Warm Up (10/3/17)

A potter is making cups and plates. It takes her 6 minutes to make a cup and 3 minutes to make a plate. Each cup uses ¾ lbs. of clay, and each plate uses 1 lb. of clay. She has 20 hours available to make the cups and plates and has 250 lbs. of clay.

a. What are the variables?

Cups and plates

So, c = # of cups

p = # of plates

$6\text{ min} \cdot \frac{1\text{ hour}}{60\text{ min}} = \frac{6}{60}\text{ hours}$

$= \frac{1}{10}\text{ hours}$

b. Write inequalities for the constraints.

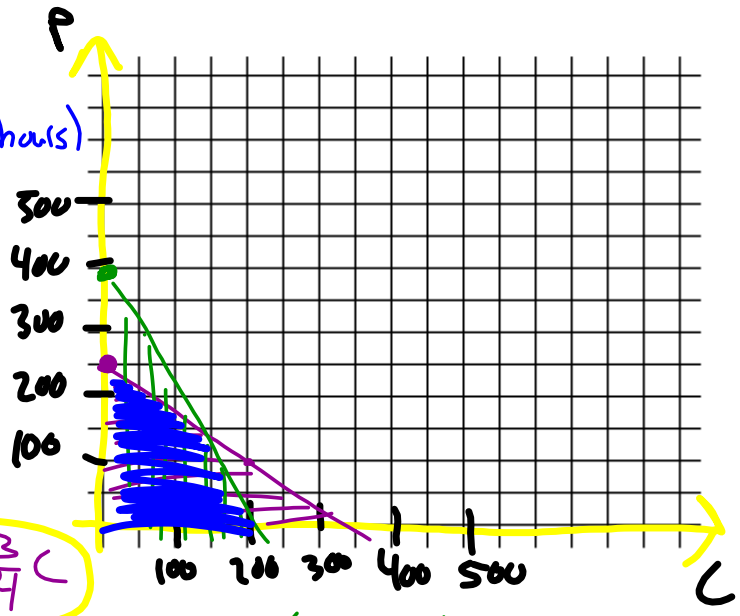
Constraints are time and materials

$\frac{3}{4}c + p \leq 250$

$\frac{1}{10}c + \frac{1}{20}p \leq 20$

(Converted from min. to hours)

c. Graph and shade the solution set.



Solve for P

$\frac{3}{4}c + p \leq 250$

$-\frac{3}{4}c \qquad -\frac{3}{4}c$

$p \leq 250 - \frac{3}{4}c$

$\frac{1}{10}c + \frac{1}{20}p \leq 20$

$-\frac{1}{10}c \qquad -\frac{1}{10}c$

$\frac{1}{20}p \leq 20 - \frac{1}{10}c$

$20\left(\frac{1}{20}p\right) \leq \left(20 - \frac{1}{10}c\right)20$

$p \leq 400 - 2c$

Module 2: Lesson 12 and Lesson 13

Relationships Between Two Numerical Variables

Lesson Summary

- A scatter plot can be used to investigate whether or not there is a relationship between two numerical variables.
- A relationship between two numerical variables can be described as a linear or nonlinear relationship.

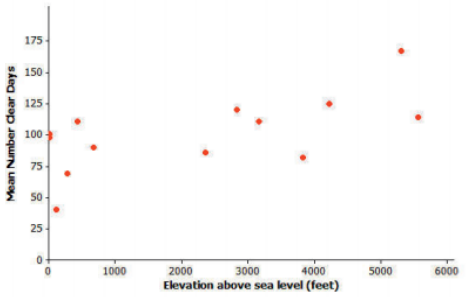
- A scatter plot can be used to investigate whether or not there is a relationship between two numerical variables.

- Linear, quadratic, and exponential functions are common models that can be used to describe the relationship between variables.
- Models can be used to answer questions about how two variables are related.

The table below shows data for 14 U.S. cities.

City	x (Elevation Above Sea Level in Feet)	y (Mean Number of Clear Days per Year)	w (Mean Number of Partly Cloudy Days per Year)	z (Mean Number of Cloudy Days per Year)
Albany, NY	275	69	111	185
Albuquerque, NM	5,311	167	111	87
Anchorage, AK	114	40	60	265
Boise, ID	2,838	120	90	155
Boston, MA	15	98	103	164
Helena, MT	3,828	82	104	179
Lander, WY	5,557	114	122	129
Milwaukee, WI	672	90	100	175
New Orleans, LA	4	101	118	146
Raleigh, NC	434	111	106	149
Rapid City, SD	3,162	111	115	139
Salt Lake City, UT	4,221	125	101	139
Spokane, WA	2,356	86	88	191
Tampa, FL	19	101	143	121

Here is a scatter plot of the data on elevation and mean number of clear days.



Data Source: www.ncdc.noaa.gov

Exercises 1–3

1. Do you see a pattern in the scatter plot, or does it look like the data points are scattered?

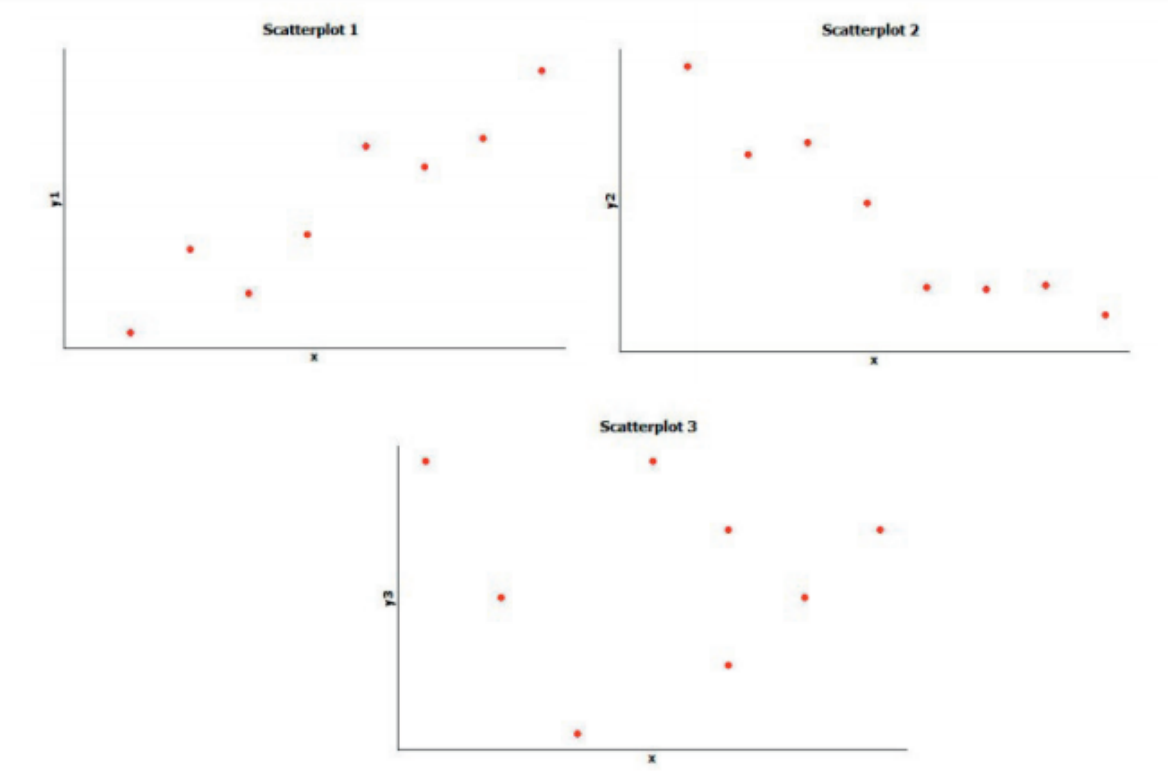
Although the points looked scattered at first glance, when we look closer there appears to be some kind of relationship that would suggest as elevation increases so do the number of clear days for that city.

2. How would you describe the relationship between elevation and mean number of clear days for these 14 cities? That is, does the mean number of clear days tend to increase as elevation increases, or does the mean number of clear days tend to decrease as elevation increases?

As the elevation of the city increases there is also an increase of the average number of clear days in that city as well.

3. Do you think that a straight line would be a good way to describe the relationship between the mean number of clear days and elevation? Why do you think this?

A straight line would be a good, general way to describe the pattern of the scatter plot, even though it may not look like it's a strong correlation.



4. If one of these scatter plots represents the relationship between height and weight for eight adults, which scatter plot do you think it is and why?

Scatter plot 1 because it would make sense that as a person's height increases so does their weight (generally speaking).

5. If one of these scatter plots represents the relationship between height and SAT math score for eight high school seniors, which scatter plot do you think it is and why?

Scatter plot 2 because height and intelligence are not related at all.

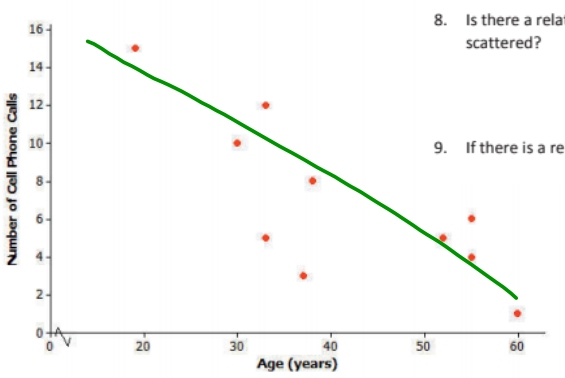
6. If one of these scatter plots represents the relationship between the weight of a car and fuel efficiency for eight cars, which scatter plot do you think it is and why?

Scatter plot 2 because as the weight of a car increases the fuel efficiency decreases.

7. Which of these three scatter plots does *not* appear to represent a linear relationship? Explain the reasoning behind your choice.

Scatter plot 2 because all the points appear to be too scattered and random to form any line shape.

Scatter Plot 1



8. Is there a relationship between the number of cell phone calls and age, or does it look like the data points are scattered?

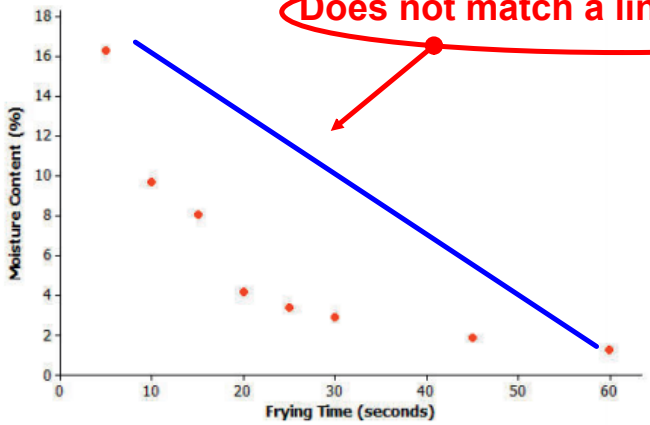
Yes, there is a relationship

9. If there is a relationship between the number of cell phone calls and age, does the relationship appear to be linear?

Yes

Scatter Plot 2

Does not match a linear relationship



Data Source: R.G. Moreira, J. Palau, V.E. Sweat, and X. Sun, "Thermal and Physical Properties of Tortilla Chips as a Function of Frying Time," *Journal of Food Processing and Preservation*, 19 (1995): 175.

10. Is there a relationship between moisture content and frying time, or do the data points look scattered?

Yes, there appears to be a relationship.

11. If there is a relationship between moisture content and frying time, does the relationship look linear?

It appears as the frying time increases, the moisture content decreases. However, the relationship does not look linear.

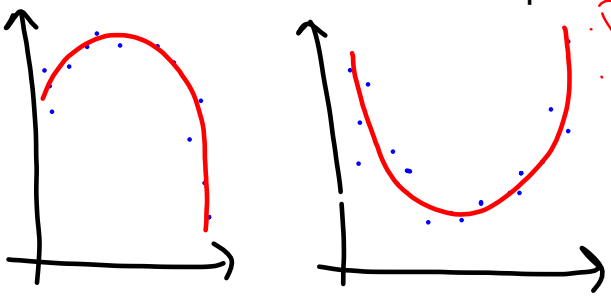
Types of Relationships between Data Points

Relationships between data points don't always have to be linear. They can have no relationship (we call this "No Correlation"), a quadratic relationship, or an exponential relationship.

No Relationship

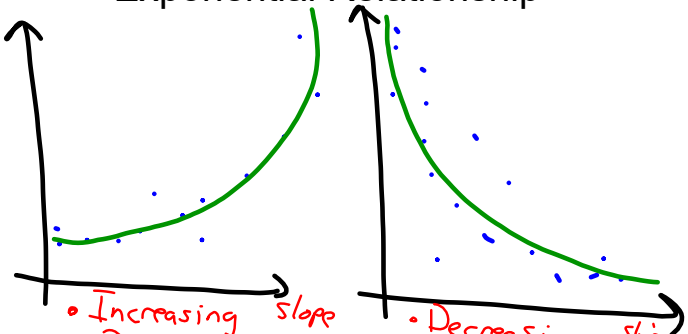
- No correlation
- No Distinct Pattern
- Data points are completly Random

Quadratic Relationship



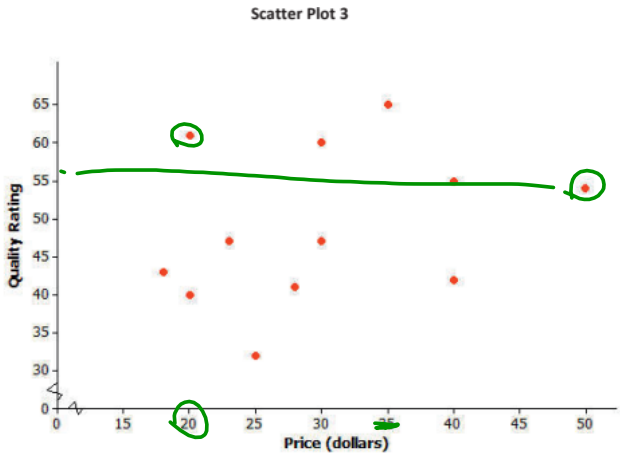
- Parabolas
- "U" shape

Exponential Relationship



- Increasing slope
- Positive correlation
- Decreasing slope
- Negative correlation

- Exponentials have the highest increase/decrease rate



Data Source: www.consumerreports.org/health

12. Scatter Plot 3 shows data for the prices of bike helmets and the quality ratings of the helmets (based on a scale that estimates helmet quality). Is there a relationship between quality rating and price, or are the data points scattered?

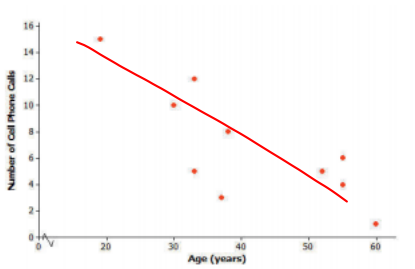
No relationship between price and quality

13. If there is a relationship between quality rating and price for bike helmets, does the relationship appear to be linear?

Again, since there's no correlation there is no need to define the relationship as linear or non-linear.

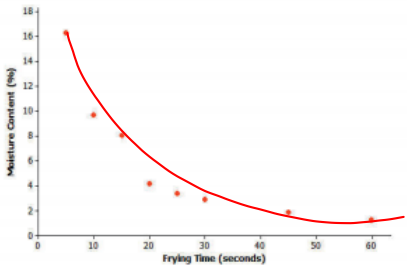
Classify each one of the previous examples as linear, quadratic, exponential, or no correlation.

Scatter Plot 1



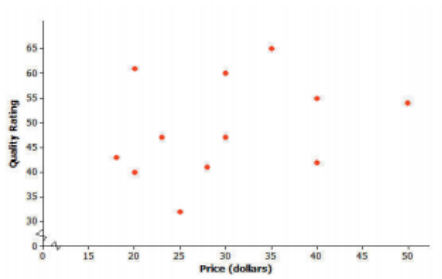
• Linear

Scatter Plot 2



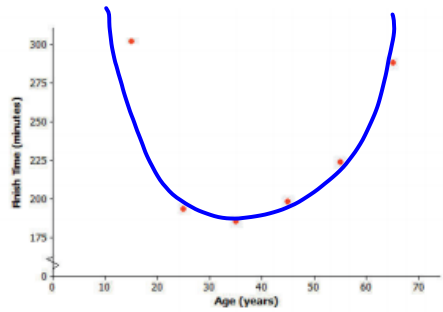
• Exponential

Scatter Plot 3



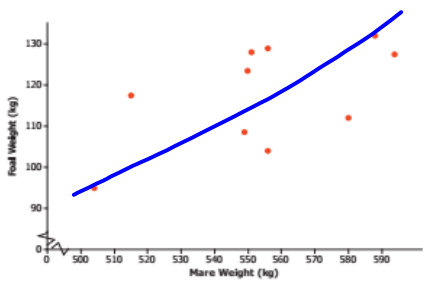
• No Correlation

Scatter Plot 4



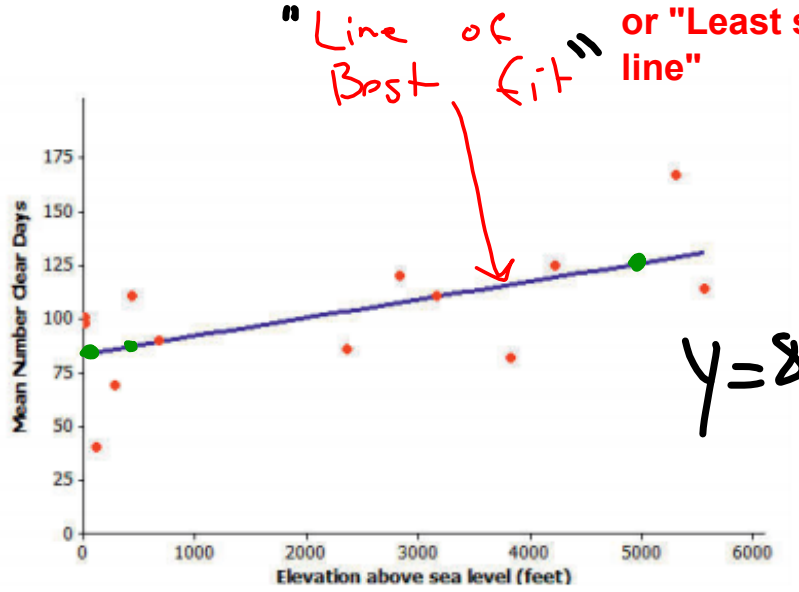
Quadratic

Scatter Plot 5



Linear

Examining a Linear Model



3. Assuming that the 14 cities used in this scatter plot are representative of cities across the United States, should you see more clear days per year in Los Angeles, which is near sea level, or in Denver, which is known as the mile-high city? Justify your choice with a line showing the relationship between elevation and mean number of clear days.

We expect Denver to have more clear days per year than L.A.

4. One of the cities in the data set was Albany, New York, which has an elevation of 275 ft. If you did not know the mean number of clear days for Albany, what would you predict this number to be based on the line that describes the relationship between elevation and mean number of clear days?

Albany has 85 clear days

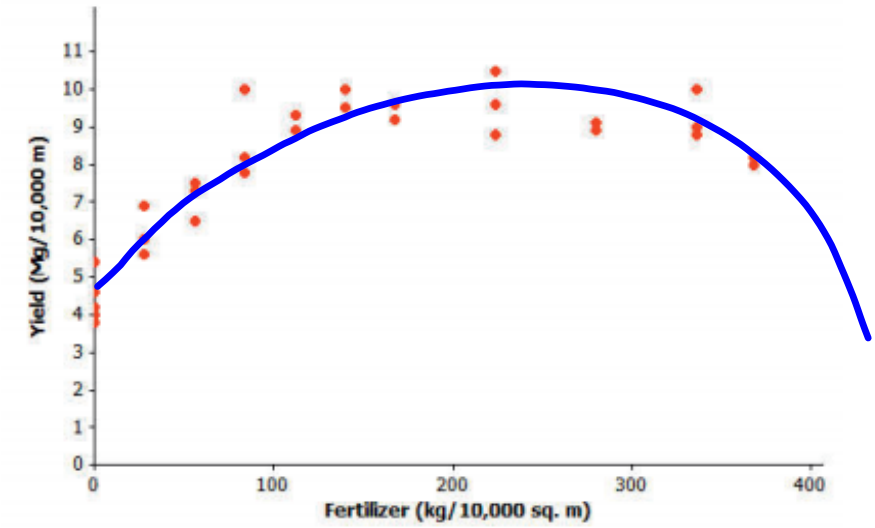
5. Another city in the data set was Albuquerque, New Mexico. Albuquerque has an elevation of 5,311 ft. If you did not know the mean number of clear days for Albuquerque, what would you predict this number to be based on the line that describes the relationship between elevation and mean number of clear days?

ABQ should 126 clear days

6. Was the prediction of the mean number of clear days based on the line closer to the actual value for Albany with 69 clear days or for Albuquerque with 167 clear days? How could you tell this from looking at the scatter plot with the line shown above?

No, there were less clear days than predicted for Albany and more clear days than predicted for Albuquerque.

Examining a Quadratic Model



7. The researchers who conducted this study decided to use a quadratic curve to describe the relationship between yield and amount of fertilizer. Explain why they made this choice.

The data points look like they follow the trend of a quadratic relationship

8. The model that the researchers used to describe the relationship was $y = 4.7 + 0.05x - 0.0001x^2$, where x represents the amount of fertilizer (kg per 10,000 sq. m) and y represents corn yield (Mg per 10,000 sq. m). Use this quadratic model to complete the following table. Then sketch the graph of this quadratic equation on the scatter plot.

$y = 4.7 + 0.05(0) - 0.0001(0)^2$
$= 4.7 + 0 - 0$
$= 4.7$

$y = 4.7 + 0.05(100) - 0.0001(100)^2$
$= 4.7 + 5 - 1$
$= 4.7 + 4$
$= 8.7$

x	y
0	4.7
100	8.7
200	10.7
300	10.7
400	8.7

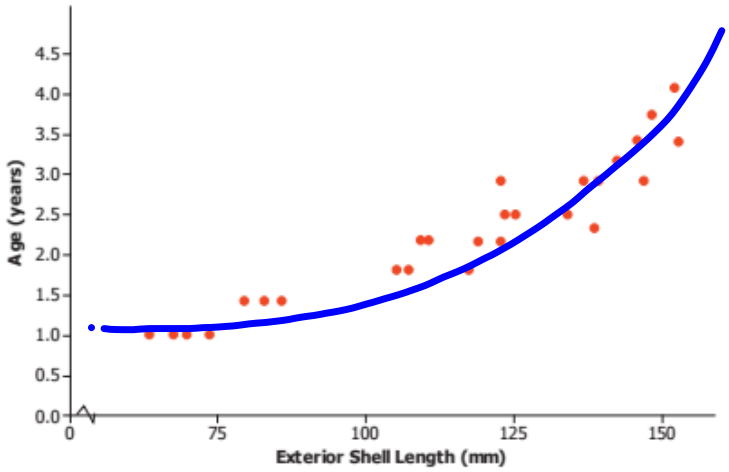
Repeat for the last 3 values

9. Based on this quadratic model, how much fertilizer per 10,000 sq. m would you recommend that a farmer use on his cornfields in order to maximize crop yield? Justify your choice.

250 kg/ 10,000 sq. m

(From looking at the graphing calculator)

Examining an Exponential Model



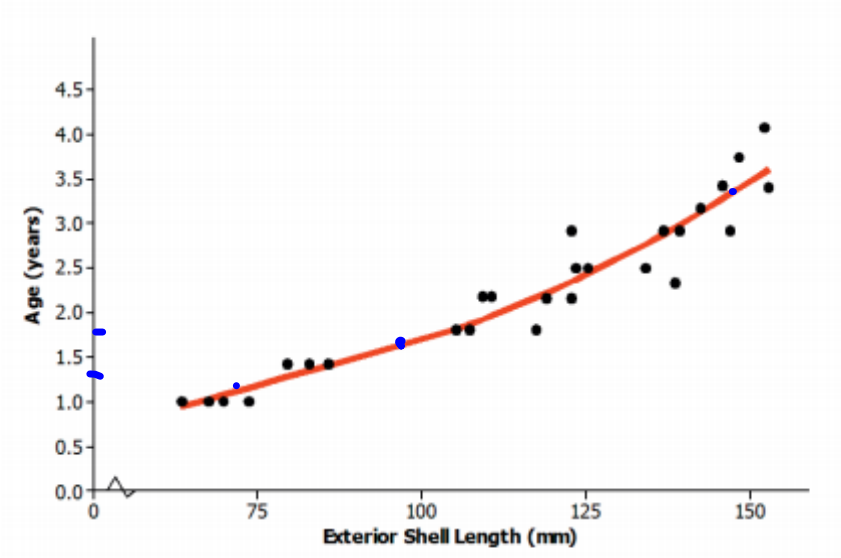
Data Source: Kerry E. Maxwell, Thomas R. Matthews, Matt R.J. Sheehy, Rodney D. Bertelsen, and Charles D. Derby, "Neurolipofuscin is a Measure of Age in *Panulirus argus*, the Caribbean Spiny Lobster, in Florida" *Biological Bulletin,* 213 (2007): 55.

10. The researchers who conducted this study decided to use an exponential curve to describe the relationship between age and exterior shell length. Explain why they made this choice.

The data looks like it follows an Exponential curve

Examining an Exponential Model

11. The model that the researchers used to describe the relationship is $y = 10^{-0.403 + 0.0063x}$, where x represents the exterior shell length (mm), and y represents the age of the lobster (in years). The exponential curve is shown on the scatter plot below. Does this model provide a good description of the relationship between age and exterior shell length? Explain why or why not.



12. Based on this exponential model, what age is a lobster with an exterior shell length of 100 mm?

About 1.75 years ← the graph

Calculator → 1.68 years old

13. Suppose that trapping regulations require that any lobster with an exterior shell length less than 75 mm or more than 150 mm must be released. Based on the exponential model, what are the ages of lobsters with exterior shell lengths less than 75 mm? What are the ages of lobsters with exterior shell lengths greater than 150 mm? Explain how you arrived at your answer.

75mm: 1.17 y/o

150 mm: 3.48 y/o