Title:	"GET A HALF-LIFE" Fossil Fuels and Radioactive Decay	
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Course: **Grade:**	Physical Science 9-12	**Duration:** 45 minutes

Objective:
The students will model radioactive decay in order to explain how scientists determine the age of rocks in a sequence.

Summary of Lesson:
Students will be introduced to radioactive dating and its importance in our ongoing study of fossil fuels. In this experiment, each coin represents an atom. A coin has a 50 percent chance of showing heads, so in any round we would expect approximately half the coins to show heads. The students will be using the scientific method to test and observe the pattern of the coin sample and determine the" half life "of the coin sample from the obtained data. Hopefully, the result is a clear- cut operational concept of the half- life of radioactive substances. This concept is useful in explaining why fossil fuels are considered nonrenewable.

Arkansas Standards:

CODE	STANDARD
NS.12.PS.2	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.13.PS.5	Describe in detail the methods used by scientists in their research

Instructional Strategies and Practices:
Short lecture using PowerPoint presentation followed by experiment and discussion questions.

Bloom's Level: Highest Level Only
Application and evaluation

Materials and Resources:

(These web sites may change over time. If a web site is no longer available, use key words and phrases to find more current resources.)

- Carbon 14 Information-

http://www.esrl.noaa.gov/gmd/outreach/isotopes/c14tracer.html

- Background information- https://www.britannica.com/science/radioactivity https://isaacphysics.org/concepts/cp_radioactive_decay
- Experiment modified from-
- https://4.files.edl.io/49c0/11/16/18/215219-23c3aba6-acb1-497d-986e-24e8c89e41a4.pdf
- Lab activity example http://www.education.com/science-fair/article/model-of-radioactive-decay/
- Student Handout: Get A Half Life: Radioactive Decay
- 100 pennies
- Sturdy bag for shaking pennies
- *Get A Half Life* presentation

Formative Assessment:
Accurate and complete data table and construction of graph; Appropriate responses to analysis and discussion questions

Notes to Teacher:
This activity is designed to give the students an understanding of the relative age of fossil fuels and how this is determined. It is best to scaffold with some background information about radioactive decay. A PowerPoint presentation is included in this lesson. It is suggested that the instructor show the PowerPoint to students and then conduct the experiment.

The experiment calls for pennies, but candies such as M&Ms or Skittles would work if you wanted to give your students a special treat.

Student Activity:
1. Distribute Student Handout 1 Get A Half Life: Radioactive Decay
2. Use **Get A Half Life PowerPoint, slides 1-7** to provide background information for students.
3. Select student helper(s) to remove and count the pennies.
4. Have students copy the Data Chart from the handout to record their observations.
5. Use **Get A Half Life PowerPoint, slides 8-10** to explain the experiment procedure.
6. Put the coins in the bag. Close the bag securely and shake the bag.
7. Now spill the coins out on a table being careful not to lose any.
8. Ask student helper(s) to gather and count all the coins that are heads. Put them aside.
9. In the Data Chart, students will record this number of coins in the column Coins Removed, then subtract and calculate the number remaining and put that number in the Coins Remaining column.
10. Collect the coins that were tails and put them back in the bag. Close the bag and shake!
11. Repeat steps 3, 4, and 5 until you have run out of coins to put back in the bag
12. Students will create a bar graph to display their data
13. To conclude the experiment, answer the analysis questions in the handout.

Student Handouts: Printable copies of the handouts are available at https://arkansasenergyrocks.com/educators/lesson-plans-9-12/. Student handouts accompany each lesson plan.

"GET A HALF-LIFE" | Student Handout 1 | Radioactive Decay

Radioactive carbon decays at a known rate. This allows scientists to look at the amount of decay in a fossil's radioactive carbon and determine a relative date.

Students should view articles in the following web sites for back ground information before they begin the experiment. If these web sites are no longer available, use key phrases—"calculate your radiation dose" and "radiation basics"—to locate current resources.

https://www.epa.gov/radiation/calculate-your-radiation-dose
https://www.epa.gov/radiation/radiation-basics

Materials:

- 100 Pennies
- Sturdy bag large enough to hold pennies with room to shake

Directions:

1. Copy the Data Chart to record your observations.
2. Put the coins in the bag. Close the bag securely and shake the bag.
3. Now spill the coins out on the table in front of you. Do not lose any!
4. Gather and count all the coins that are heads. Put them aside. In the Data Chart record this number of coins in the column Coins Removed. Now subtract and calculate the number remaining and put that number in the Coins Remaining column.
5. Collect the coins that were tails and put them back in the bag. Close the bag and shake!
6. Repeat steps 3, 4, and 5 until you have run out of coins to put back in the bag.
7. Create a bar graph to display the data
8. Answer the analysis questions

Data Chart

Trials	# of Coins Removed	# of Coins Remaining
#1		
#2		
#3		
#4		
#5		
#6		
#7		
#8		
#9		
#10		

Analysis Questions:

1. Explain what each coin represents.

   _____
   _____
   _____

2. Note how many times you had to toss the coins before they were all used up. Did you find a pattern? What does the bar graph show?

   _____
   _____
   _____

3. If you repeated this experiment again, do you think you would get the same or different results? Why?

   _____
   _____
   _____

4. Explain why this experiment was useful in replicating a model of radioactive decay.

   _____
   _____
   _____

5. Why were the coins a good way to model half-lives? Would the model work as well if we used 1000 coins?

   _____
   _____
   _____

6. Why do we categorize fossil fuels as nonrenewable energy resources?

_____
_____
_____

7. Explain how this activity this relates to fossil fuels?

_____
_____
_____