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 emitting radiation which results in loss of 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 the Decay 1 column.
- Place all remaining candies, back into the cup and repeat the process until you no longer have any candy left or until you reach the Decay 10 column.
- 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.) In theory how many candies would show a letter each time?**

- 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.**

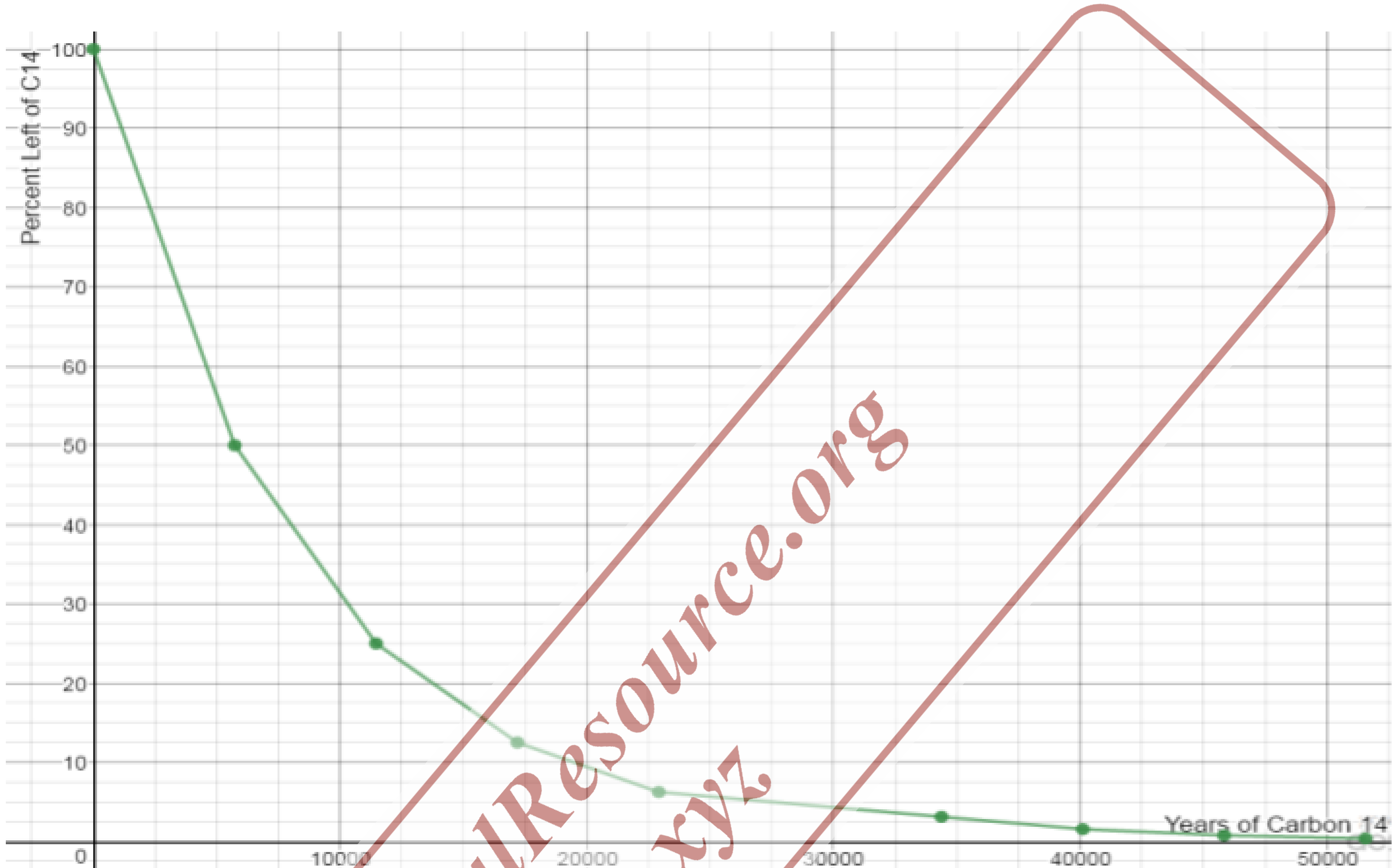
3. **What does this data demonstrate about radioactive decay?**

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 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 the 12 grams has 6.03×10^{23} carbon 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 carbon 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**
Age in Years	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 atoms. 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?**

Final thought: 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.
    a. Important note: Make sure your students verify that each candy has a letter and a blank side. I have had cases where students had candies that were blank on both sides, skewing their data.
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.
6. You can use my website, http://EarthScience.xyz/AbsoluteDating to show visuals and a video about absolute dating.

Absolute Dating Answer Sheet

1. How would you calculate the "Theoretical Decay?" (Think of your odds while flipping a two headed coin.)
    a.
    b.
2. Compare and contrast your group's values to the averages of the class and the theoretical value.
    a.
3. What does this data demonstrate about radioactive decay?
    a.
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
Age in Years	0								

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.
    b. [This is a real scenario, click link to read about it.]
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 5 percent of its carbon 14. How old was the woolly mammoth tooth?
    a.
    b. [This question is based on a real situation. Click link to learn more.]
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?
    a.
8. According to the chart, do scientists need to wait until a half-life is completed in order to use absolute dating? Explain.
    a.
9. Why can't scientists use C14 as a means of dating bones older than 60,000?
    a.