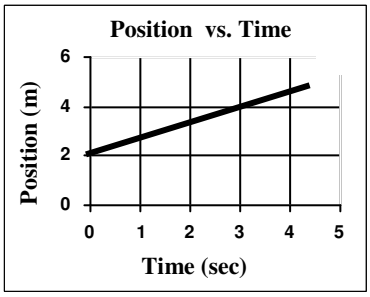
Linear Equations and Applications

*All linear equations have the **general form**:*
y = mx + b *(m = slope; b = y-intercept).*
Graphs with actual physical meaning may have different variables for the x and y axes. X and y, then, must be reassigned to make the specific form of the linear equation for that particular graph. Also, on physical graphs, the slope and y-intercept have actual physical meaning.



General Equation: y = mx + b

y-axis variable: position (x)
x-axis variable: time (t)
y-intercept: 2 m (starting point)
slope: 3m/2sec = 1.5 m/s (velocity)

Specific Equation: x = 1.5t + 2

What is the general equation for **all** linear graphs:
What does the y-intercept of this graph mean?
Circle all good points on this graph.
Is the object moving forward or backward?

Calculate the slope of this graph (keeping units).

What does the slope of this graph mean (look at units)?

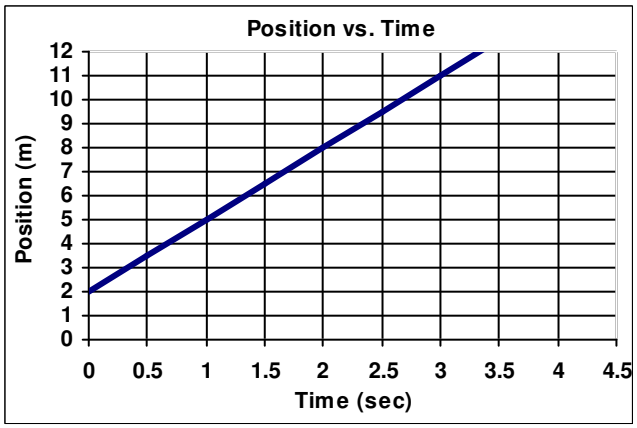
Does this graph have a steep or shallow slope?

Is the object moving fast or slow?

*Write the variables and equation for this graph (for y and x change them to the variables used on **this** graph):*

y =
x =
b =
m =

Linear Equation for <u>this</u> graph:



Using the specific linear equation for this graph answer the following:

Where will the object be at 7 seconds?

Circle all good points on the graph.
What does the y-intercept mean?
Calculate the slope of the graph (keep units).

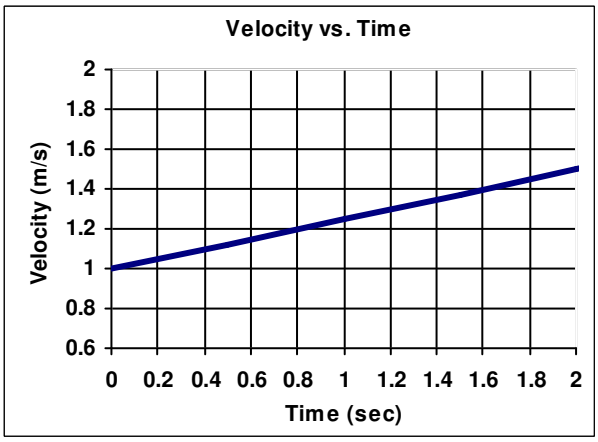
What does the slope of this graph mean?

Is it a steep or shallow slope?

*Write the variables and equation for **this** graph:*

y =
m =
x =
b =

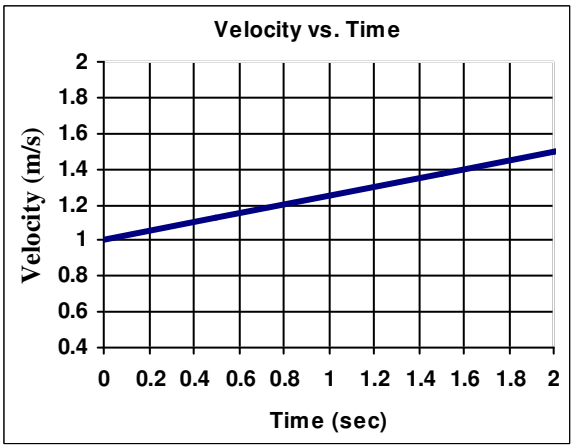
Linear Equation for this graph:



Using the linear equation for this graph answer the following:

When will the object be going 4 m/s?

What is the independent variable on this graph?
Does the object have a positive or negative velocity?
Is the object moving fast or slow?



What does the y-intercept mean?
Is it moving forward or backward?
Find the linear equation for this specific graph.

What does the slope mean?

When is the object going 6 m/s?

Graphs come from experimental data. Scientists rarely use data at the extremes of the graph, including initial points: they tend to be less accurate. So, only use the y-intercept to find slope if you have no other good point.

The y-intercept means:

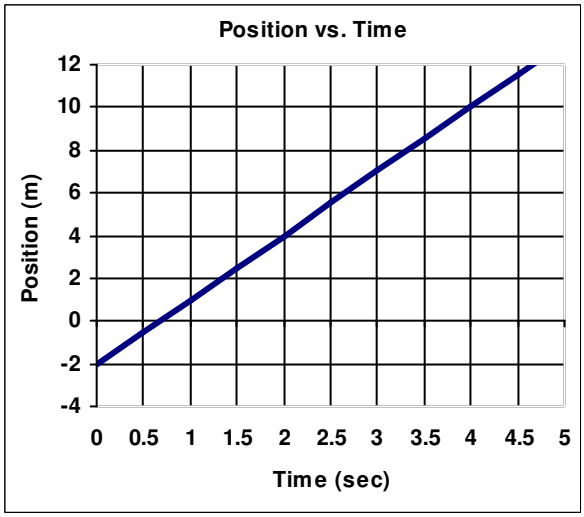
The slope means:

Did it start in front or behind the zero point?

Is it moving forward or backward?

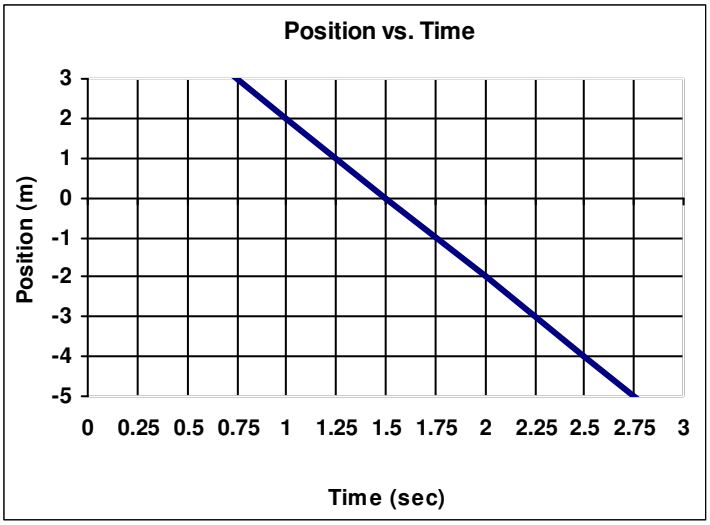
Write the linear equation for this graph.

When will the object be zero meters away?



Extrapolation: finding information not on the graph.

When will the object be 25 meters away?



What does the slope of this graph mean?

Is the object moving backwards or forwards?

Is the object's velocity positive or negative?

What would the y-intercept mean?

Find where the object started.

Expanding the Concept: Graph Applications

Graphs with multiple segments—*each segment has its own linear equation.*

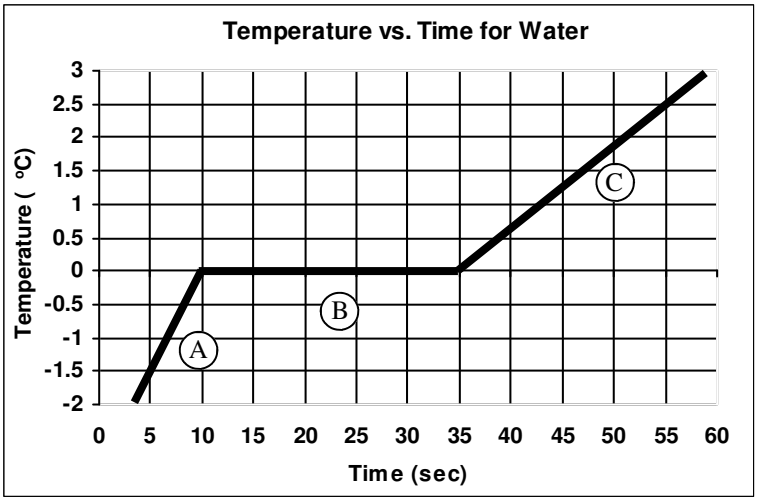
What is the meaning of the y-intercept?
What phase of matter is segment A: solid, liquid or gas?
What phase is segment C?
What do we call solid water?
Is the object's temperature raising or falling during A?

Is heat going into or out of the object?
What is happening during segment B?

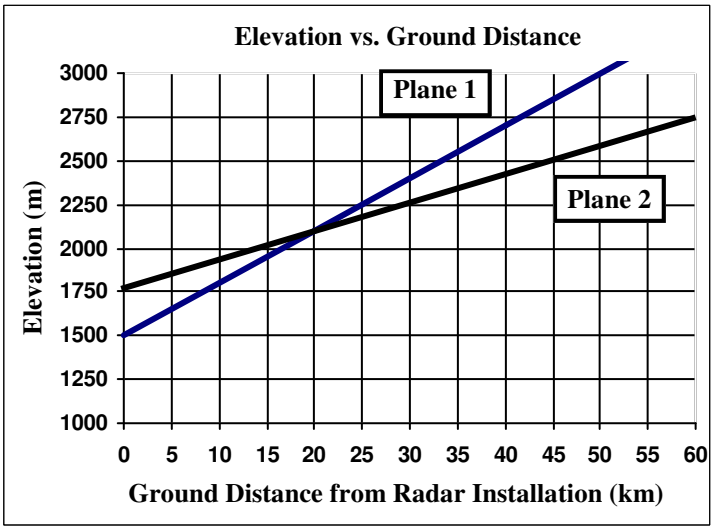
What do we call the temperature at B?

What temperature is this on the Fahrenheit scale?

Why does it take time before the temperature continues to rise?



When will the object reach 10° Celsius?



Graphs with multiple lines—*each line has its own linear equation.*

Which plane began at a higher elevation?

Which plane will require less distance to reach its cruising altitude?

Circle the point at which the planes were at the same altitude and distance.

How can you tell that the planes were not in the same place at the same time?

How would the graph change if they did?

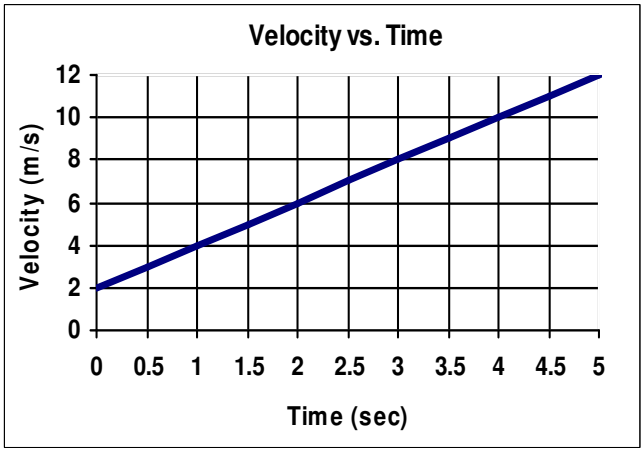
Find the rate at which each plane climbs.

How much distance does Plane 2 require to reach its cruising altitude of 10,000 m?

Challenge Question: Find the altitude at which the two planes were the same distance away from the airport (the intersection).

Area — Sometimes the area under the graph has physical meaning.

Find the area under the graph for the first 4 seconds.
(You need the total area from the x-axis to the line.)



Use the units to figure out what the area of this graph means.

The Area of a Velocity vs. Time Graph = _____.

A graph under the x-axis will have a negative area: the object is moving backwards.

In Calculus finding the area under a graph is known as <u>Integration</u>.

Changing slope — *each segment has its own slope.*

Find the slope for each segment (keeping units):

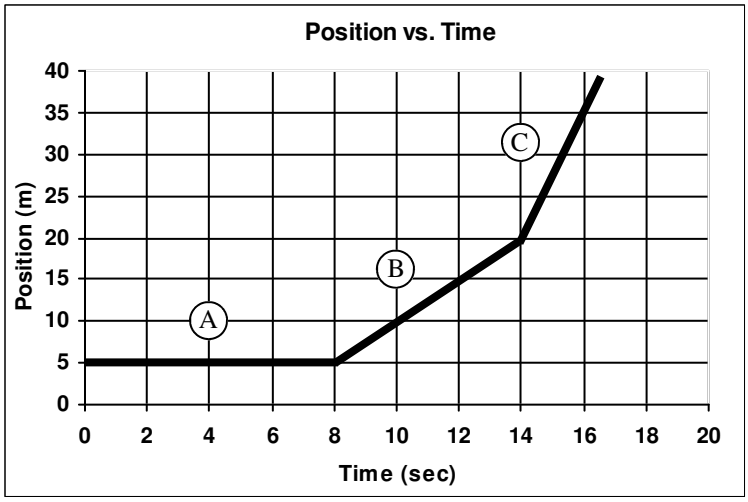
Slope A =

Slope B =

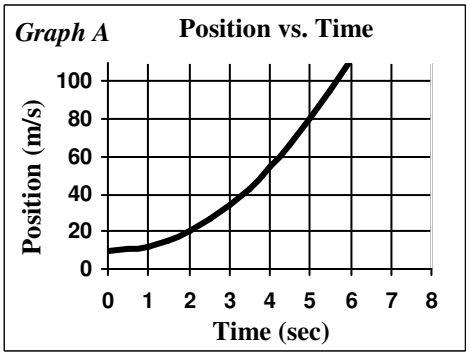
Slope C =

What does the slope mean?

What is this object doing?



Acceleration Graphs have smooth, curved lines, showing constantly changing slope (velocity). The above graph shows an object speeding up twice, a roughly drawn acceleration graph.



Which graph shows positive acceleration?

Which graph shows negative acceleration?