Unit 5 **(Get a) Half Life** Name ______________________

Date ____________ Per. ______

The theory of how half life break-down works is very mathematical. But it can also be modeled for us to see with simple materials.

As you do this lab, try to ask yourself, “How is what I’m doing like the decay of a radioactive nuclide?”

Part I: What is radioactive decay?

Materials:

Tap Water & Colored Water	Calculator
500 mL Beakers	100 mL Graduated Cylinder
Tape or labels to mark the beakers	Graph Paper

CAUTION: Please work neatly. Do not spill water. If you do, clean it up or tell the teacher.

Water spills onto the floor or near electrical outlets can be a serious hazard.

Procedure :

1. Obtain two large beakers for your lab group from your teacher. One will contain colored water, and the second just a little dry powder.
2. Label the beaker of water, “Radionuclide.” (Use neat, big letters.) Label the beaker with the dry powder, “Decay Product.”
3. Ask your teacher for the half life of your nuclide. Record it here: ________________
4. Record the water volumes in your two beakers in the table below. (500 mL and 0 mL. Don’t forget the units!)
5. Pour out exactly half of the colored water into your “Decay Product” beaker. What you just did represents one half life of your radionuclide.
6. Record the new volumes of your two beakers below .
7. Repeat this disintegration (Steps 5 & 6) 5 more times and record your data

Number of Half Lives that have passed	Volume of Original Radionuclide Water	Volume of Decay Product Water
0	400 mL	0 mL
1		

8, Graph your data. Choose appropriate intervals for the vertical and horizontal axes and be sure you label the appropriate units of measure.

Discussion: A. How is this procedure like real radioactive decay?

____

B. How is this procedure *unlike* real radioactive decay? (Give more than one answer if you can.)

____

Part II: What happens if you use a radionuclide with too long a half life?

Scientists use a number of different radionuclides to determine the ages of different rocks and fossils. (Rubidium-87, Uranium-238, Carbon-14, etc.) How can they decide which radionuclide is the best for each job?

Procedure:

1. Obtain a second beaker of the same colored water.
2. Describe its color exactly, so if it change you will know. _________________________
3. Take out 10 mL of colored water and replace it with 10 mL of pure tap water.

   Did the color change? ________
   (It MUST have, because you took out some of the coloring and added fresh water.!)

   Can you SEE it's a different color? _______

   Why can't you see the color change? ______________________________________

Part III: What happens if you use a radionuclide with too *short* a half life?

Procedure:

1. You now need a third beaker with the same color of water.

   Describe it's color as exactly as you can. _________________________________
2. Pour out half (200 mL) of the colored water into a sink or waste water receptacle.
3. Now add the same volume (200 mL) of fresh colorless water to bring the sample back up to 400 mL.
4. How did the color change? ___________________________________
5. Repeat the procedure, pouring out half of the new colored water and adding 200 mL of fresh water. Do this a total of 10 times. (Again, take care not to spill water.)
6. Can you still see the color? _______

Would you be able to see the color if you did this 100 times? ____________

7. What is the problem with using a real radionuclide with too short a half life?

____

Wrap-Up:

C. What happens to a radionuclide through time?

____

D. What is a half life?

____

E. Find a reference that lists several radionuclides.
Name one radionuclide with
a relatively short half life: ______________________

What is it's half life? ______________________

F. Name one radionuclide with a *long* half life: ______________________

What is it's half life? ______________________

G. The half life of Barium-137m is about 2.6 minutes. ("m" means metastable; not really stable.)
How long are three half lives of Barium-137m? ___________

If you started with 10 grams of Ba-137m, how much would be left after 2.6 minutes? _______

If you started with 10 grams of Ba-137m, how much would be left after 5.2 minutes? _______

How much of that 10 g would still be Ba-137m after 10.4 minutes? _______

H. The half life of Rubidium-87 is 4.9×10^{10} years. Would Rubidium-87 be a good substance to use to find the age of the campfires of early humans? __________ Explain your answer.

____

I. The half life of Carbon-14 is 5700 years. Would you use Carbon-14 to find the age of the first living things on Earth? __________ What's the problem with using C-14 to measure this?

____

____

Key to: (Get a) Half Life

In Part I the amount of radionuclide will decrease, fast ar first, and then more slowly through time. The decay product will increase, fast ar first, and then more slowly through time.

A. Like radioactive decay, half of the original substance is lost each “X” minutes.

B. Unlike radioactive decay, we can see this water change. Also, this procedure is not expensive or as potentially dangerous.

In Part II it will be impossible to see any change in color because the half life is too long.

In Part III, representing a short half life, after a while, so little color is left that it’s impossible to see.

C. Through time, the original radionuclide decays, or becomes less and less.

D. Half life is the amount of time it takes for half the radionuclide to decay, or change.

E. (Answers will depend on the reference and the choice of which nuclides to use.)

F .Students will probably chose Rb-87 (4.9 x 10^{10} years) or U-238. (4.5 x 10^{9} years)

G. 2.6 minutes x 3 = 7.8 minutes. 5 grams. 1.25 grams.
(Barium-137m is a real radionuclide that is often used in lab applications.)

H. No.
So little Rb-87 would have changed to Strontium-87 that we could not measure the decay product.
Rubidium-87 has too long a half life.

I. No.
In such a long time, there would be too little Carbon-14 remaining to measure.
Carbon-14 has too short a half life.

(Get a) Half Life Tips

Difficulty: Easy to do. Not so easy to understand.

Content: Important

Preparations: Have ready for each lab group three 500 mL beakers with 400 mL of colored water,and a second dry beaker with some drink mix powder that will become another color when it is wet.
(Complimentary colors are suggested.)

You may want to use a different sets of colors to represent different radionuclides and decay products. So all the students who get the same two colors (water and dry powder) have the same half life.

If you do this, you can list the colors and half lives on the blackboard:

Blue	:30	(30 seconds)
Yellow	1:00	(1 minute)
Green	1:30	(One and a half minutes)

(Times written :30 and 1:00 are listed as they are used in the earthquake epicenter labs in Unit 3.)

Materials: As listed on the lab plus....
Food Coloring Box (Small - About 3-5 colors)
Colored drink powder such as colored Kool Aid (Several colors)
(A *different* color than the food coloring)
Pails for used water if students work away from sinks.

Time: 30 - 40 minutes

Suggestions for the Teacher:

1. Make half lives roughly a minute or two.

2. Use just one (1) drop of food coloring for each 400 mL sample of colored water.

(continued)

3. If you don’t want the students working at sinks, provide some receptacle (a pail?) for each group.

4. Some sources call atoms like Carbon-14 and Uranium-138 radioisotopes. But isotopes differ only in the number of neutrons. These two substances differ in both neutrons and protons. Nuclide is a better term than isotope because we can correctly talk about different elements as different nuclides. They are not different isotopes because they differ in both neutrons and protons. I suggest NOT making a big point of this with young students. Half life is tough enough without needing to learn the definition of a nuclide. You have more important things to teach in this lab!

5. If you want to be able to detect and measure ionizing (dangerous) radiation, you may be able to obtain an old, yellow Geiger counter (free) from your Civil Defense unit in your county government. Tell them it’s for use in a school. Be sure to get one that works

Student Intro:

1. Please work neatly. Water spills can be messy and even dangerous. Some one could slip on a wet floor or even get a bad electrical shock.

2. This lab shows us how half life works. You can’t show this with a real radioactive substance because of the cost of the equipment and, for strongly radioactive substances, great danger.

3. Although you can see, hear or feel radiation, even in dangerous amounts, it can be measured with instruments like a Geiger counter.

Post-Lab: It is suggested that you discuss these questions and answers (A-I)

Extensions: The American Nuclear Society has people who train teachers about nuclear radiation and they may be able to give you a booklet of nuclear labs and demonstrations you (or a bright student) can do in your classroom. If you bring in real radioactive substances, be sure to clear it with your department head and/or administration. While they can be used safely, you will want to take care with nuclear issues and parent/community members. Don’t make yourself vulnerable.

Source: In memory of the Navajo Code Talkers and the Diné from Keyenta.