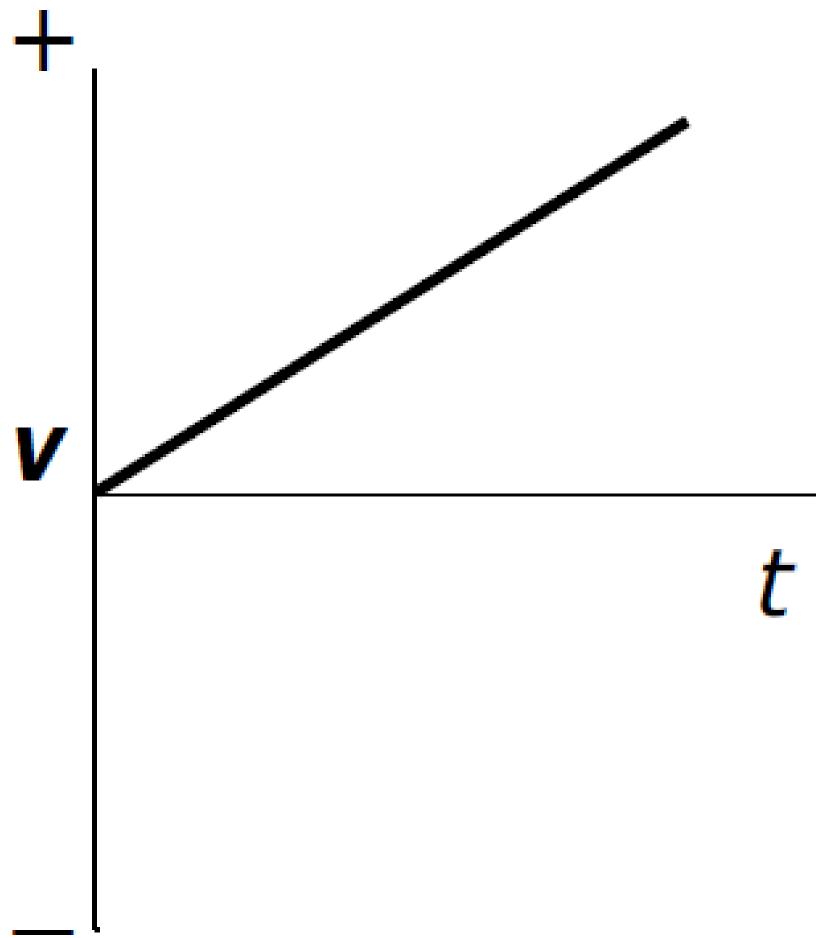
The object is moving at a fixed speed to the left.

The slope of the line on a velocity time graph equals the average acceleration.

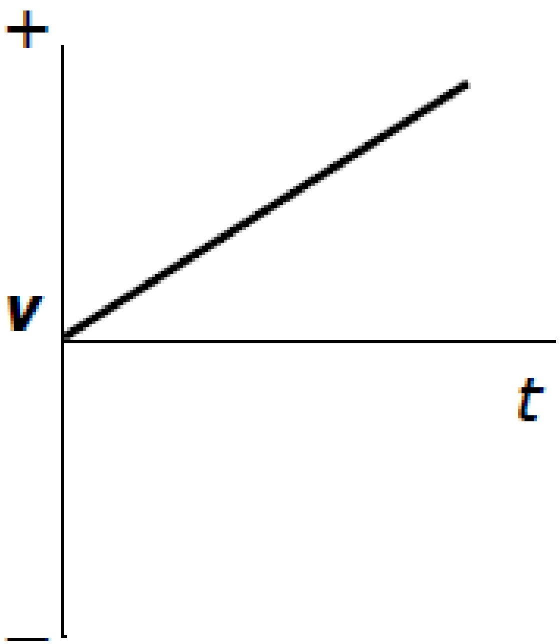


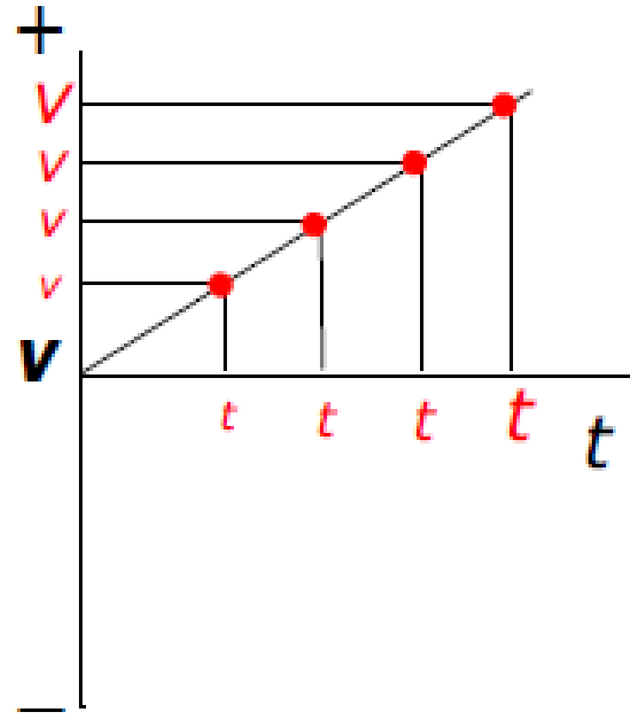
$$\vec{a} = Slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{8-4}{4-2} = \frac{4}{2} = 2m/s^2$$

Describe the motion depicted by the ***v-t graph below***



Explanation

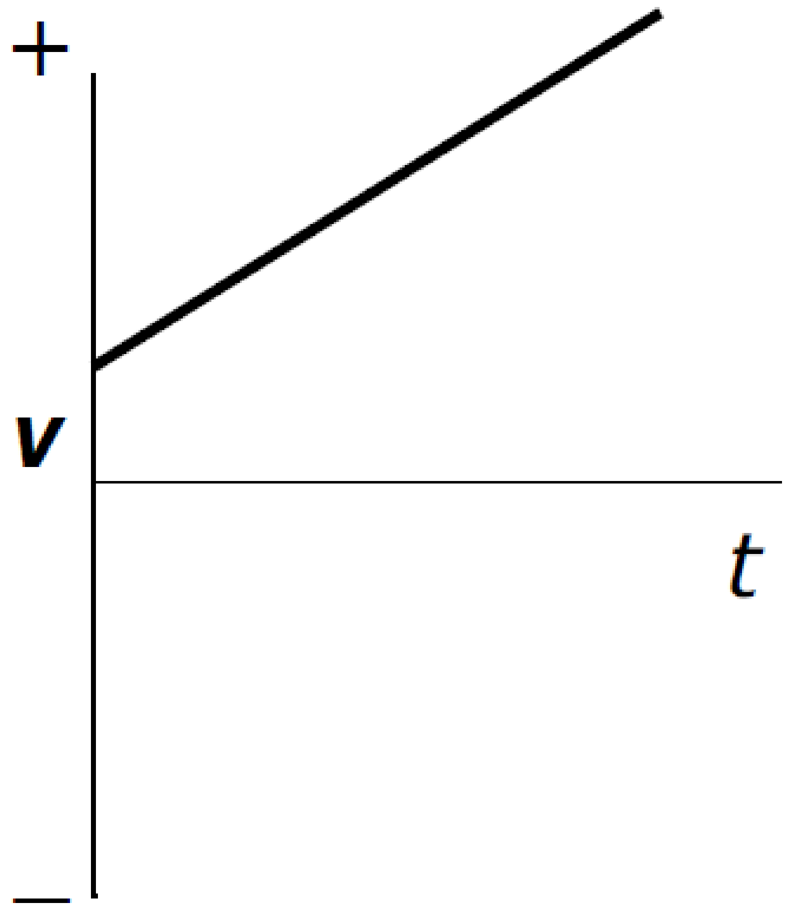




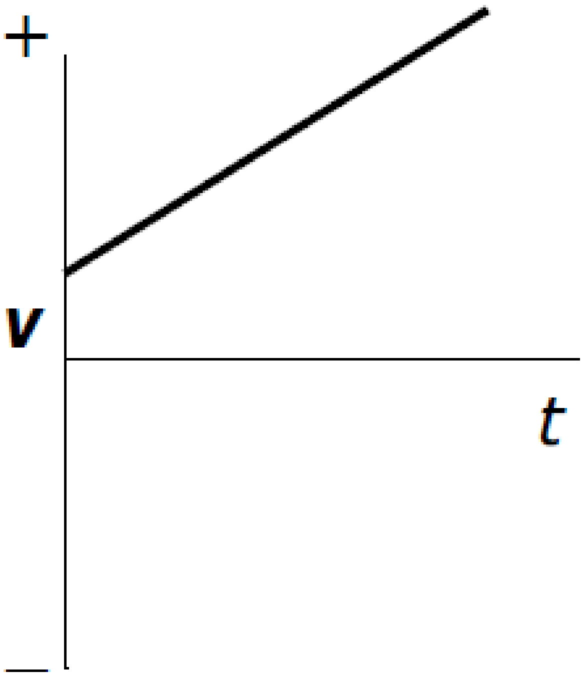
Answer
The object starts from rest and accelerates to the right.

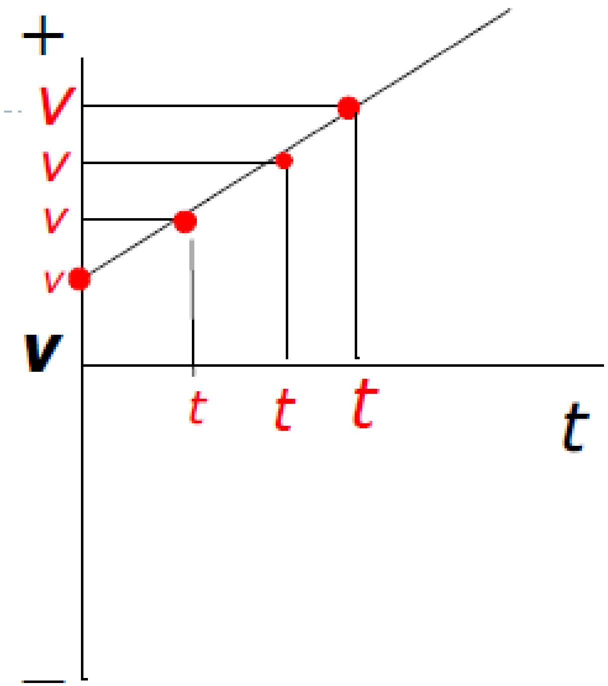
As time goes on, the speed increases from zero. All "*v*" *values are positive meaning the object is traveling to the right.*

Describe the motion depicted by the ***v-t* *graph below***



Explanation



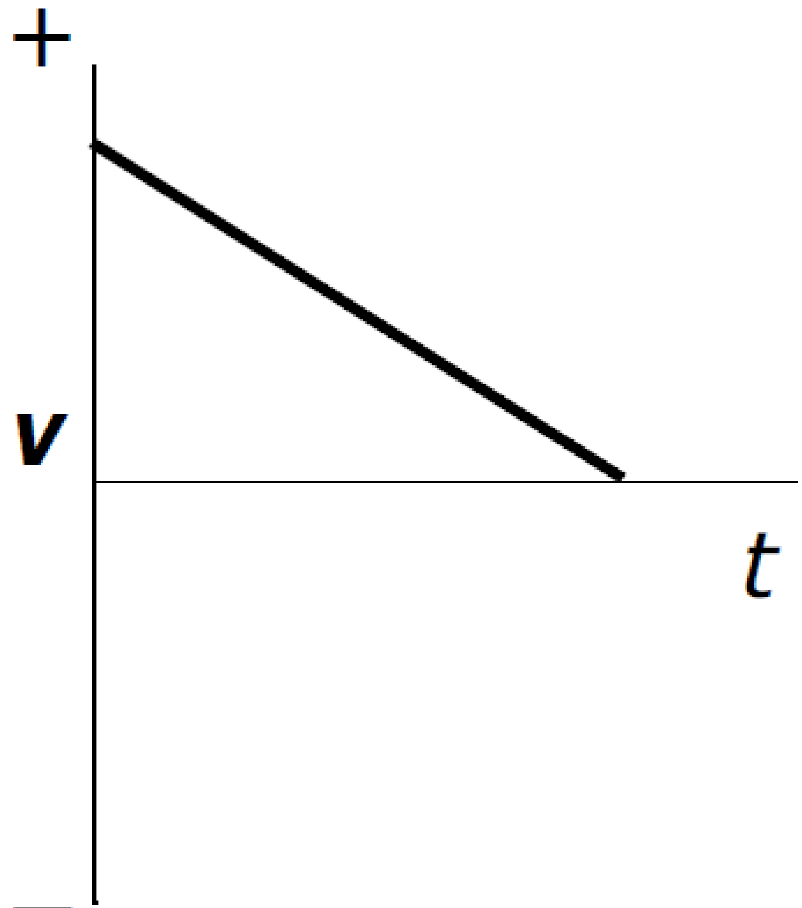


Answer

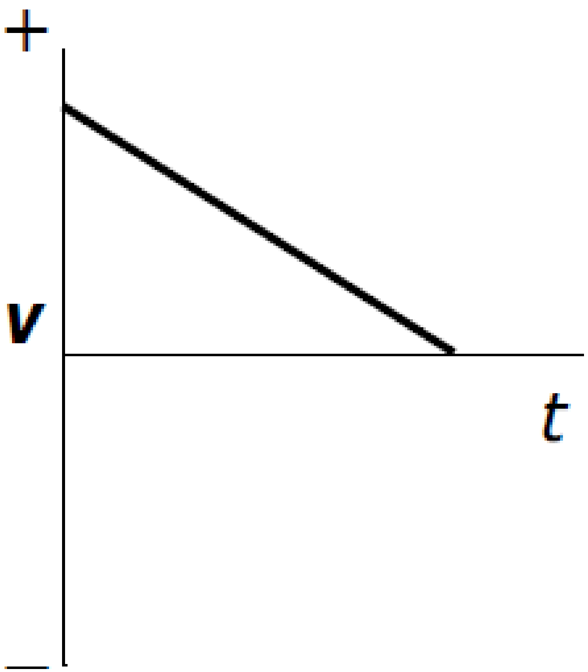
At time zero the object is already moving to the right. It continues to accelerate to the right.

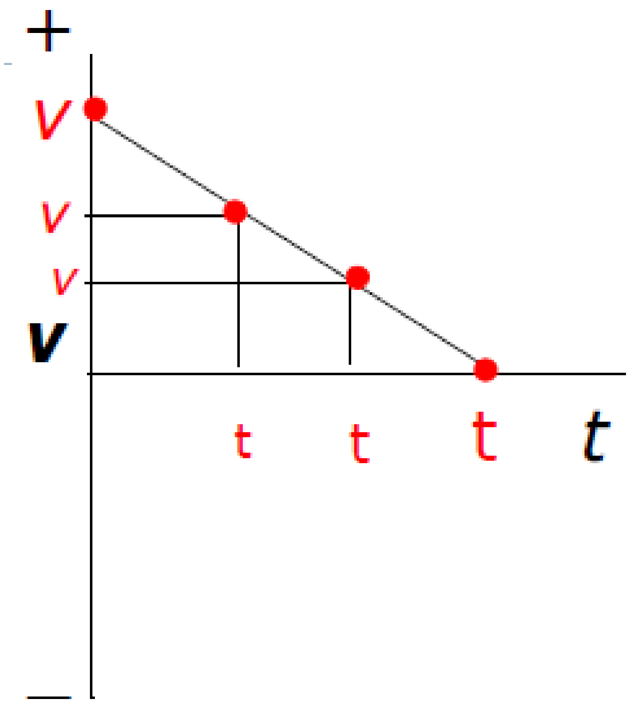
At time zero, there is already a positive value for the speed. As time goes on, the positive speeds increase. That is, the object picks up speed to the right.

Describe the motion depicted by the ***v-t* graph below**



Explanation

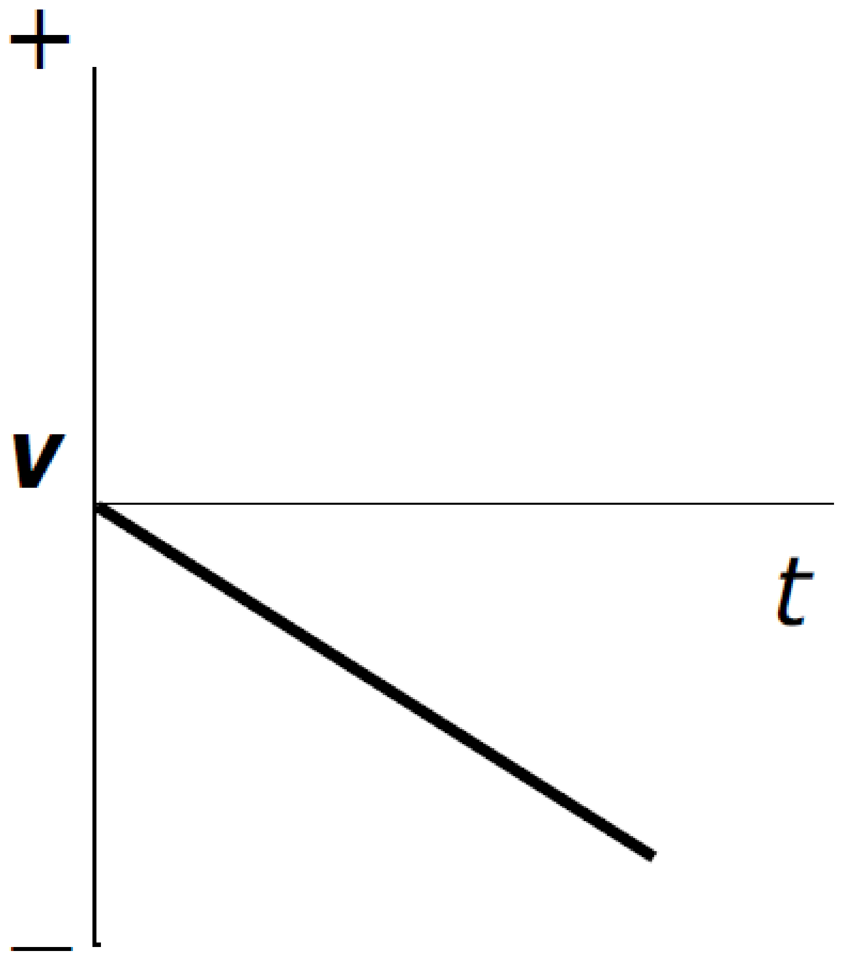




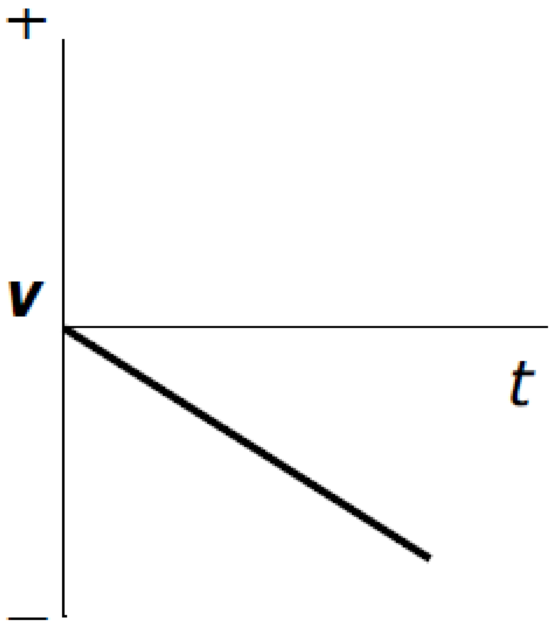
Answer
The object is moving to the right but accelerating to the left. It therefore slows down and stops.

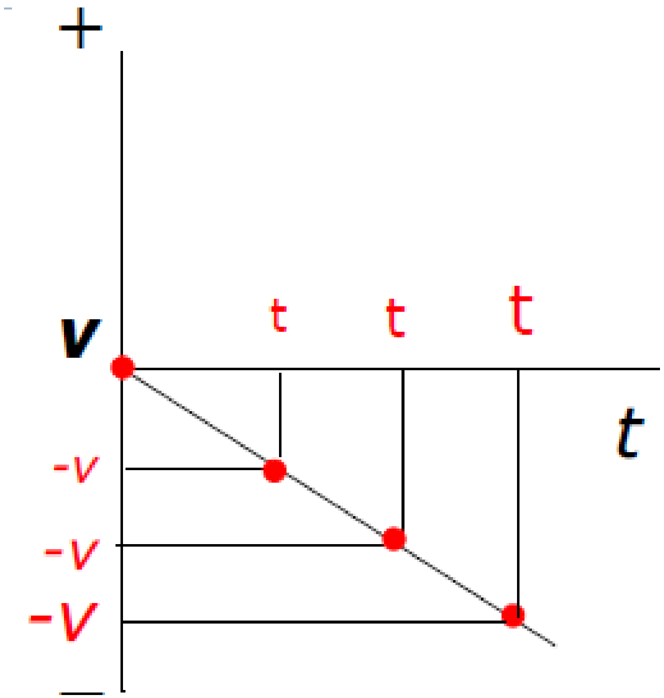
At time zero, there is already a positive value for the speed. As time goes on, the positive speeds **decrease.** The object keeps moving to the right but slows down and stops.

Describe the motion depicted by the ***v-t graph below***



Explanation

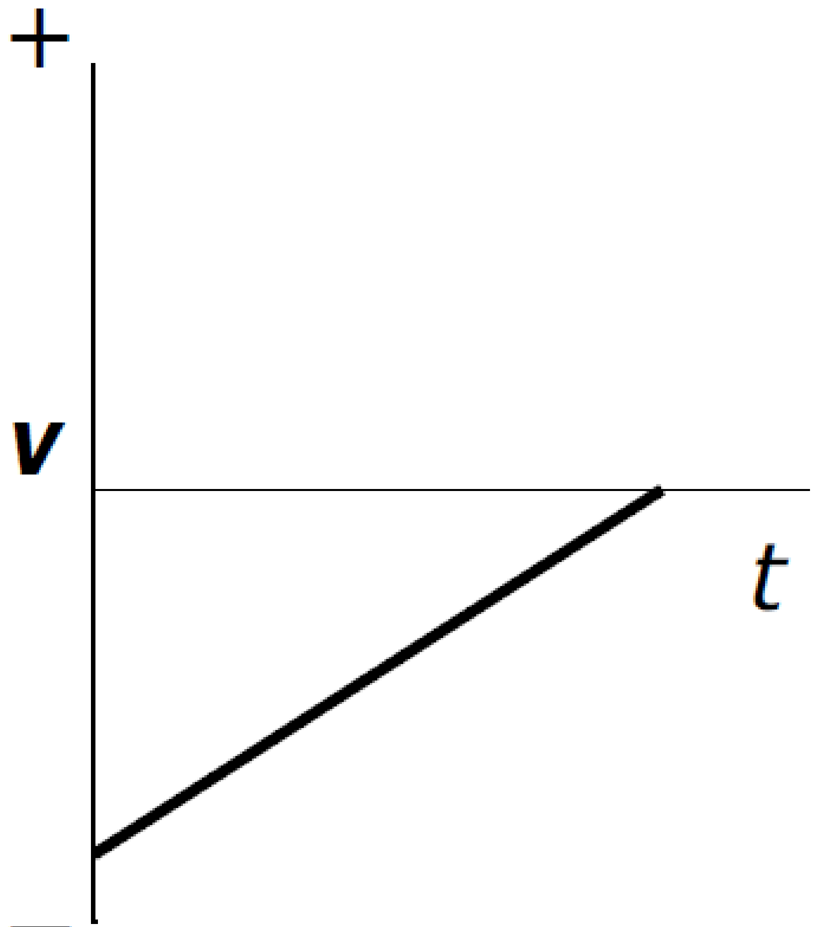




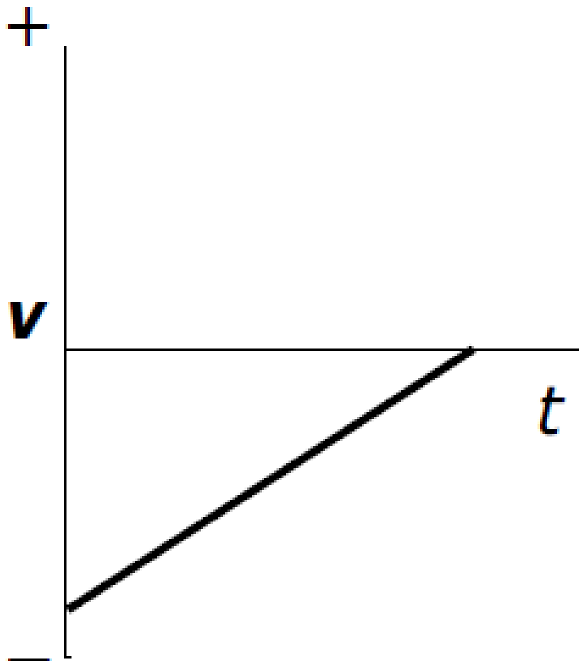
Answer
The object starts from rest and accelerates to the left.

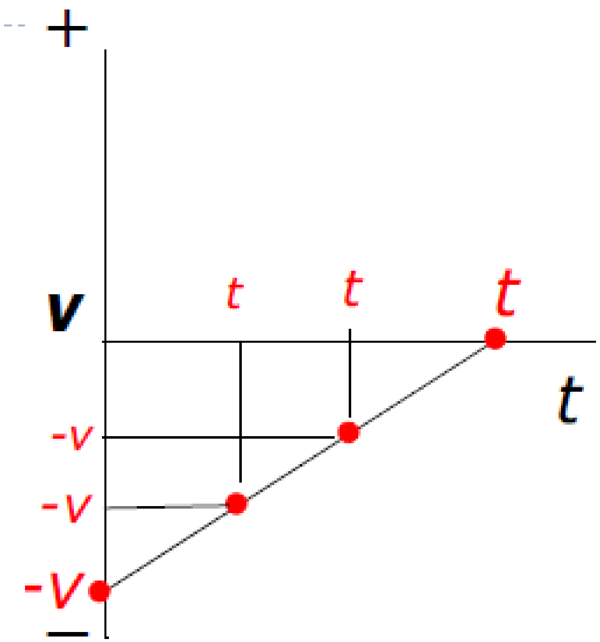
At time zero, the object is not moving. Then, as time goes on there is an increase in "negative" speeds as the object picks up speed to the left.

Describe the motion depicted by the ***v-t graph below***



Explanation



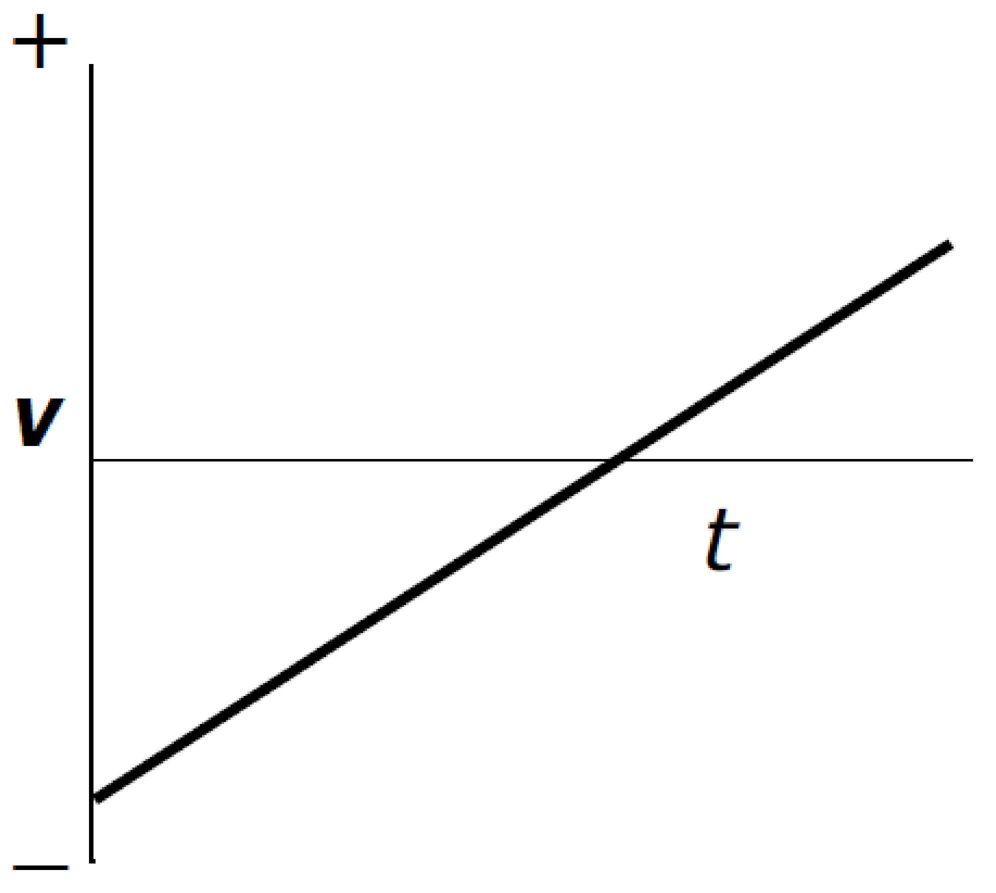


Answer

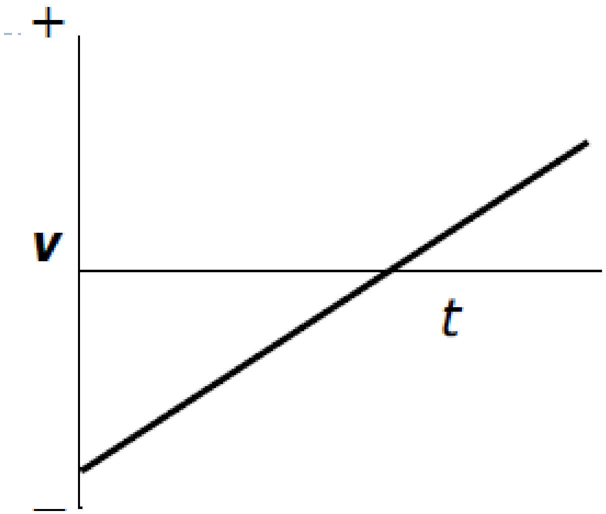
The object starts with an initial speed to the left but slows down and stops.

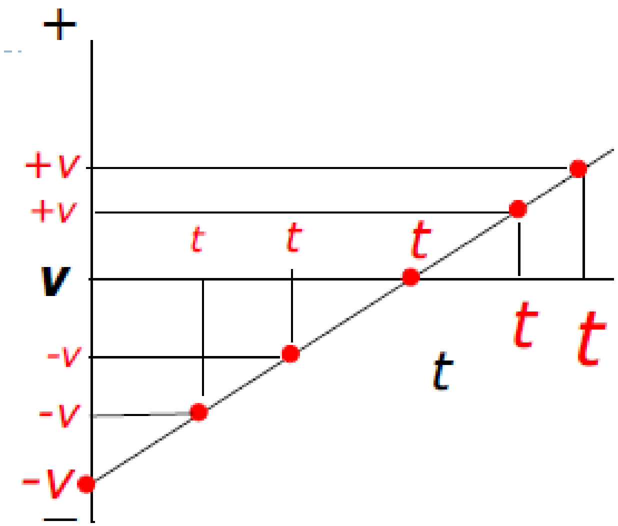
At time zero, the object has a maximum speed to the left . However, as time increases, speed decreases, and the object stops.

Describe the motion depicted by the ***v-t graph below***



Explanation



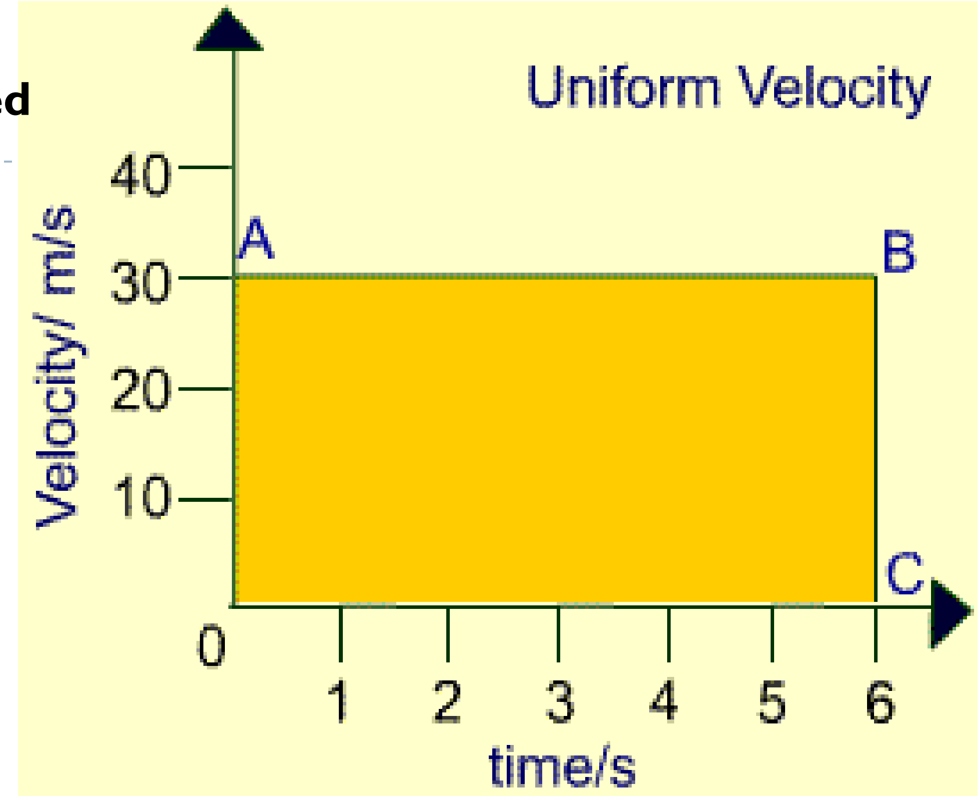


Answer

The object starts with an initial speed to the left and accelerates to the right.

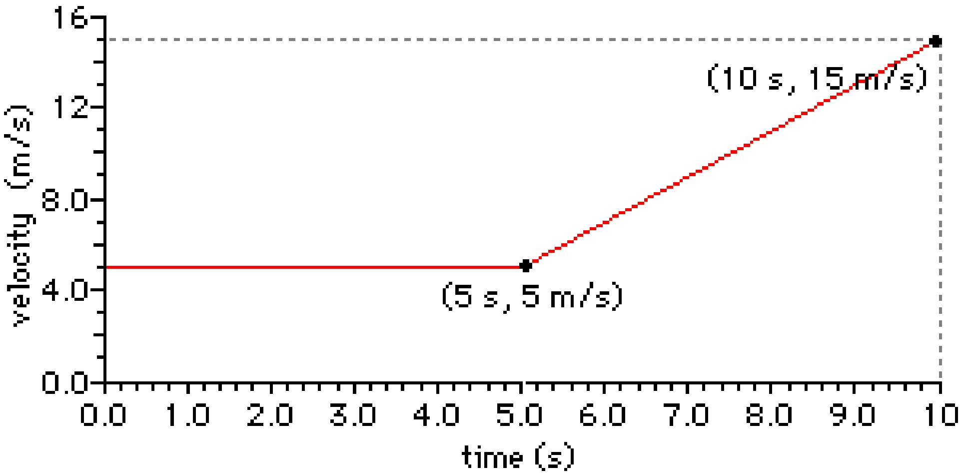
At time zero, the object has a maximum speed to the left . However, as time increases, speed decreases, and the object stops. But it continues to accelerate to the right, meaning that after its brief stop, it took off to the right.

To find out the Distance travelled On a v-t graph!!

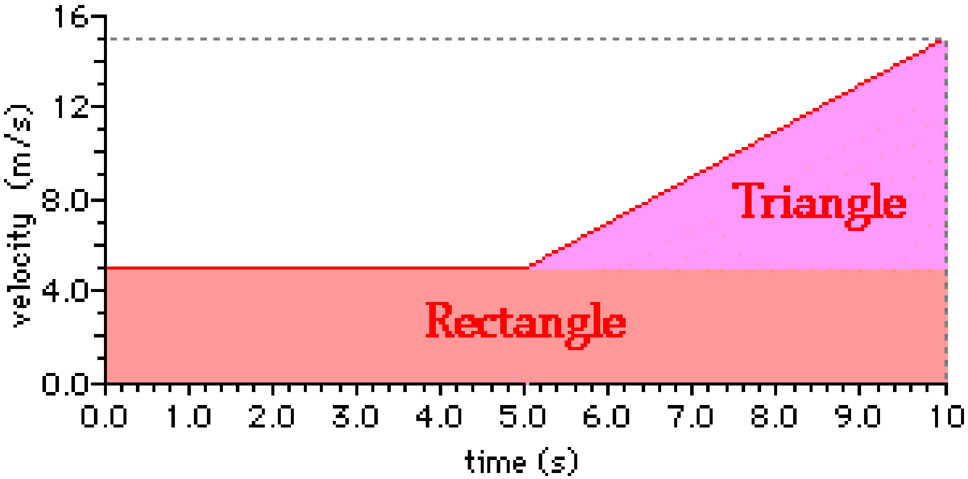


On a velocity - time graph **the area between the graphed line and the x-axis equals the displacement**

Area = l x w = 6 s x 30 m/s = 180 m



Object is moving at a constant speed for 5.0 s then it speeds up for the next 5.0 sec.



Displacement is equal to the **area between the drawn line and the x-axis**

$$\vec{d} = A_{Rectangle} + A_{Triangle}$$

$$= lw + \frac{bh}{2}$$

$$= (10.0s)(5.0m/s) + \frac{(10.0m/s)(5.0s)}{2}$$

$$= 50m + 25m$$

$$= 75m$$

ACCELERATION

- Acceleration is a vector quantity which is defined as "the rate at which an object changes its velocity." An object is accelerating if it is changing its velocity

CONSTANT ACCELERATION

- Sometimes an accelerating object will change its velocity by the same amount each second. This is known as a constant acceleration since the velocity is changing by the same amount each second.

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 ...

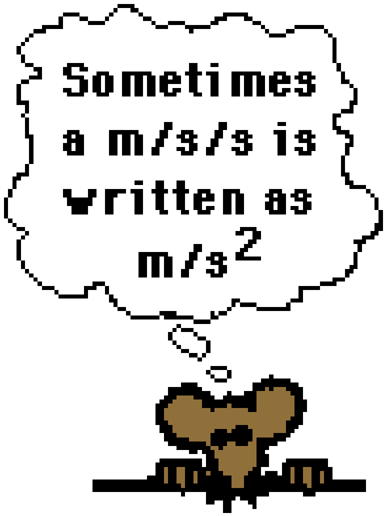
Time (s)	Velocity (m/s)
0	0
1	1
2	4
3	5
4	7

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

Calculating Acceleration

- **Acceleration can be found using the following formula:**

$$\vec{a} = \frac{\Delta \vec{v}}{t} = \frac{\vec{v_2} - \vec{v_1}}{t}$$



$\vec{a}$ = acceleration

$\vec{v}_2$ = final velocity

$\vec{v}_1$ = initial velocity

t = change in time

Note: The units for acceleration is m/s/s or m/s^2

Example 1:

A skier is moving at 1.8 m/s (down) near the top of a hill. 4.2 s later she is travelling at 8.3 m/s (down). What is her average acceleration?

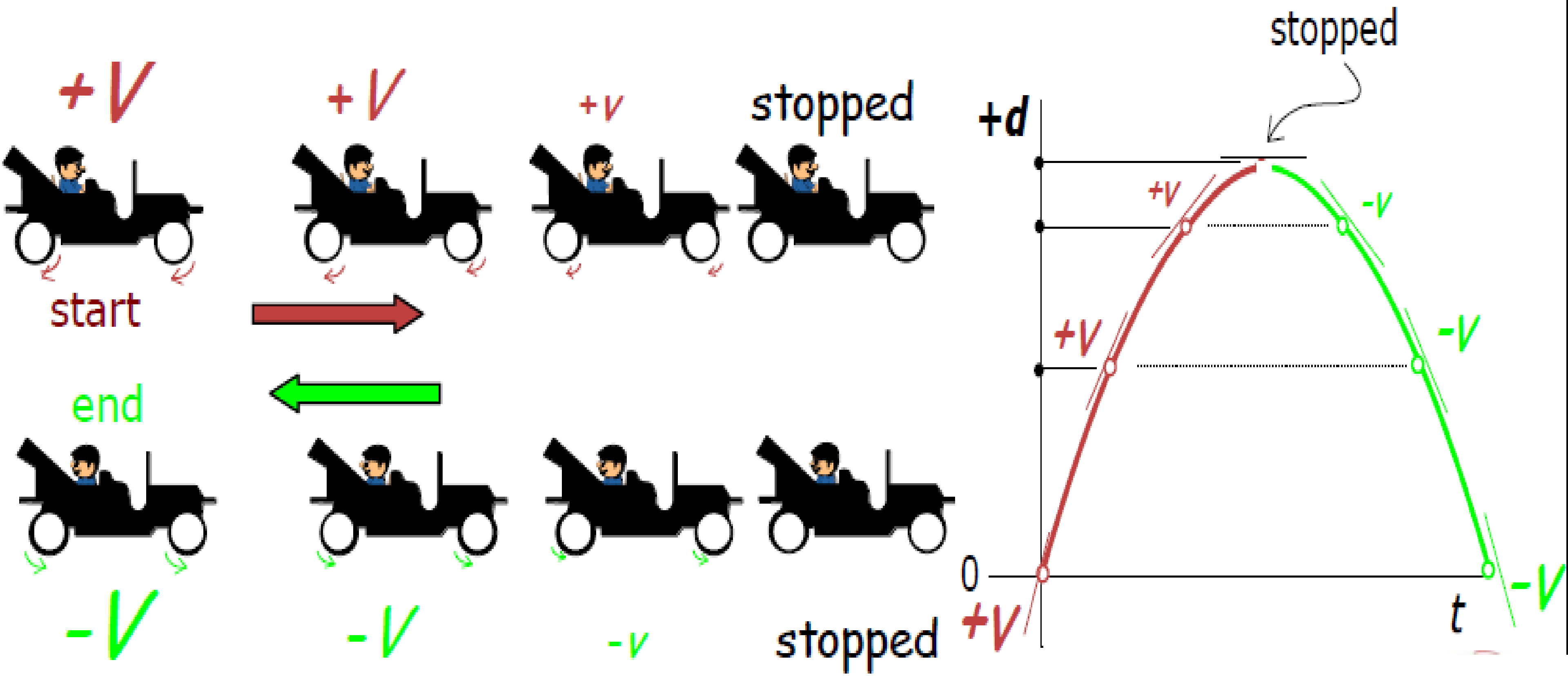
Example 2:

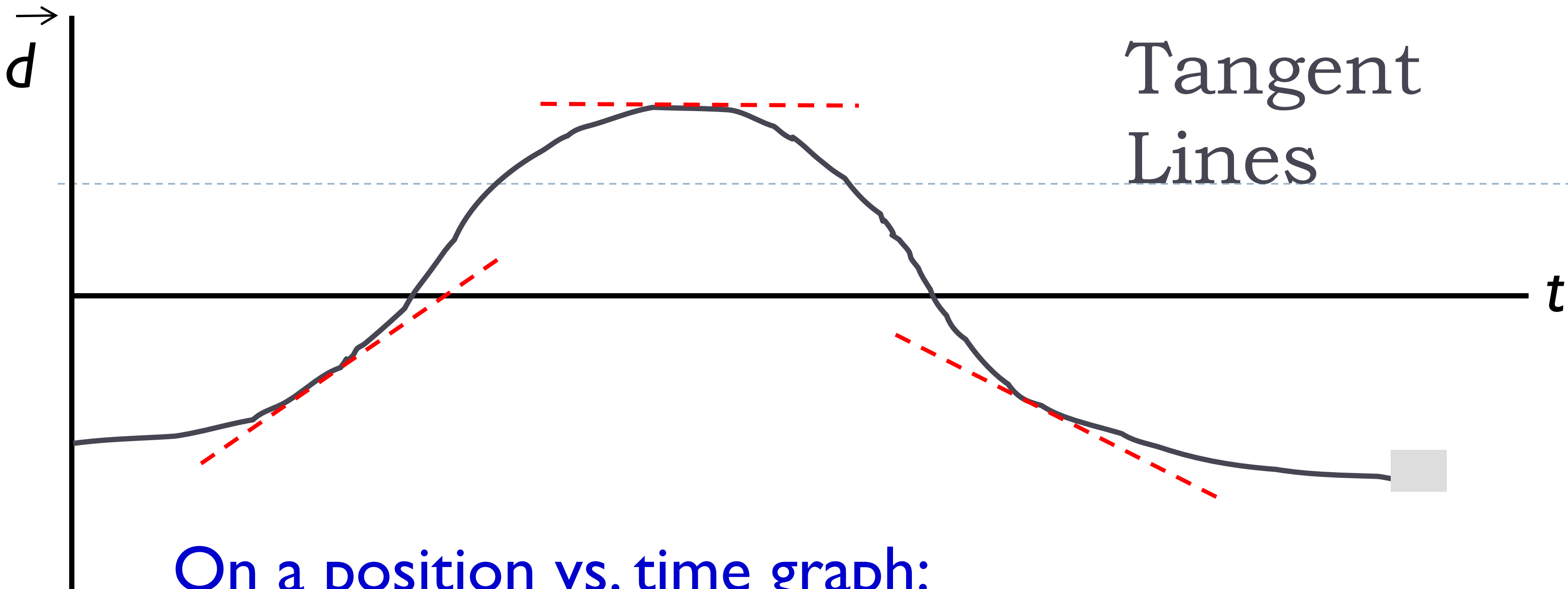
A rabbit, eating in a field, scents a fox nearby and races off. It takes only 1.8 s to reach a top velocity of 7.5 m/s [N]. What is the rabbit's acceleration during this time?

Note: The direction of velocity and acceleration will determine the size of the velocity (ie. If an object is speeding up or slowing down)

		Velocity	
Acceleration		+	-
	+	Moving Forward, Speeding up	Moving Forward, Slowing down
	-	Moving backward, slowing down	Moving backward, speeding up

Displacement-time Graphs (Accelerated Motion)



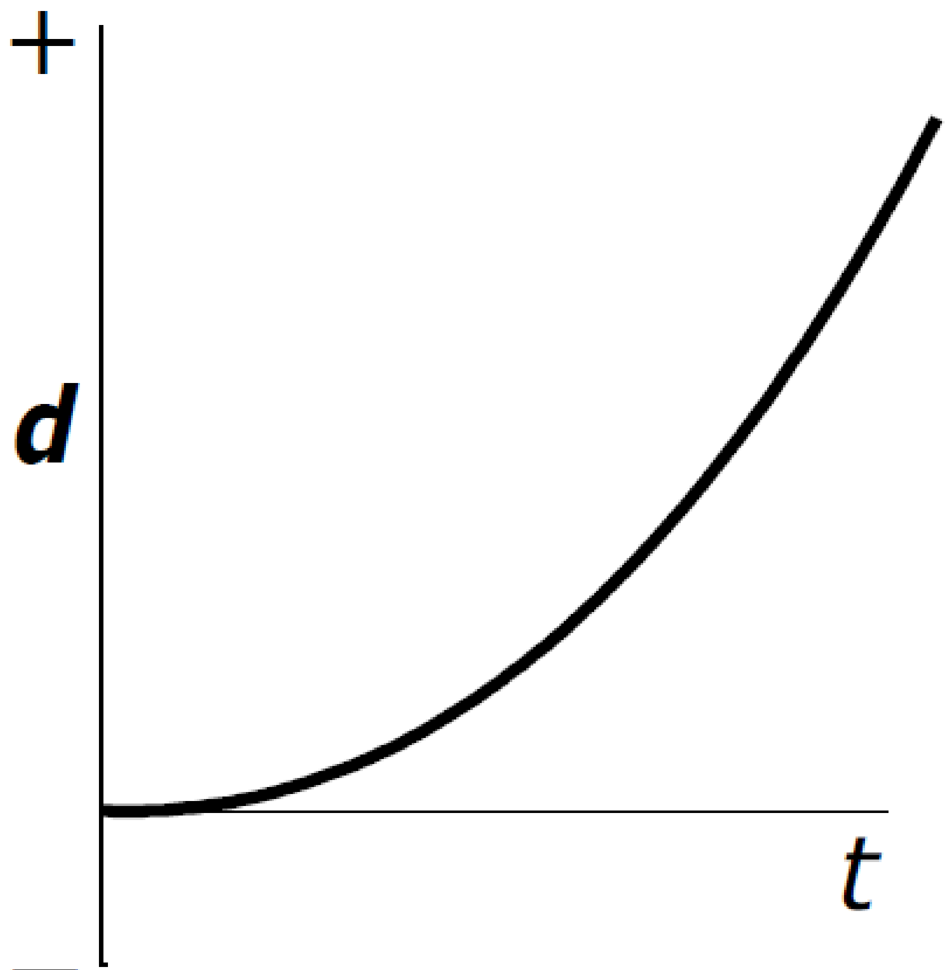


On a position vs. time graph:

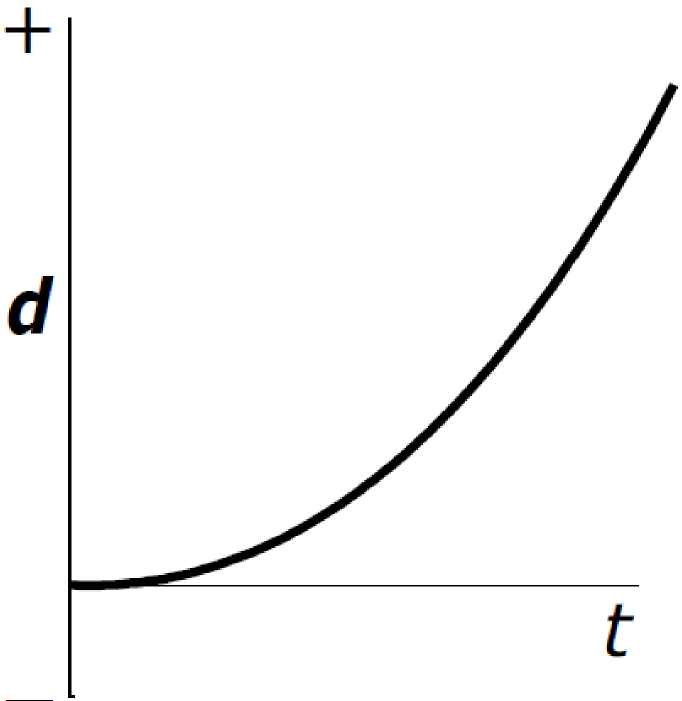
The slope of a tangent line will give the velocity at that point in time. (instantaneous velocity)

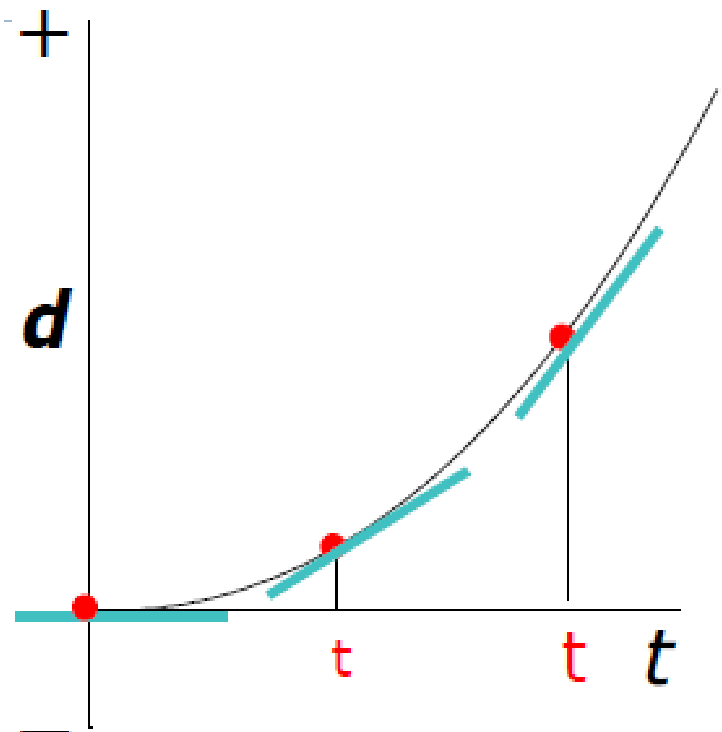
SLOPE	VELOCITY
Positive	Positive
Negative	Negative
Zero	Zero

Describe the motion depicted by the ***d-t graph below***



Explanation

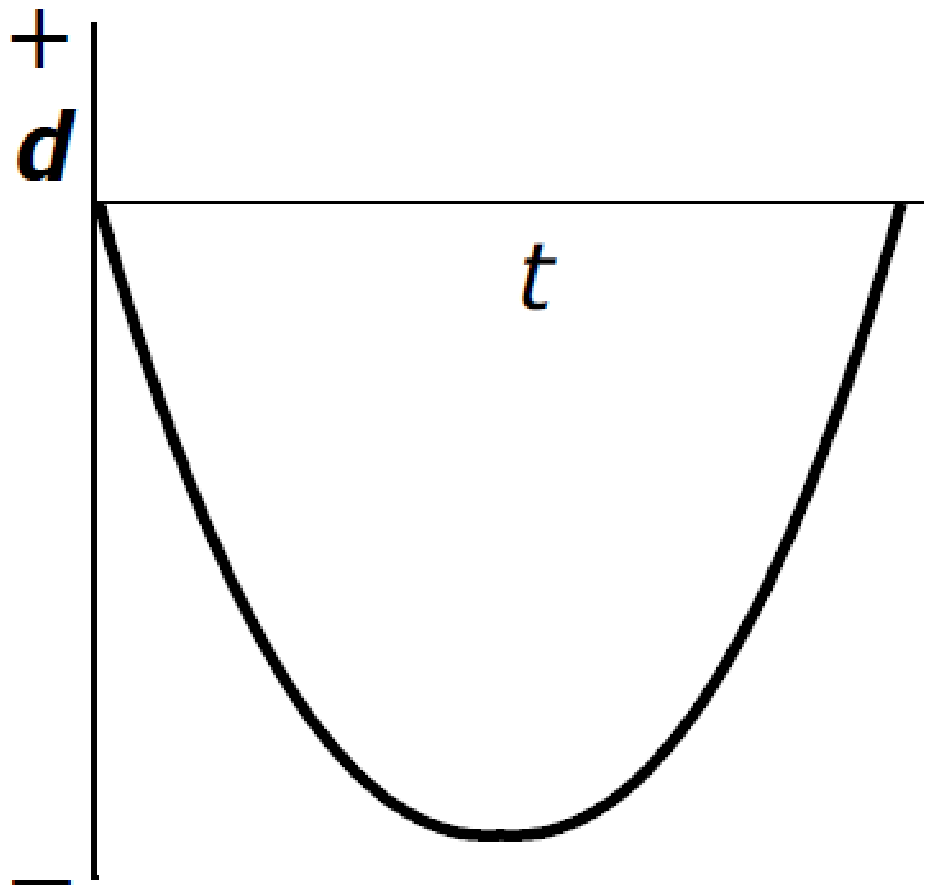




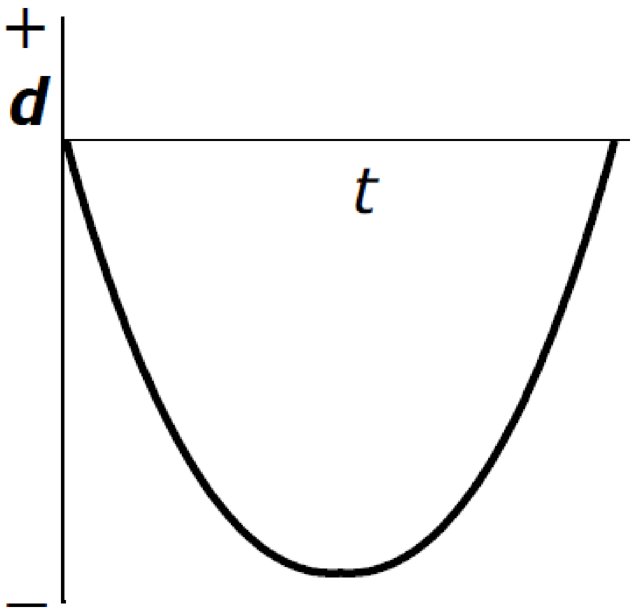
Answer
The object is accelerating to the right.

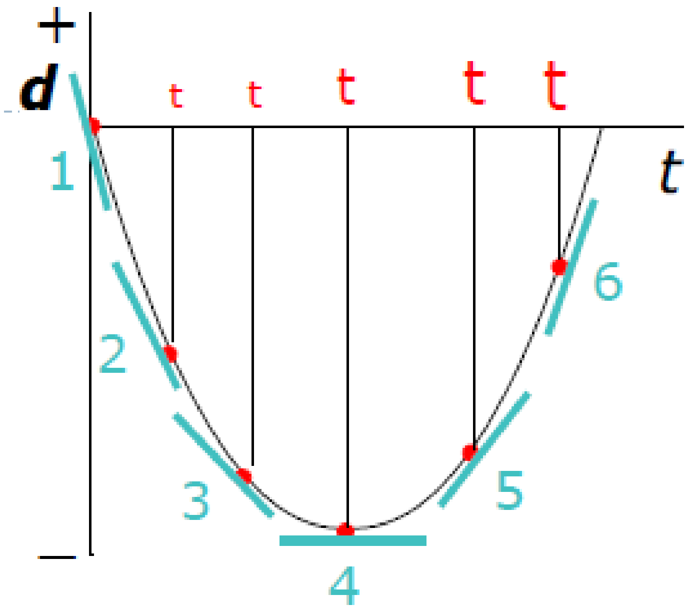
As time goes on, the tangents acquire larger and larger **positive slopes, i.e. larger speeds to the right.**

Describe the motion depicted by the ***d-t graph below***



Explanation

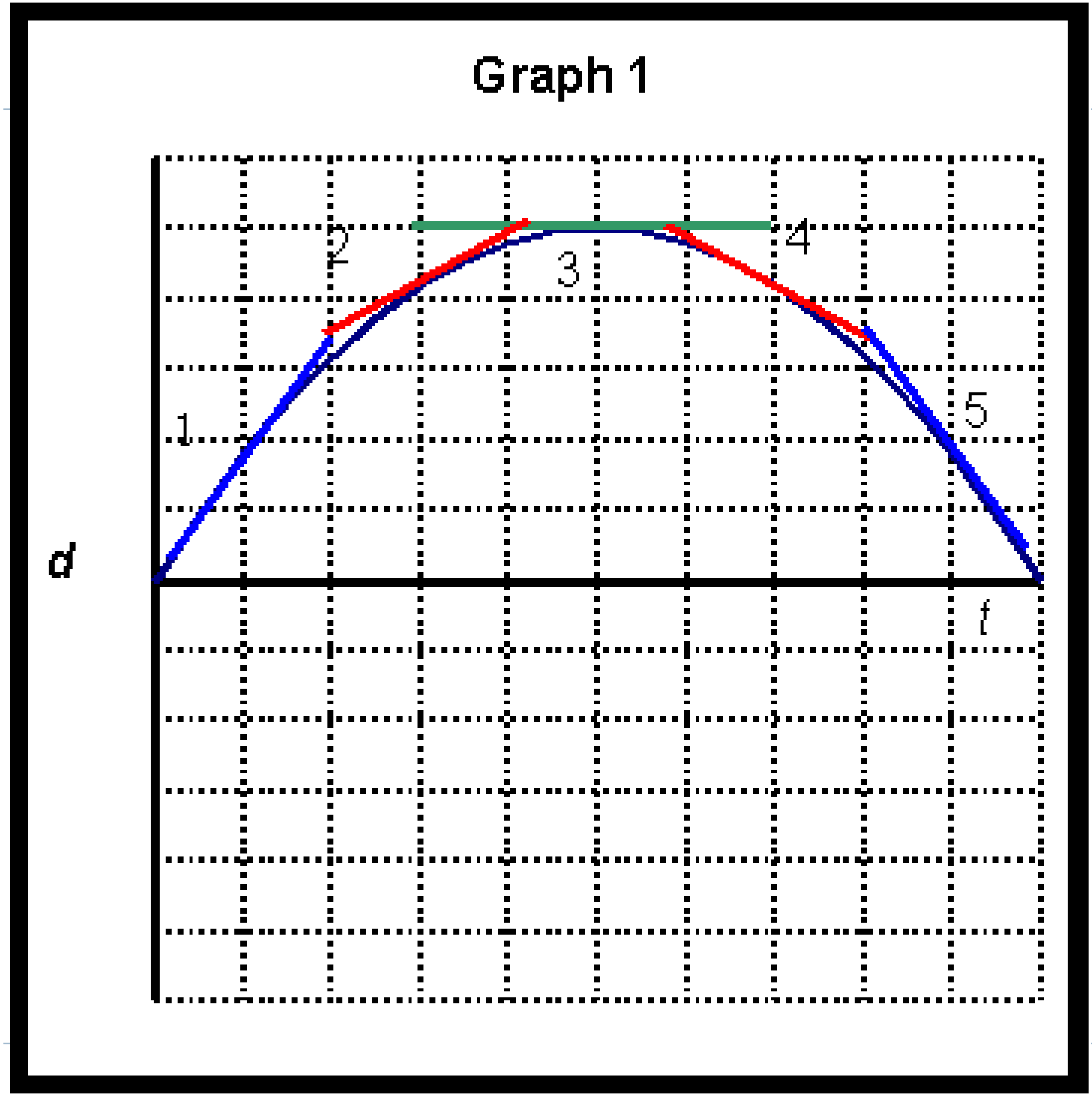


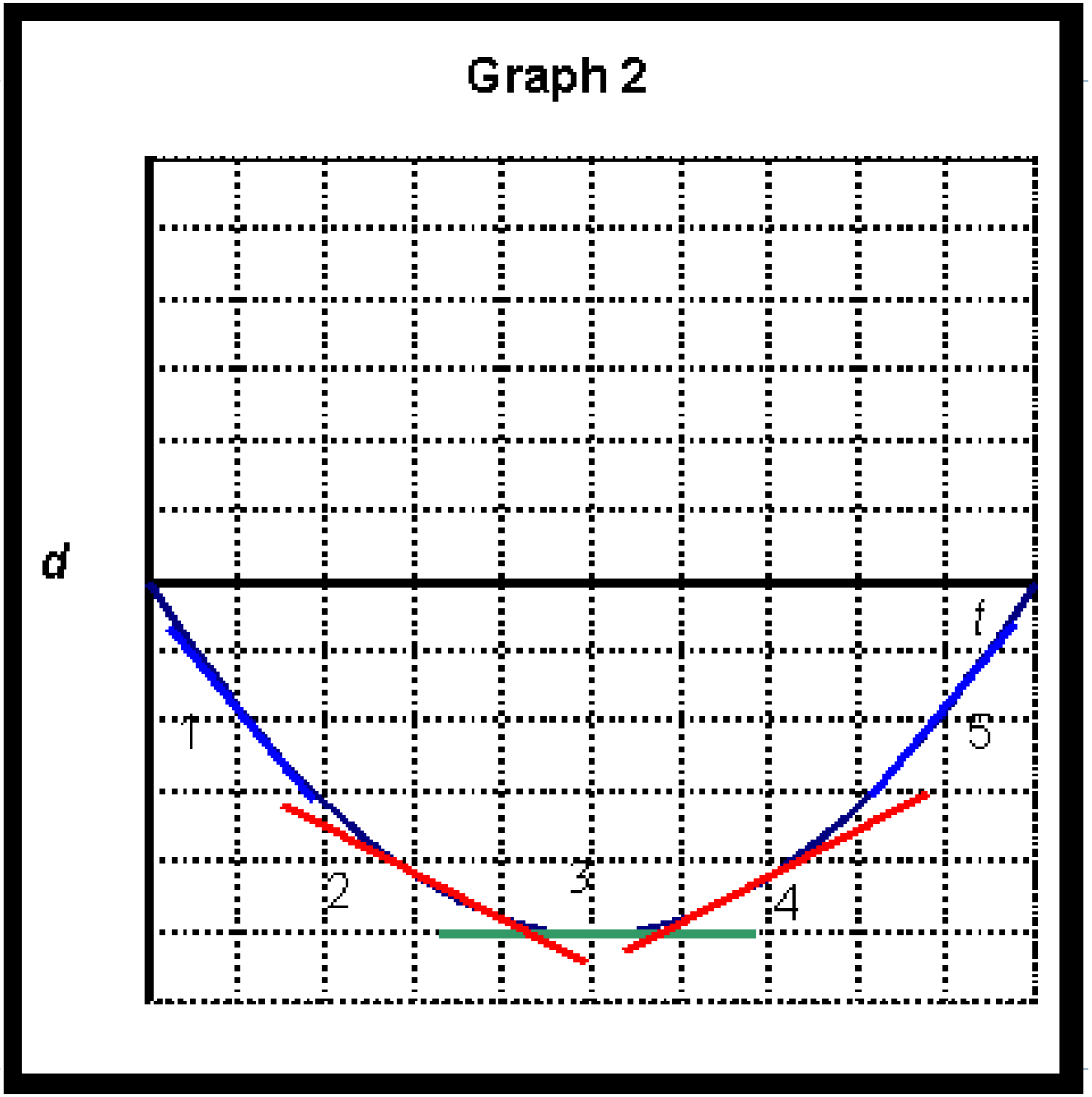


Answer

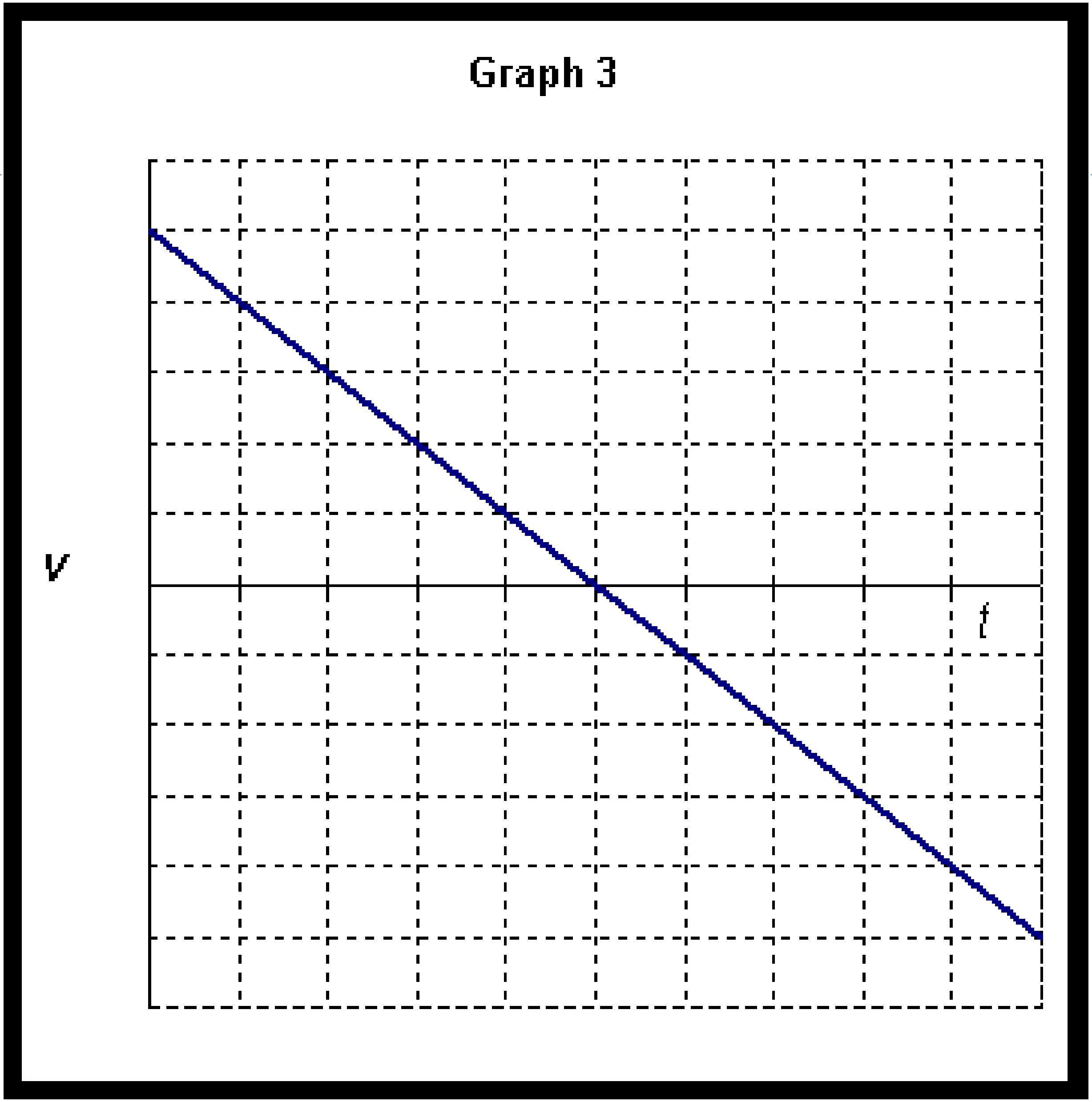
The object heads left but with ever **decreasing speed. At half-time it stops very briefly and then speeds up to the right.**

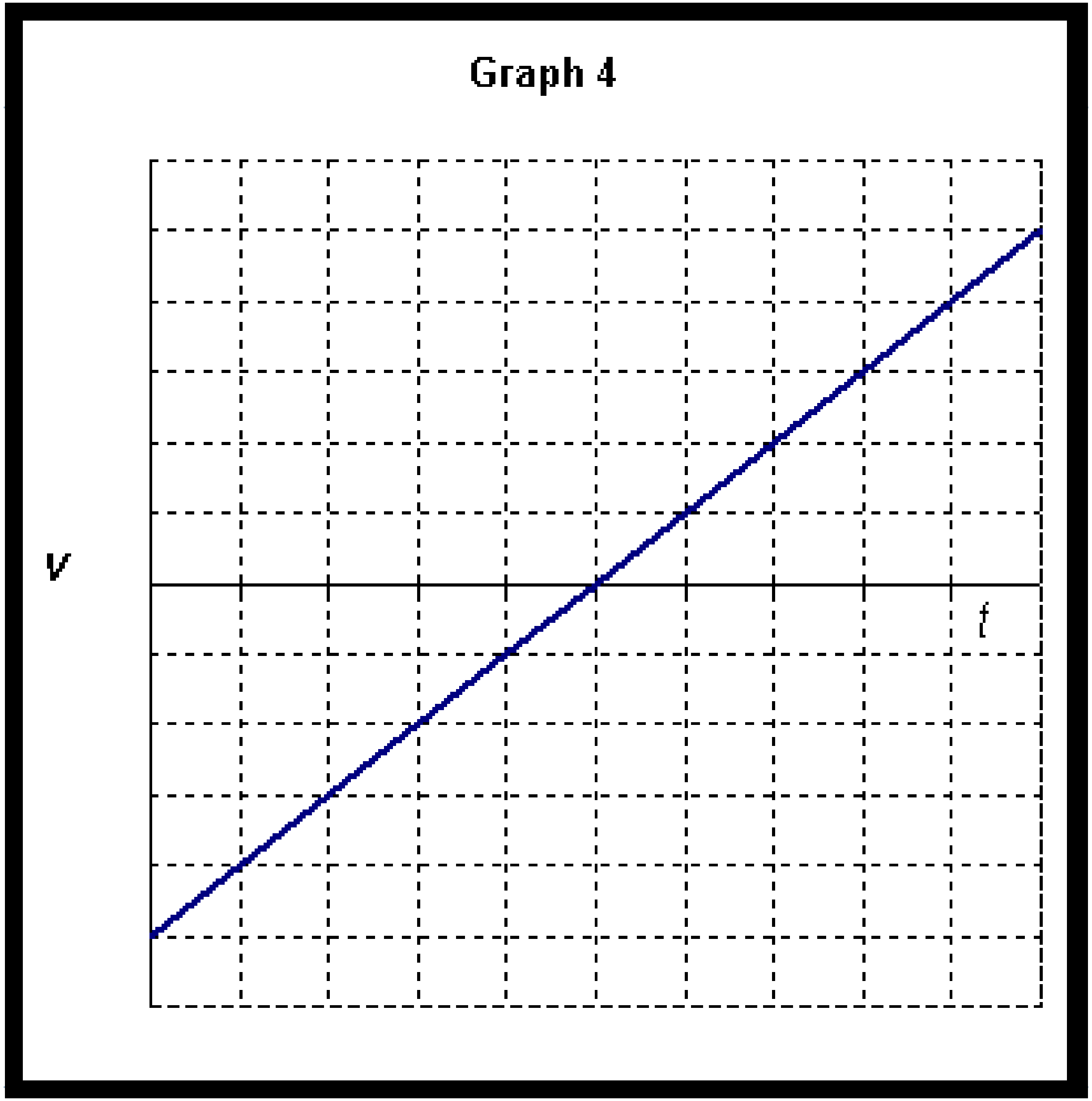
Tangents 1, 2, and 3 have **negative slopes that are getting smaller. This means the object is moving to the left and slowing down. At 4 it is stopped. Then it picks up speed to the right as indicated by the positive slopes of 5 & 6.**

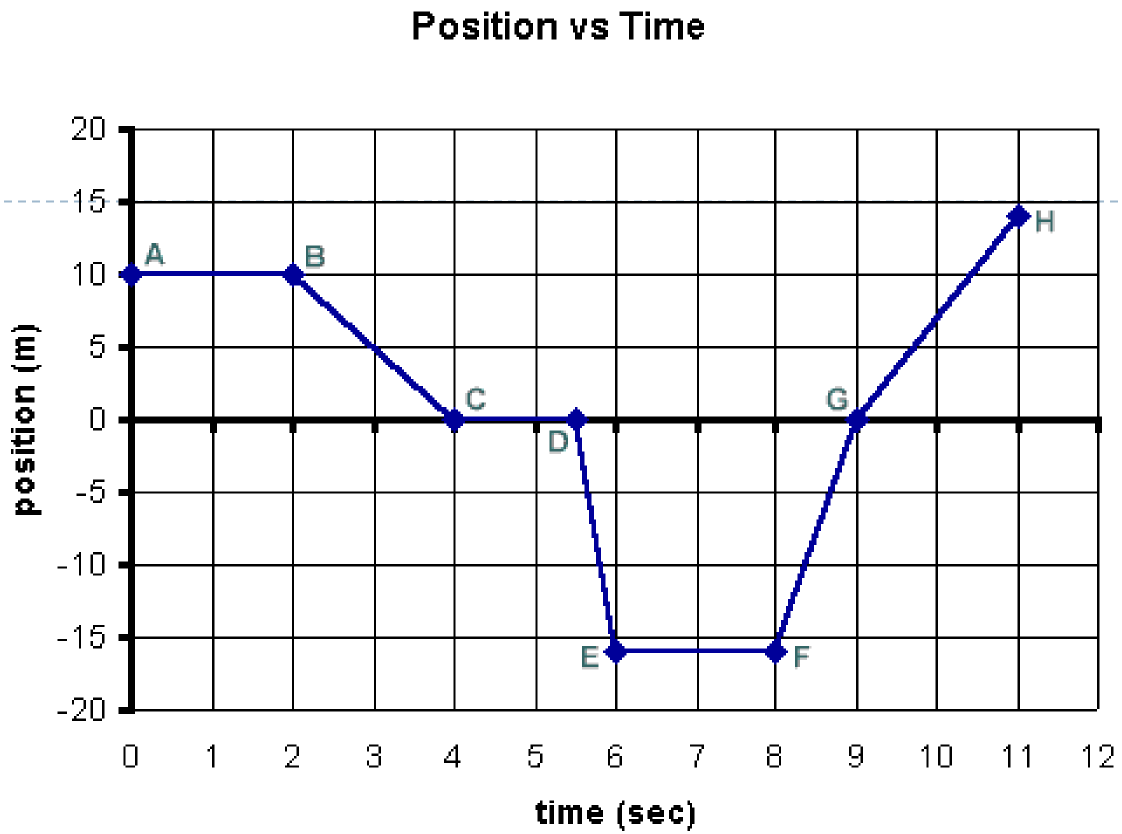

Graph 1
1
2
3
4
5
d
t



Graph 2
d
t
1
2
3
4
5


Graph 3
v
t


Graph 4
v
t

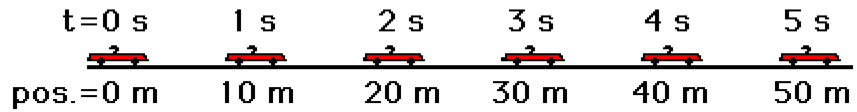


A. Describe what is happening in each leg of the trip.

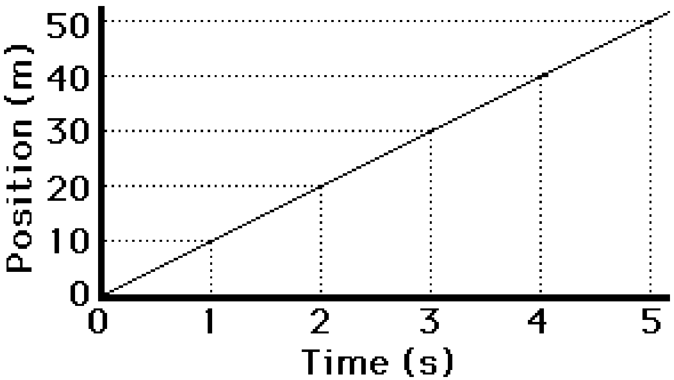
B. During which parts of the trip is the object stopped?

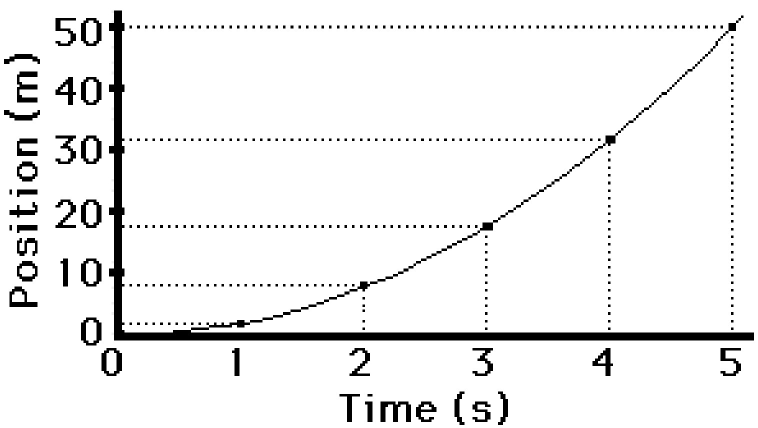
C. During which part of the trip is the object moving the fastest? What is its Velocity?

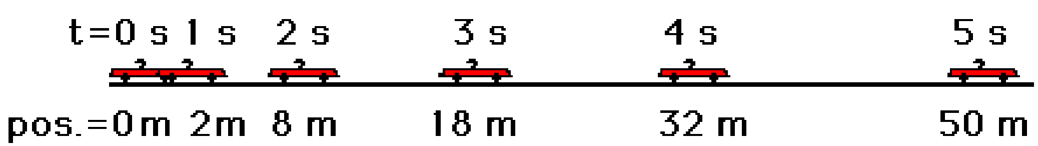
Motion Graphs – Position vs. Time



constant, **rightward (+)** **velocity** of +10 m/s

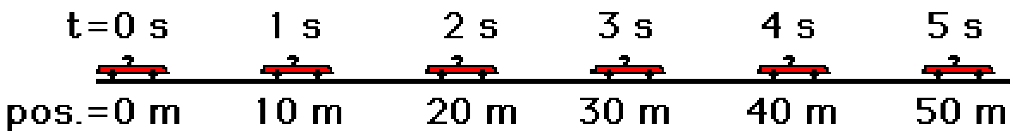


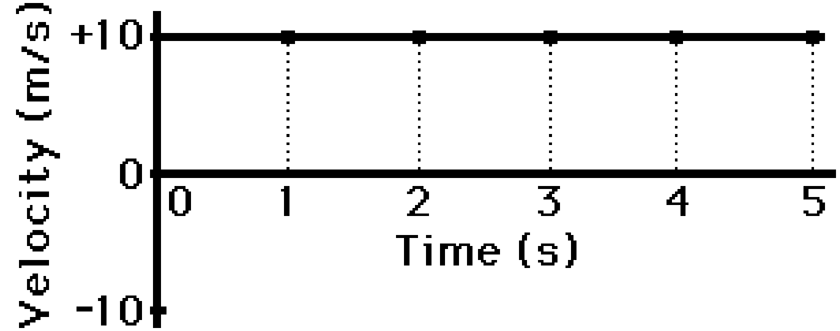




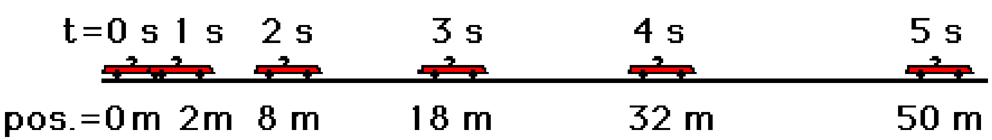
a **rightward (+)**, **changing velocity** - that is, a car that is moving rightward but speeding up or *accelerating*

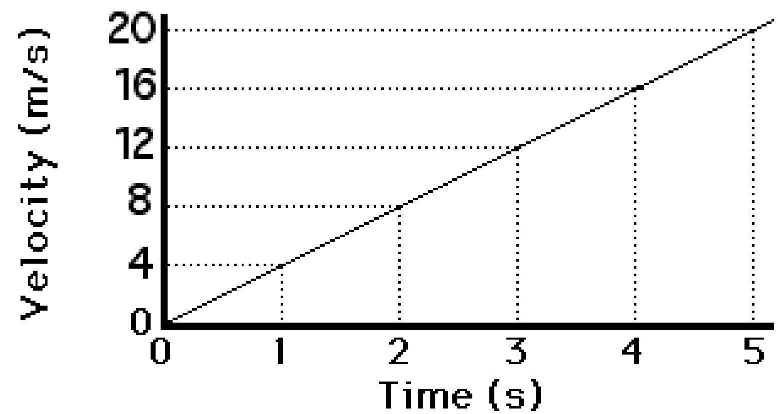
Motion Graphs – Velocity vs. Time





constant, rightward (+) velocity of +10 m/s





a **rightward (+), changing velocity -** that is, a car that is moving rightward but speeding up or *accelerating*