Linear Equations

Rate of Change

A linear equation is an equation in which the variables are raised to the first power. A linear equation may have one variable or several variables.

For example: $3x + 4y + 7z + 1 + 0$ is a linear equation with three variables (x, y and z).

Another example of a linear equation with one variable is: $y=3x + 2$ with x as the lone variable.

The linear equation we will be working is: $y = mx + b$

Vocabulary:

Range: the DEPENDENT (y)

Domain: the INDEPENDENT variables (x)

Rise: change in the dependant variable

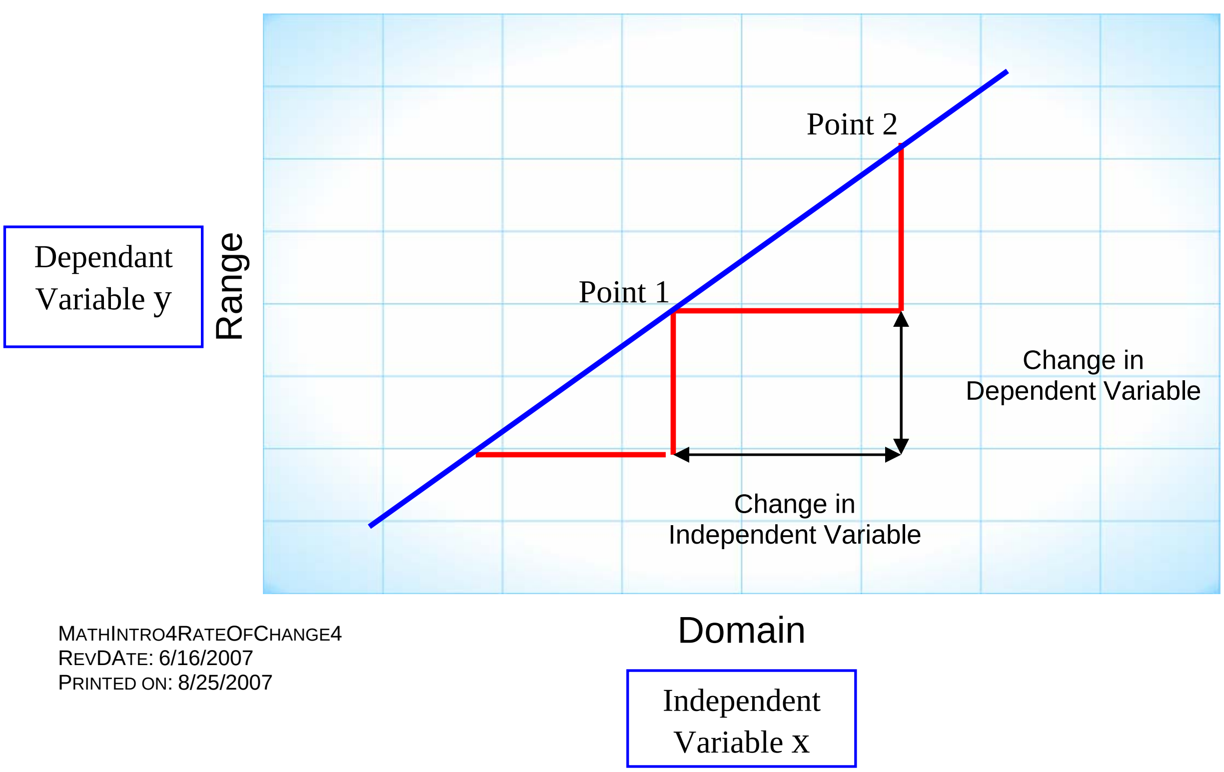
Run: change in the independent variable

Rate of change: slope: (m)

$$\text{Rate of change} = \text{slope} = \frac{\text{dependent variable}}{\text{independent variable}}$$

Linear functions have a constant rate of change. The rate of change is equal to the slope (on a graph). The greater the rate of change, the steeper the graph

We can calculate the rate of change by finding the slope between two points on a graph



We will use the standard formula $m = \dfrac{y2 - y1}{x2 - x1}$ to find the slope (*m*)

Before we get started, these next two examples, show why (y) is dependent on (x)

$$y = 2(x)\ solve\ \ for\ y \qquad\qquad x = 10$$

$$y =$$

$$y = 2(x)\ solve\ \ for\ y \qquad\qquad x = 100$$

$$y =$$

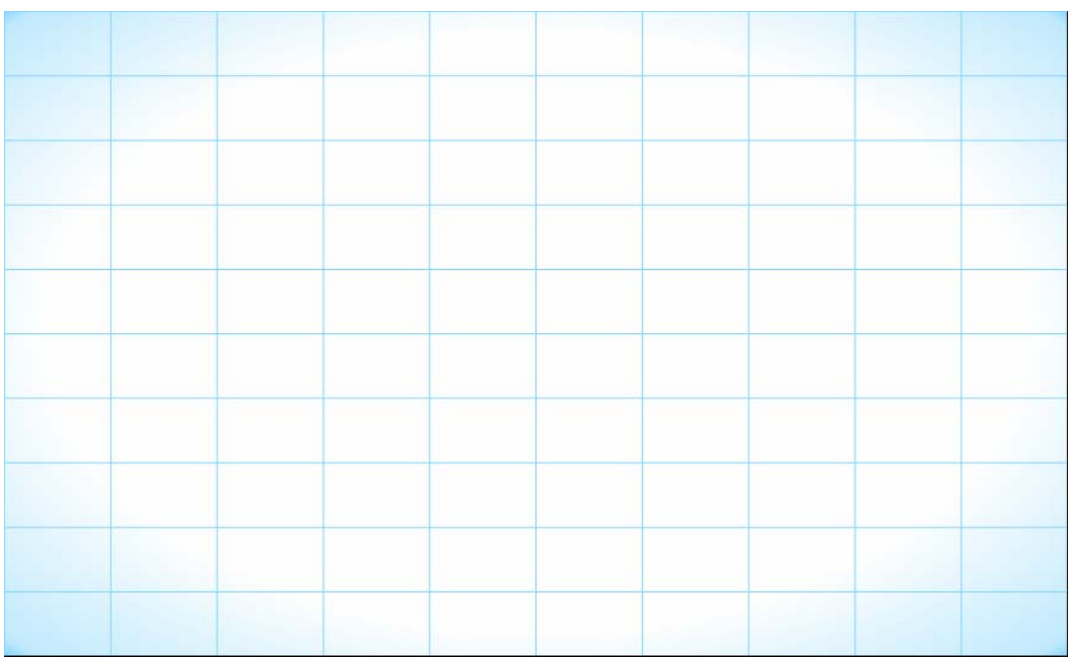
Remember:

Pretty **P**lease **M**y **D**ear **A**unt **S**ally
(From left to right; **P**arentheses; **P**ower; **M**ultiply; **D**ivide; **A**dd, **S**ubtract)

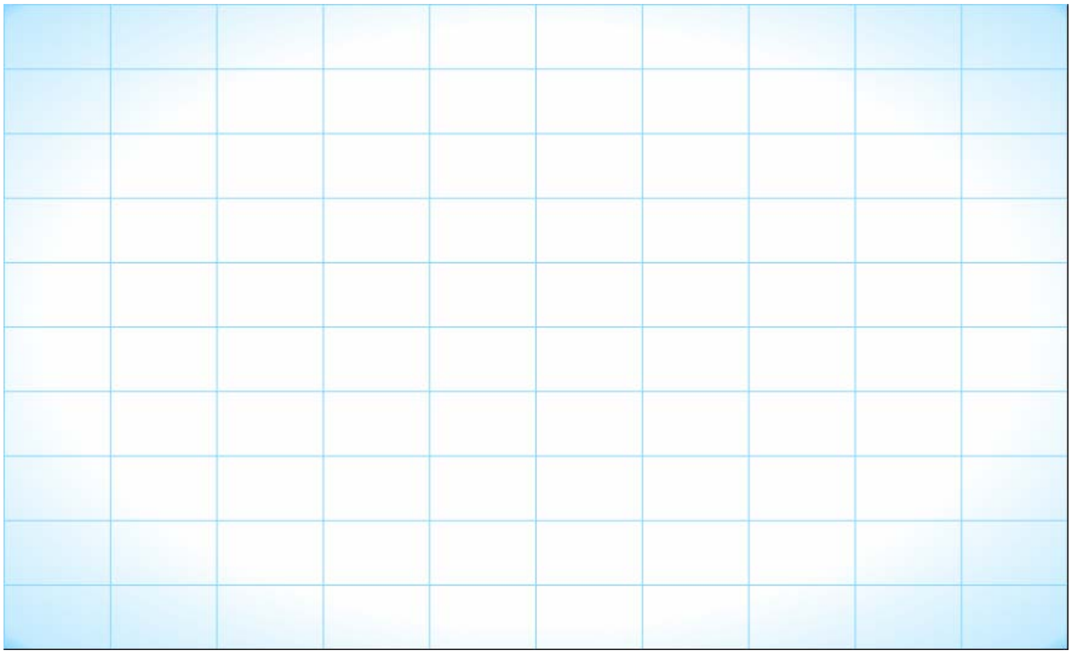
Example 1: You can rent a car for $10 a day, plus there is an additional $30 fee for insurance.

First, find the domain and the range and two data points.

What will the rental charge be for 5-days, 20-days?



Example 2: A 50/50 mix of coolant (50% coolant/50% water) under 16 lbs. of pressure boils at approximately 260° F. 100% coolant under pressure boils at approximately 280° F.
If the amount of coolant *deceases* to a 30/70 mix (30% coolant/70% water) what will the coolant mixture boil at? First, find the domain and the range and two data points. Then, using the graph, estimate the rate of change to determine the new boiling point.



What are the data points? $(50, 260)\ (0, 280)$

$$\frac{260-280}{50-0} = \frac{-20}{50} = -.4$$

$$m\,(slope) = -.4$$

$$y = -.4(30) + b$$

$$y = -12^\circ + b$$

$$y = -12^\circ + 0$$

$$y = -12^\circ$$

The boiling point of the coolant at the new 30:70 ratio is about 248°

Example 3: All vehicles are required to undergo static emission testing. In these tests, the vehicle is placed in an environmental chamber with the engine off for up to 15 days to determine the amount of emissions released by the tires, gasoline, paint, vinyl, plastics, coolant and even the windshield washer solvent. One particular system being produces the following emission readings:

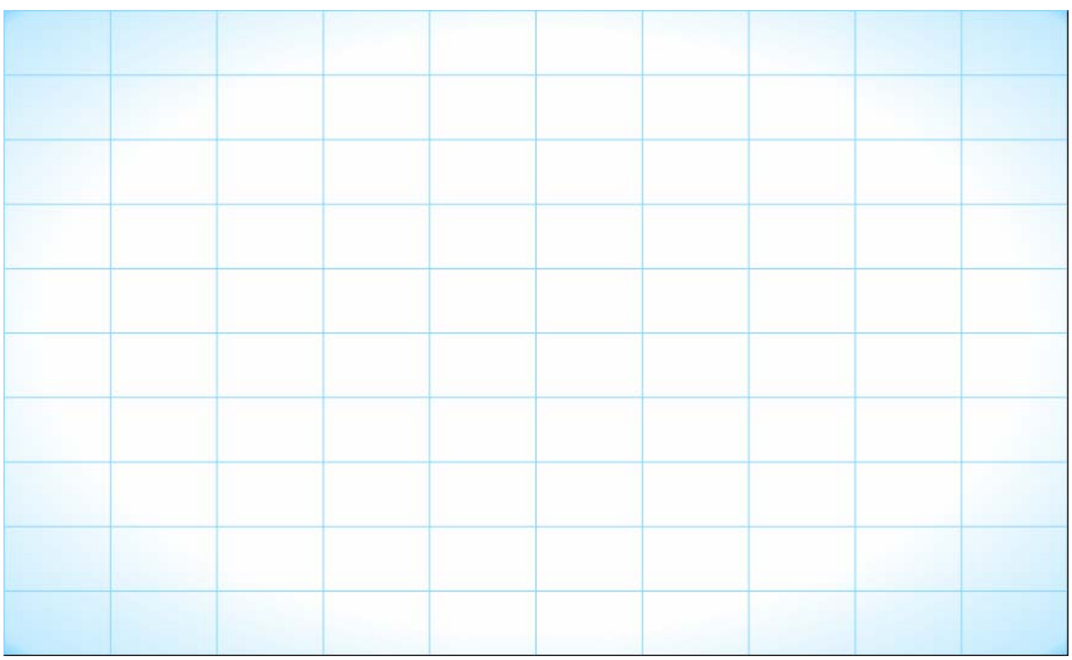
Days	Parts Per Million (PPM)
2	5.4
5	6
10	7

First, find the domain and the range and two data points. Then using the graph below estimate:

a. The PPM at “0” days (the initial amount of emissions being produced before the vehicle was placed in the test chamber

b. What was the PPM reading on day 7?

c. What day was the concentration 5.8 PPM?



Now find the exact reading.

a. Find “b”, or the PPM at “0” days (the initial amount of emissions being produced before the vehicle was placed in the test chamber

b. What was the PPM reading on day 7?

c. What day was the concentration 5.8 PPM?

Example 4: The voltage output of a MAP (Manifold Absolute Pressure) sensor increases as manifold pressure (vacuum/engine load) increases. Examine the scan tool data and create a linear model.

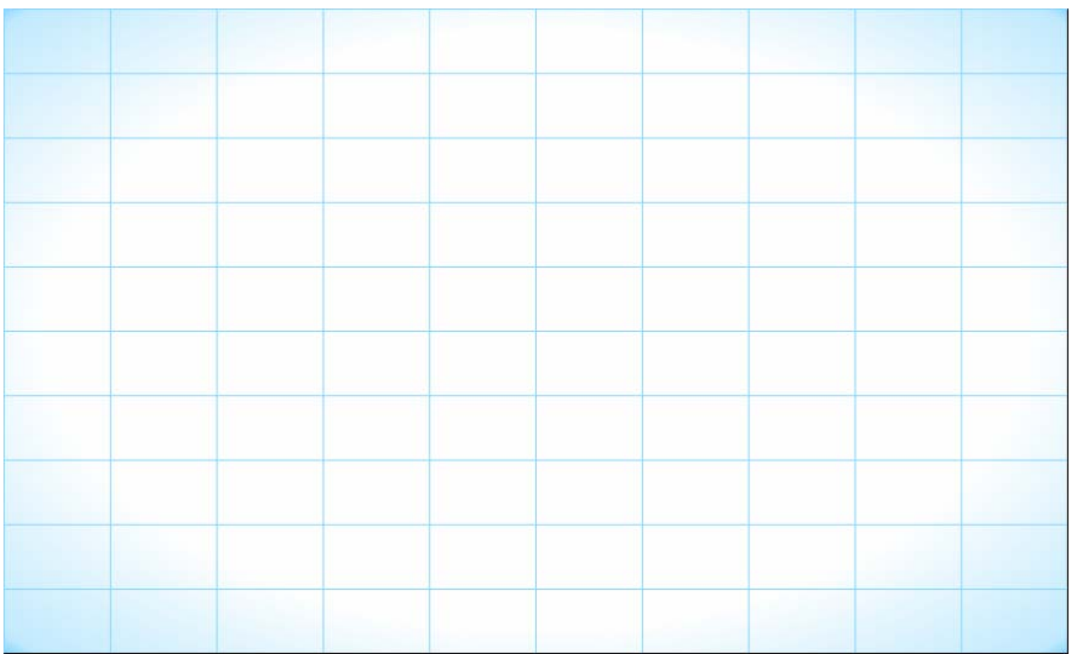
mmHg (millimeters of Vacuum)	Output Voltage
150	1.2
450	2.4

First, find the domain and the range and two data points and then:

a. Determine the slope (rate of change) and the initial value (voltage output at engine at idle)

b. Determine the output voltage at 750 mmHg

c. Determine the mmHg if the voltage is 4.8v



Example 5: Solve for y

$$y = 3x - 12 \qquad \text{find } y \text{ when } x = 10$$

Example 6: Solve for y

$$y = 3x - 12 \qquad \text{find } y \text{ when } x = 9$$

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Worksheet – Rate of Change

Name: ________________________________ AM-1: _____ PM _____ Date: __________

Please show all your work!

1. A TPS (Throttle Position Sensor) scan tool readings are given in steps. As the number of steps increases, the voltage *decreases*. The voltage at idle (throttle closed) is 14 volts and 6 volts at 3000 steps. First, find the domain and the range and two data points (round to 4-places) and then graph the changes on the graph below and determine the voltage output at:

a. 1000 steps

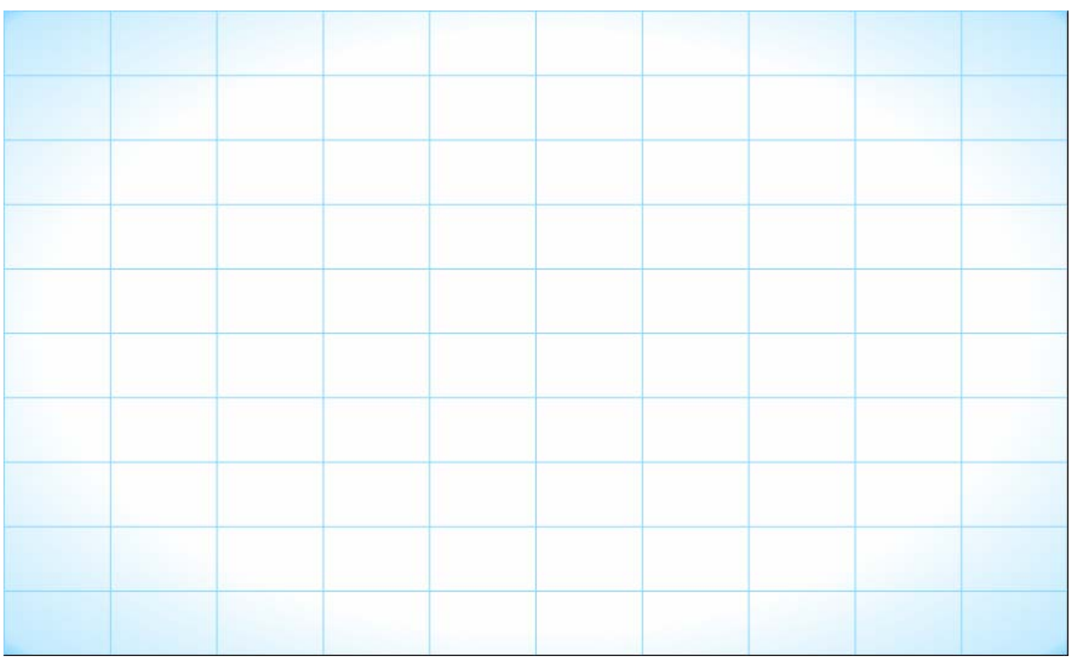
b. 1800 steps

c. 2600 steps

d. 4000 steps

e. 5000 steps (WOT — Wide Open Throttle)

Hint: Remember to use the standard formula $m = \dfrac{y2 - y1}{x2 - x1}$ to find the slope (*m*)



Worksheet – Rate of Change

Name: ______________________________ AM-1: _____ PM _____ Date: __________

2. Due to evaporation, the depth of water in a reservoir is decreasing at a rate of 0.25 inch per hour. How much does the water depth change in 6.5 hours, 12.5 hours?

3. You dive along the highway at a constant speed of 50 miles per hour. How far do you travel in 2.5 hours, in 5.7 hours, and in 4.5 hours if you if you already drove 75 miles?

4. A tree increases its diameter by 0.2 inch per year by adding rings. How much does the diameter of the tree increase in 4.5 years, in 20.5 years?

5. Solve for y

$$y = -2x + 6 \quad \text{if } x = 3.5$$

6. Solve for y

$$y = 22x + 658 \quad \text{if } x = 13.55$$

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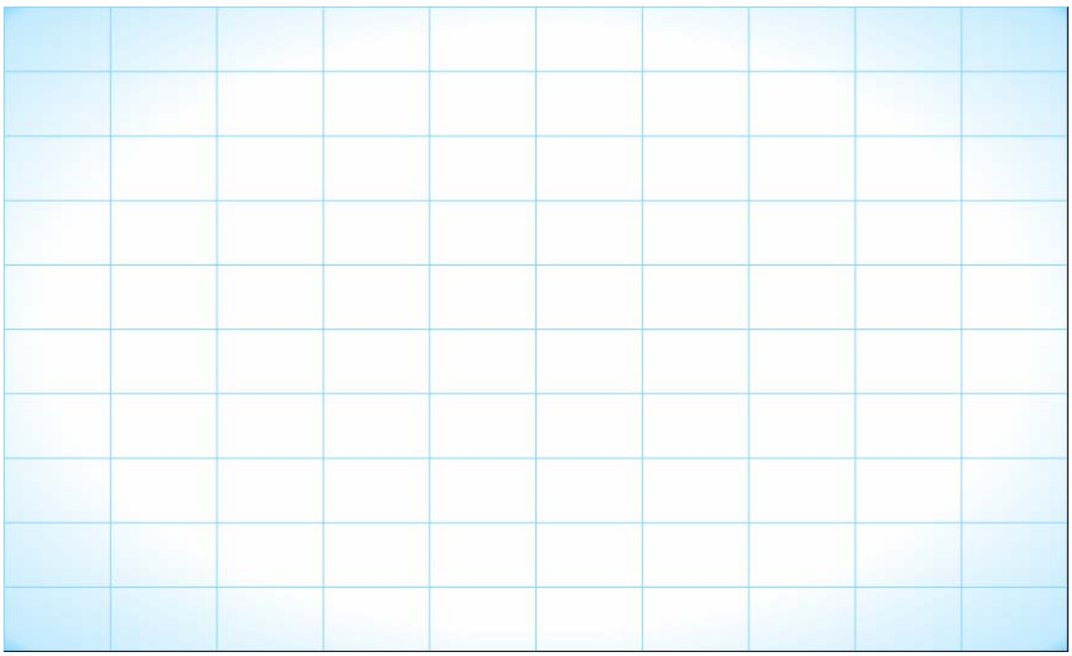
Homework – Rate of Change

Name: _________________________________ AM-1: _____ PM _____ Date: __________

1. The quick-lube bay has completed 25 LOF's (Lube-Oil change and Oil Filter Change) by Thursday. If they can do 4 - LOF's an hour from 8:00 a.m to 12:00 p.m. (noon) on Friday, how many LOF's will they have completed for the week? Hint: find the domain and the range and two data points and then graph the changes on the graph below.



2. Solve for y

$$y = 14x + 147 \quad \text{if } x = 19$$

3. Solve for y

$$y = -.25x + 80 \quad \text{if } x = 50$$

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Homework – Rate of Change

Extra Credit!!!!!!!!!!!!!

The temperature/pressure in an Air Conditioning System increases as the outside air (ambient) temperature increases. Using the provided data points (10, 40) and (60,80), determine:

a. range (either temperature or pressure)
b. domain (either temperature or pressure)
c. the slope (*m*)
d. the initial (static) pressure with the system off (y-intercept) and *b*
e. the temperature at 70 psi (*y*)
f. the pressure at 50°F (*x*)