Name: _____

Absolute Dating

Absolute dating is different than relative dating. With **absolute dating** we are looking for actual ages of rocks and fossils. We are no longer just comparing which rock is older than another rock like we do when using relative dating. To be able to absolute date, we need to understand that over time atoms decay by losing a neutron and gaining a proton. This causes an element to lose mass. We call this **radioactive decay** and the element is considered unstable. When radioactive decay happens new elements are actually formed over time; usually a long time. For example, Uranium 238 (unstable) decays and ends up as lead-206 (stable). After it turns into lead-206 it quits decaying. **We would call the Uranium 238 the parent and we would call the lead-206 the daughter.**

We are going to explore radioactive decay in the following activity. First, create a document on which you will collect and analyze data.

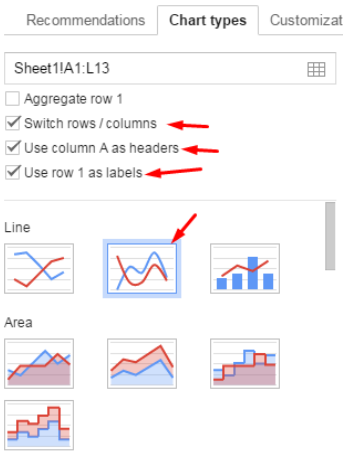
- In your groups create a Google Spreadsheet. Share it with your group partners and your teacher. Give it a title and make sure the names of each person in your group are on it.
- Create the following table:

	A	B	C	D	E	F	G	H	I	J	K	L
1		Start	Decay 1	Decay 2	Decay 3	Decay 4	Decay 5	Decay 6	Decay 7	Decay 8	Decay 9	Decay 10
2	Group's Decay	100										
3	Class Avg. Decay	100										
4	Theoretical Decay	100										

We are going to explore radioactive decay using candy. The candy you have has two sides, a letter side and a blank side. The candies represent carbon-14.

- Make sure you count the candy in your cup. You need exactly 100. Do NOT eat any unless you have more than 100.
- Make sure each candy has a letter side.
- Place a clean sheet of printing paper on your table.
- Shake the cup and pour out the candies onto the paper.
- You are going to eat or move to the side any candy that has the blank side facing up. These candies represent decayed carbon-14 atoms.
- Record how many candies you have left onto your spreadsheet and place the value into Decay 1.
- Place all candies left, back into the cup and repeat the process until you no longer have any candy left or until you reach Decay 10.
- Once you are done with your group's decay, answer the following question.

1. **How would you calculate the "Theoretical Decay?" (Think of your odds while flipping a two headed coin.)**



- Once your group has an answer to number 1, write in the theoretical values of carbon-14 decay in your spreadsheet.
- Please report to your teacher your group's decay numbers so that the class average decay can be calculated.
- Once we have class averages, add them to your spreadsheet.
- Once you have all rows filled out, create a line chart that would visually demonstrate the data you gathered. To the right you can see an example of an appropriate line chart.
- Add a title to your chart.

2. **Compare and contrast your group's values to the averages of the class and the theoretical value.**

3. **What does this data demonstrate about radioactive decay?**

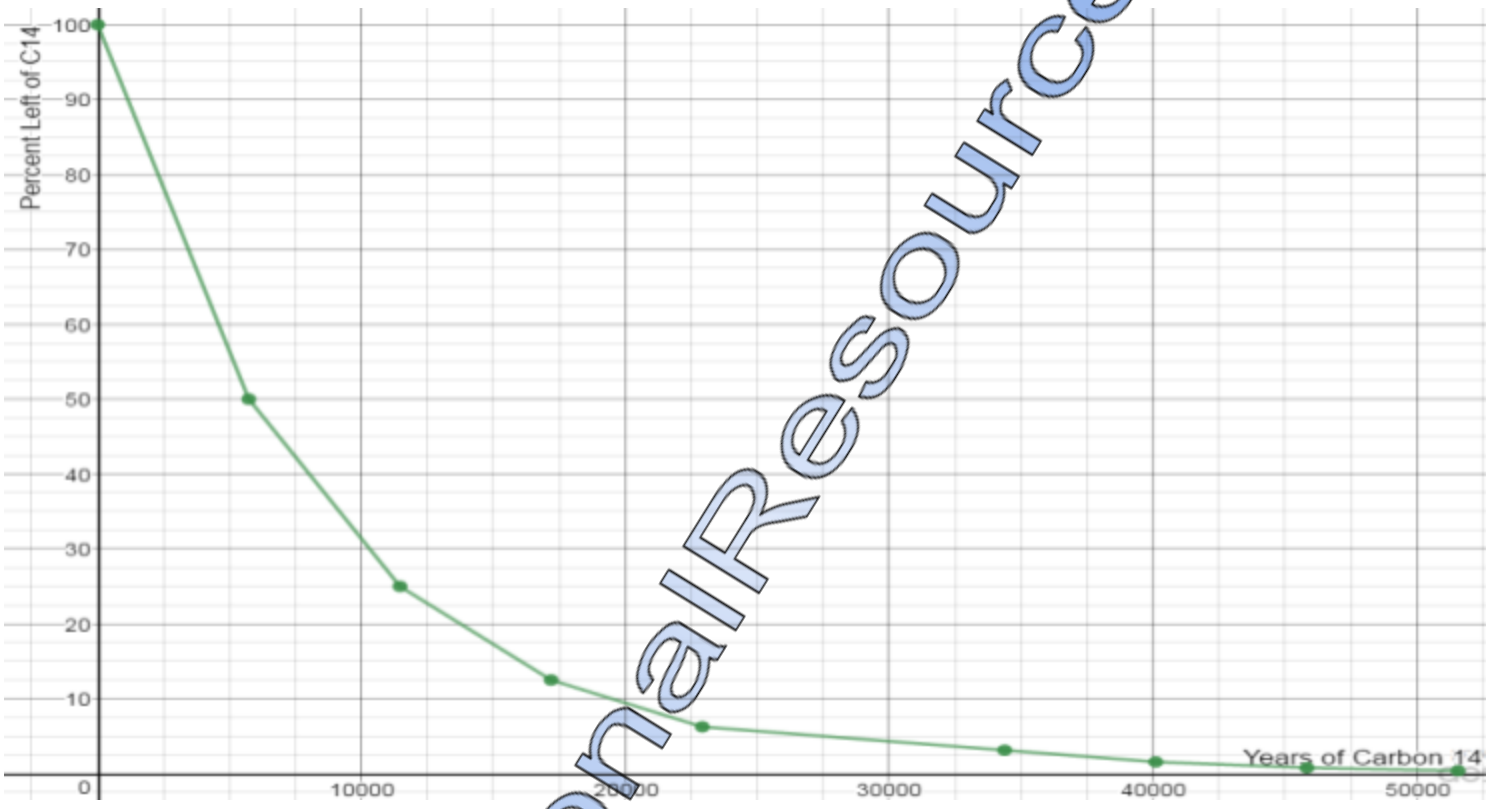
Each of the "Decay" numbers from your activity represent what is called half-life. **Half-life** is the time it takes for half of the atoms of a sample to decay. If scientists can figure out the half-lives of radioactive isotopes they can use that information to absolutely

date rocks and fossils. Carbon 14 takes 5730 years for each half-life to occur. So basically we are saying that if we have a sample of carbon that weighs 12 grams and 12 grams of carbon which has 6.03 X 10^{23} atoms in it, it will take about 5730 years for this sample of carbon to lose half of its atoms. Every 5730 years it will lose half of the remaining atoms.

4. **Complete the following chart.**

Decay of Carbon-14

Percent of C14 Remaining	100	50	25	12.5	6.25	3.125	1.56	.78	.39
Years ago	0	5730							



Using the graph above answer the following questions.

5. **How old would a coprolite, fossilized poop, be that was found in a cave in Oregon if it contained about 22% of its original C-14?**

6. **In 2011, a young girl found a strange rock that ended up being the molar of a mammoth. After being carbon dated, they found that it only contained 1 percent of its carbon 14. How old was the woolly mammoth tooth?**

7. **Scientists in Greenland pulled an ice core out of a glacier. At the bottom of the glacier they found some plant matter that contained about 30% of its carbon 14. How old was the bottom of the glacier?**

8. **According to the chart, do scientists need to wait until a half-life is completed in order to use absolute dating? Explain.**

9. **Why can't scientists use C14 as a means of dating bones older than 60,000?**

Because scientists can't use C14 to absolute date rocks and organisms that are millions of years old, they actually use other radioactive isotopes. A widely used absolute dating technique is to use potassium-argon. Potassium-40 has a half-life of 1.3 billion years. We can even use Uranium-238 which has a half life of 4.5 billion years. Scientists used the Uranium-238 method to date the oldest rock found in Canada which is 3.96 billion years old.

Teacher Instructions, Notes and Reflection

1. The purpose of this lab is to demonstrate how radioactive decay works and how to use it to calculate half-life.
2. You will need 100 candies with two sides like MMs and Skittles. I use both and mix them. It is important to have one side with writing like the "M" for MMs and "S" for Skittles.
3. Students will create a spreadsheet from which they can create a visual representation of their data. This is good because they will be able to compare how their group did compared to the class and to the theoretical value.
    a. I teach spreadsheets quite often. My students should already know how to create simple calculations in a spreadsheet so I didn't leave instructions for them to create a formula in hopes that I would see students using a formula to find the theoretical value without having to use a calculator. I was a little disappointed that nobody thought of creating a formula. After they were done creating a graph we discuss the formula and made sure they understood the importance of it.
    b. The formula to use is "=b4/2" They could then use the copy tool 

and drag this across their spreadsheet and find the theoretical value very quickly for each half-life.
4. Most students didn't know what I meant by "theoretical value." I used the example of tossing 100 coins in the air, in theory how many of them would land on heads. It is a great opportunity to reinforce the idea of probabilities which are theoretical.
5. If the lab is done right, once their group is finished with their candies they should be able to use a graph and notice that the class and groups numbers are probably no the exact same as the theoretical value. The direction of the line graph however with follow the direction of the theoretical value.

Absolute Dating Answer Sheet

1. **How would you calculate the "Theoretical Decay?" (Think of your odds while flipping a two headed coin.)**
    a. **Theoretical decay is in this situation is calculated by cutting in half each number. 100, 50, 25, 12.5 etc...**
    b. **Before I have my theoretical decay value discussion I have them discuss and try to come up with what this means.**
2. **Compare and contrast your group's values to the averages of the class and the theoretical value.**
    a. **They should notice that their trend lines follow the theoretical value. If there are any discrepancies they should mention these and possible reasons as to why.**

3. **What does this data demonstrate about radioactive decay?**
    a. **Each toss of the candies loses about half of the original amount.**
4. **Complete the following chart.**
    a. **This was tricky for some of my students to fill out. Some tried to cut the "years ago" in half. They should realize that they are doing the opposite for each half life that they did before. Now students should be multiplying 5730 by however many half lives they are on because every 5730 years is equal to 1 half life.**

Decay of Carbon-14

Percent of C14 Remaining	100	50	25	12.5	6.25	3.125	1.56	.78	.39
Years ago	0	5730 x 1	5730 x 2 11460	5730 x 3 17190	5730 x 4 22920	5730 x 5 28650	5730 x 6 34380	5730 x 7 40110	5730 x 8 45840

5. **How old would a coprolite, fossilized poop, be that was found in a cave in Oregon if it contained about 22% of its original C-14?**
    a. **12,500 to 16,000 years old**
    b. **This is a real scenario, click link to read about it.**

    In 2011, a young girl found a strange rock that ended up being the molar of a mammoth. After being carbon dated, they found that it only contained 5 percent of its carbon 14. How old was the woolly mammoth tooth?
    c. **30,000 years old**
    b. **This question is based on a real situation. Click link to learn more.**

6. **Scientists in Greenland pulled an ice core out of a glacier. At the bottom of the glacier they found some plant matter that contained about 30% of its carbon 14. How old was the bottom of the glacier?**
    a. **About 10,500 years old**

7. **According to the chart, do scientists need to wait until a half-life is completed in order to use absolute dating? Explain.**
    a. **No. As long as they know what percent of the radioactive isotope remains, they can date the object.**

8. **Why can't scientists use C14 as a means of dating bones older than 60,000?**
    a. **By the time 8 half live have already occurred, there is less than one percent of the radioactive isotope remaining.**