Name: _____

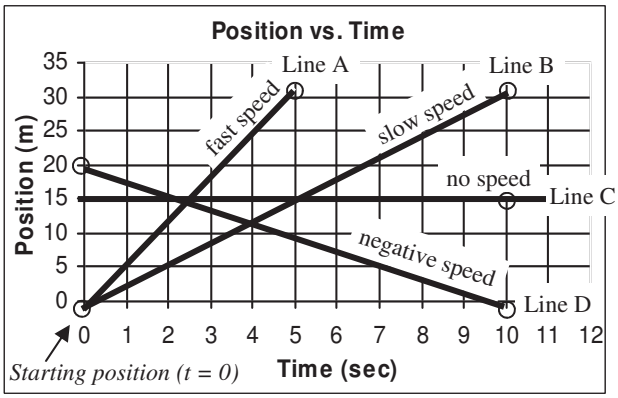
Period: _____

Unit 6:3

Graphing Linear Motion

Position vs. Time Graphs

A Position vs. Time graph shows where an object is at a particular time. The slope of a position vs. time graph shows the speed of an object. A steeper line shows faster speed. A downward line means negative speed (moving left or coming back).



A steeper line = a faster speed.

Object A travels 30 m in 5 seconds.
Line A shows fast positive speed.
$$S_{LineA} = \frac{\Delta D}{\Delta T} = \frac{30}{5} = 6\text{m/s}$$

Object B travels 30 m in 10 seconds.
Line B shows slow positive speed.
$$S_{LineB} = \frac{\Delta D}{\Delta T} = \frac{30}{10} = 3\text{m/s}$$

Object C stays 15 m away.
Line C shows a speed of zero.
$$S_{LineC} = \frac{\Delta D}{\Delta T} = \frac{0}{10} = 0\text{m/s}$$

Object D travels –20 m in 10 seconds.
Line D shows slow negative speed.
$$S_{LineD} = \frac{\Delta D}{\Delta T} = \frac{-20}{10} = -2\text{m/s}$$

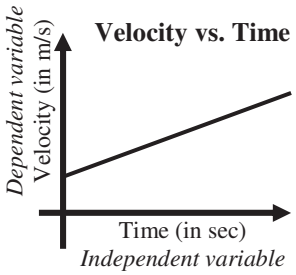
Graphing Variables

Scientists have rules for choosing which variable is graphed on which axis. This allows scientists to understand how an experiment was conducted just by reading the graph.

Conventions: X-axis (horizontal): Independent or manipulated variable.
Y-axis (vertical): Dependent or responsive variable.

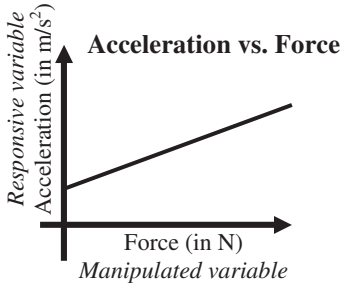
Independent vs. Dependent

The independent variable is not affected by the changing dependent variable. The dependent variable changes as the independent variable



Manipulated vs. Responsive

Sometimes it is hard to determine which is the independent variable. In these cases, the variable that you are manipulating (varying) will graphed on the x-axis.



The above object's acceleration changes (responds) as the force is changed (manipulated).

***Time** (as in "a particular moment in time") is <u>always</u> an **independent variable** (x-axis) because nothing stops time. Time does not change with speed; speed changes over time.*

***Duration** (how long it takes) can be **dependent** (y-axis). Ex. The period of a spring (how long it takes to move back and forth) changes as more mass is added. Mass is independent, not period of time.*

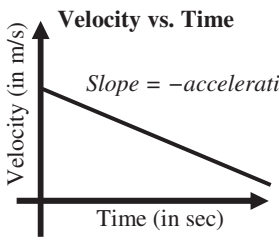
The manipulated variable is the one you are changing in your experiment and is often the experimental variable.

Meaning of Slope Changes

The slope of a position vs. time graph is speed. The slope of a velocity vs. time graph is acceleration. Yet for some graph, the slope has no physical meaning.

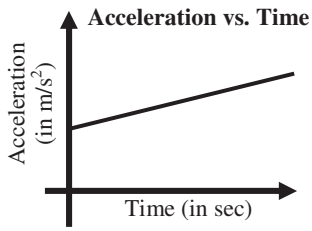
To figure out what the slope of a graph means: divide the y-axis units by the x-axis units to find the units for the slope.

$$\text{Meaning of Slope} = \frac{rise}{run} = \frac{\text{units of y-axis}}{\text{units of x-axis}}$$



This graph shows the change of velocity over time which is acceleration.

$$Slope = \frac{rise}{run} = \frac{\Delta y}{\Delta x} = \frac{\text{m/s}}{\text{s}} = \text{m/s}^2 = \text{acceleration}$$



The slope of this graph means nothing.

This graph shows the change of acceleration over time which is undefined.

$$Slope = \frac{rise}{run} = \frac{\Delta y}{\Delta x} = \frac{\text{m/s}^2}{\text{s}} = \text{m/s}^3 = ?$$

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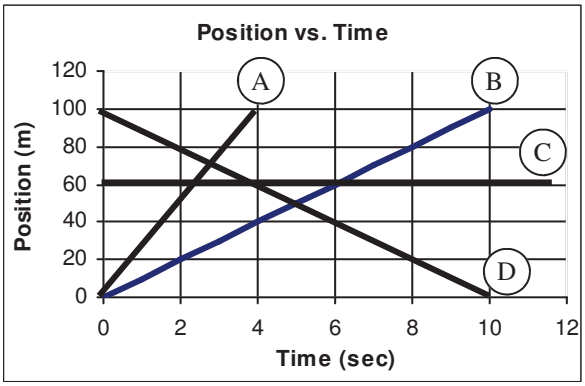
1. Linear	A. Vertical axis (y) variable.	*Circle the Independent Variable*
2. Responsive variable	B. The variable you change.	A. Time or Acceleration
3. Independent variable	C. Any straight line graph.	B. Velocity or Time
4. Dependent variable	D. Measure of how steep a line is.	C. Time or Position
5. Slope	E. The variable on the horizontal axis (x-axis).	*Circle the Manipulated Variable for these Graphs*
6. Manipulated variable	F. What changes because you change something.	A. Force on an object or Acceleration of the object?
		B. Period of a Spring or Mass hung from the spring?
		C. Number of batteries or Brightness of a bulb?



What does the slope of this line show? _____

How much time does it take Object A to travel 100m? _____

How much time does it take Object B to travel 100m? _____

Which Object (A or B) has the faster velocity? _____

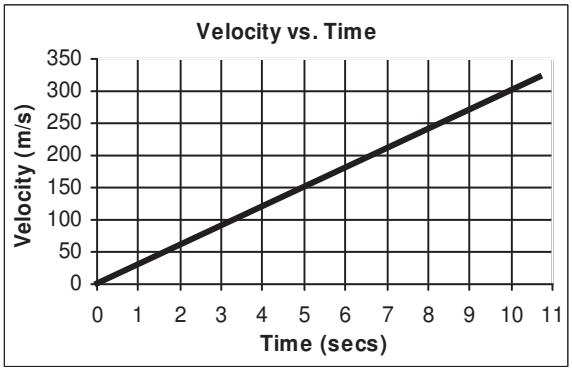
Object C starts where? _____ Object C ends where? _____

Which line shows negative speed? _____

Which line shows positive speed? _____

Which line shows an object at rest? _____

What is Object D's initial position? _____



When was the object moving at 150 m/s? _____

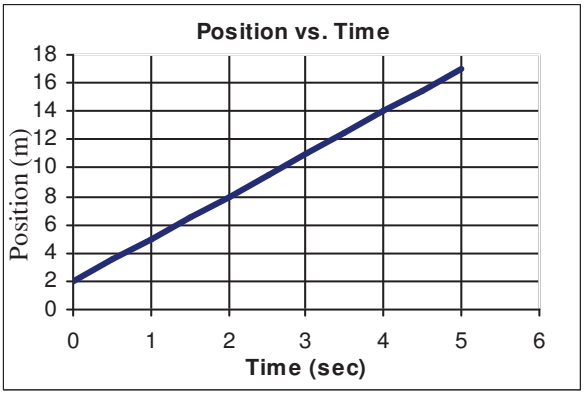
How fast is the object going after 10 seconds? _____

What was the initial velocity of the object? _____

How much speed does it gain in the first 5 seconds? _____

Find the slope of the graph (must show work) _____

What does the slope you just found stand for? _____



Which is the independent variable? _____

Which is the dependent variable? _____

Where was the object at 4 seconds? _____

Where did the object begin? _____

Find the slope of the graph (must show work)

What does the slope you just found stand for? _____

The slope of this graph means:

Which segment shows:

Increasing velocity:

Constant velocity:

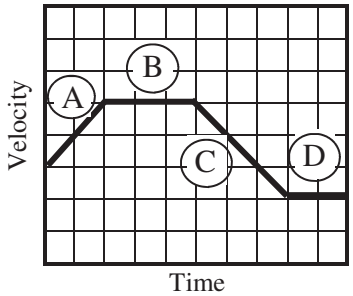
Positive acceleration:

Negative acceleration:

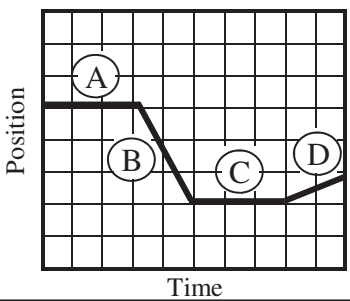
Speeding up:

Slowing down:

Velocity vs. Time



Position vs. Time



Which segments shows:

At rest:

Fast speed:

Slow speed:

Going backwards:

Going forward:

Negative speed:

Speed equals zero:

1. Linear C
2. Responsive variable F
3. Independent variable E
4. Dependent variable A
5. Slope D
6. Manipulated variable B

A. Vertical axis (y) variable.
B. The variable you change.
C. Any straight line graph.
D. Measure of how steep a line is.
E. The variable on the horizontal axis (x-axis).
F. What changes because you change something.

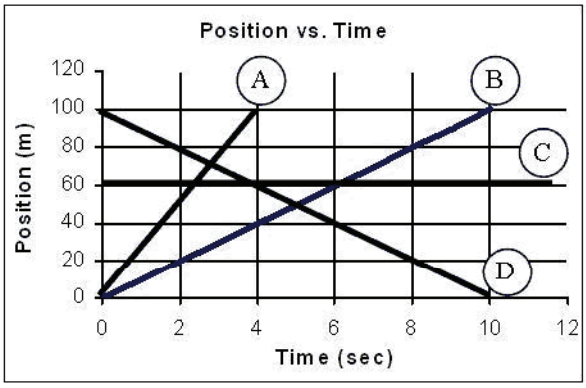
Circle the Independent Variable

A. Time or Acceleration
B. Velocity or Time
C. Time or Position

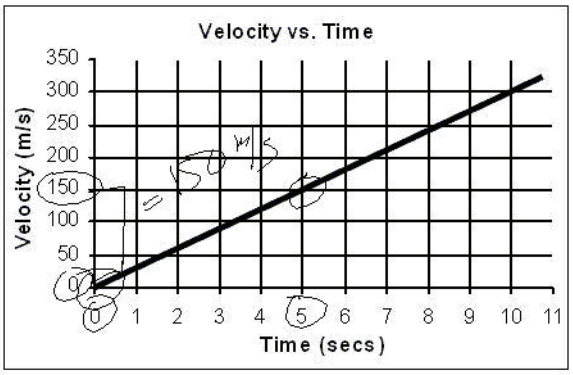
These are all points in time + can't be dependent on other things.

Circle the Manipulated Variable for these Graphs

A. Force on an object or Acceleration of the object
B. Period of a Spring of Mass put on the Spring
C. Number of batteries or brightness of a bulb



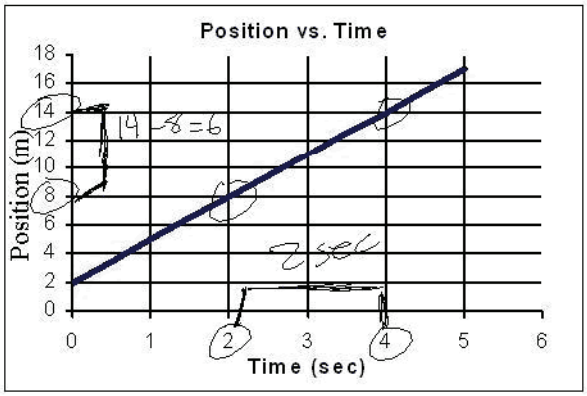
What does the slope of this line show? speed
How much time does it take Object A to travel 100m? 4 sec
How much time does it take Object B to travel 100m? 10 sec
Which Object (A or B) has the faster velocity? A
Object C starts where? 60m Object C ends where? 60m
Which line shows negative speed? D
Which line shows positive speed? A+B
Which line shows an object at rest? C
What is Object D's initial position? 100m



When was the object moving at 150 m/s? 5 sec
How fast is the object going after 9 seconds? ≈270 m/s
What was the initial velocity of the object? 0 m/s
How much speed does it gain in the first 5 seconds? 150 m/s
Find the slope of the graph (must show work)

$\Delta y = 150\ m/s$
$\Delta x = 5\ sec$
$slope = \frac{\Delta y}{\Delta x} = \frac{150}{5} = 30\ m/s^2$

What does the slope you just found stand for? acceleration



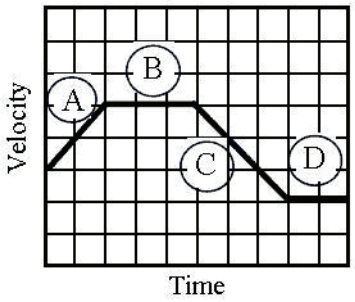
Which is the independent variable? time
Which is the dependent variable? position
Where was the object at 4 seconds? 14m
Where did the object start? 2m away
Find the slope of the graph (must show work)

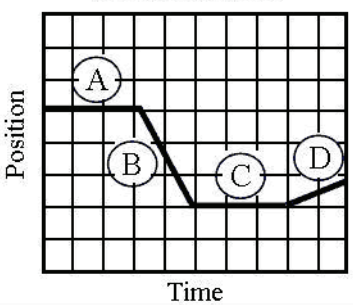
$slope = \frac{\Delta y}{\Delta x} = \frac{14-8}{4-2} = \frac{6}{2} = 3\ m/s$ (see graph)

What does the slope you just found stand for? velocity or speed

The slope of this graph means: acceleration

Which segment shows:
Increasing velocity: A
Constant velocity: B+D
Positive acceleration: A
Negative acceleration: C
Speeding up: A
Slowing down: C





Which segments shows:
At rest: A + C
Fast speed: B (fast neg.)
Slow speed: D
Going backwards: B
Going forward: D
Negative speed: B
Speed equals zero: A+C