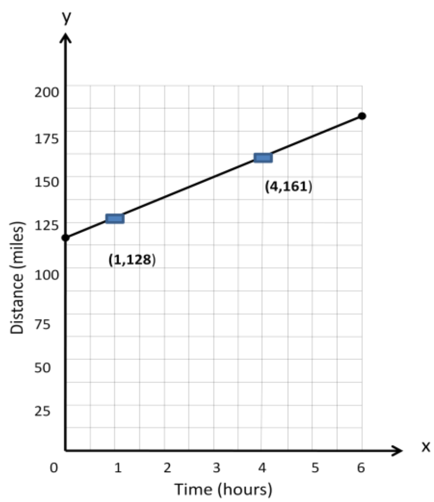
Name______________________________

Algebra 2
Lesson 2-4
Using Linear Models

We have all see the little *model* cars that children have, you probably even had several of your own. These *model* cars replicate real cars, there are even car kits that are advertized as exact scale models, that is they look just like the real thing only smaller. Well, in the math world we also have many models. Data collected from physical and natural phenomena can be quantified and placed into a mathematical model so to duplicate a process or predict an outcome of a future even.

In this section we will focus on linear models. These are models that use a linear function to describe the data. For example a car travelling at a constant speed which is the rate a.k.a. slope, if we plot time (x) and distance (y), based on the slope of the line we can predict the distance travelled in a given amount of time.

3. A person is riding a bicycle along a straight highway. The accompanying graph shows the rider's distance y in miles from an interstate highway after x hours.



a) How fast is the bicyclist traveling?

b) Find the slope-intercept form of the line.

c) How far was the bicyclist away from the interstate initially?

d) How far was the bicyclist from the highway after 1 hour and 15 minutes:

Look familiar? This is from lesson 2-2, it is a linear model of a cyclist's distance from a highway over time.

Modeling with a linear function takes on a basic form. To model a quantity that is changing at a constant rate in a linear function f, we use:

f(x)= (constant rate of change)x+(initial amount)

Look familiar? This is our slope-intercept form. The constant rate of change is the____________ and the initial amount is the ________________.

You can use the equation of slope, $m = \frac{y_2 - y_1}{x_2 - x_1}$ when you are given two data points.

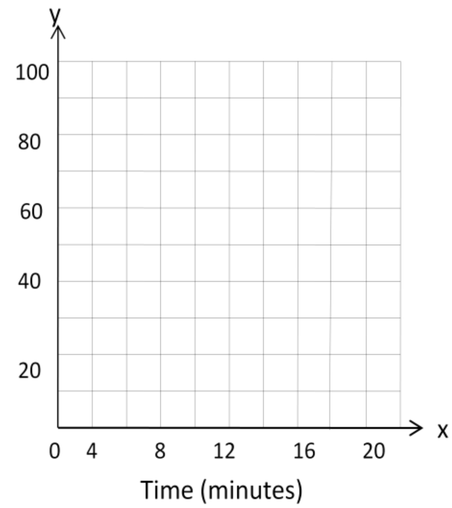
Example: After 1 hour burning a candle is 6 in. tall, 3 hours later it is 5 in. tall. Use (3,5) for (t_1,h_1) and (1,6) for (t_2,h_2)in the equation for slope. Plugging into the slope-intercept equation we can calculate the height of the candle for time, t.

Example: A 100-gallon tank is initially full of water and is being drained at a rate of 5 gallons per minute.
a) write a formula for a linear function f, that models the number of gallons of water in the tank after x minutes.
<u>follow the steps below by answering these questions and **draw a picture of what is happening**</u>:

Step 1: What is happening (driving, object falling, ice melting, babies born, water draining, etc.)? **Ans.:** water is draining out of a tank.
Step 2 What then is the constant rate of change? **Ans.:**____________

Step 3: What is the initial amount? (initial distance, temperature, bacteria count, gallons in the tank, etc.) **Ans.:** 100- gallons
Step 4: Build the equation: f(x)=-5x+100
Caution!! This one is tricky as the rate of change is *negative:* are we adding or taking away water? We are taking away/draining water therefore, the **rate of change for a decreasing amount is negative!**

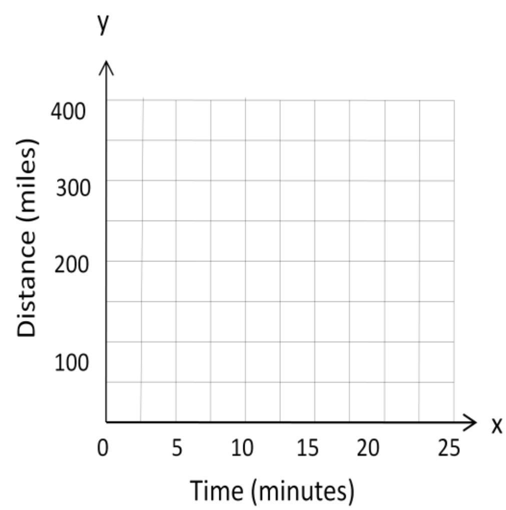
b) How much water is in the tank after 4 minutes?
Plug 4 minutes into the above equation and solve for f(x): f(x)=-5(4)+100=-20+100=80 gallons
c) Graph f. Identify the x- and y- intercepts



Not all data are linear. When plotted the data may appear to be close to linear, in which case a linear function may be used to approximate the data. Simply plot the data on the graph, this known as a **scatter plot**. Next, draw what appears to be a best fit line, that is, some points above the line, some below, and some points on the line. There are computer and calculator programs that will plot the data in a scatter plot and calculate the best fit line as well. Remember the more linear the data the more accurate your linear model approximation will be.

Example: The table shows the distance traveled in miles by car using x gallons of gasoline.
a) Make a scatter plot of the data. Can a linear function be used to model this data?
b) Find values for a and b so that f(x)-ax+b models the distance traveled on x gallons and graph the plot of that line.
c) Interpret the slope of the graph f(x).

x (gallons)	**5**	**10**	**15**	**20**
y (miles)	**84**	**169**	**255**	**338**



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Algebra 2
Problem Set 2-4
Using Linear Models

1. Do the data tables model the function f exactly or approximately?

a) f(x)=5x-2

x	1	2	3	4
y	3	8	13	18

b) f(x)=3.7-1.5x

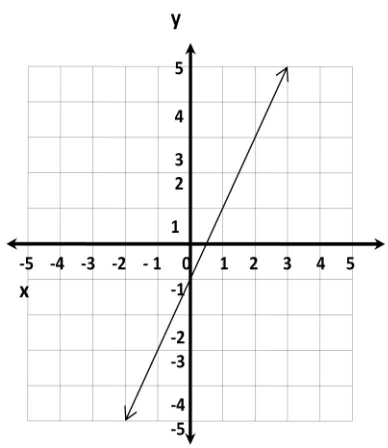
x	-6	0	6	12
y	12.7	3.7	-5.4	-14.2

*3. In 1998 there were 47 million people worldwide who had been infected with HIV. At that time the infection rate was 5.8 million people per year.

a) Write a formula for a linear function f(x) that models the total number of people in millions who were infected with HIV x years after 1998.

b) estimate the number of people who may be infected by 2010 using this mode.

2. Identify x- and y-intercepts, slope and write the formula for f(x).

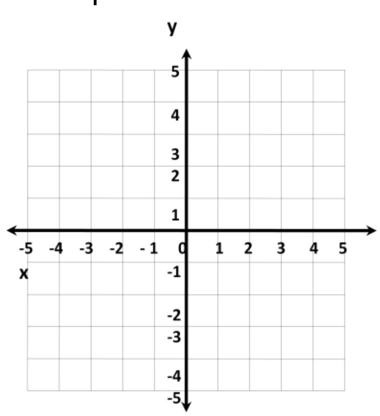


*5. In 1990 the number of births per 1000 people in the United States was 16.7 and decreasing at 0.26 birth per 1000 each year.

a) Write a formula for a linear function f that models the birth rate x years after 1990.

b) Estimate the birth rate in 2002 and compare it to the actual value of 13.9.

3 Graph f(x)=3x+2, identify the slope and y-intercept.



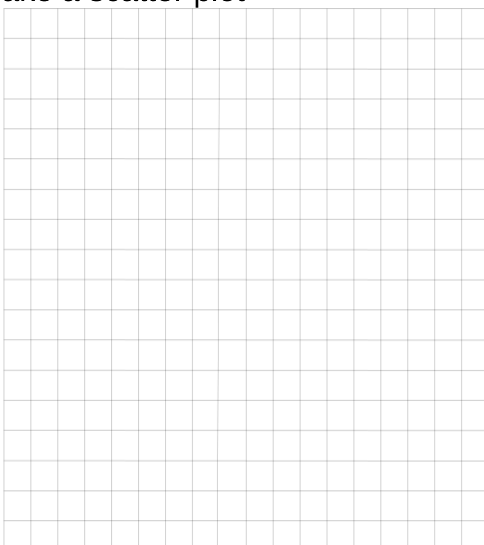
6. At a restaurant, Elena wants to leave a tip of 15% of the bill plus $1. Write a linear model that bests describes the total T.

*7. The following table lists the average number y of people per household for various years.

x	1940	1950	1960	1970
y	3.67	3.37	3.33	3.14

x	1980	1990	2000
y	2.76	2.63	2.62

a) Make a scatter plot



a) Can the data be approximated by a linear function? Draw a line to approximate the function f.

b) What is the slope of the line drawn?

c) Estimate the number of people per household in 1975 and compare it to the actual value of 2.94

8. A linear model for each situation passes through the origin. Find each missing value. Round your answer to the nearest tenth.

a) $7.60 to buy 4 lbs. apples. $16.15 to buy ____ lbs. apples.

b) 38.8 minutes to jog 4 miles. _______minutes to jog 9.5 miles.

c)1 gal. paint for 634 ft^2. ______gal paint for 5452 ft^2.

9. For each situation, find a linear model and use it to make a prediction.

a) A 3 mile cab ride costs $8.76 and an 8 mile cab ride costs $18.36. How much will a 6 mile cab ride cost?

b) A caterpillar eats 3 in.^{2} of leaves in 17 minutes and eats 83 in. ^{2} of leaves in 154 minutes. How many square inches of leaves will the caterpillar eat in 2 hours?

c) At time zero a snowflake is 850 feet altitude. The flake is at 8 feet altitude