



## PRE-CALCULUS ACTIVITY: RADIOACTIVE HALF-LIFE

CREATED BY TIFFANY ANDERSON, BEAVER COUNTRY DAY SCHOOL

This film Uranium Drive-In provides us with the opportunity to examine the tension that exists between environmental and economic interests in the United States, the world's largest producer of nuclear energy. We can also consider the potential health and environmental ramifications of a substance like uranium from a mathematical perspective.

If you need a brief review of logarithms, [this is a good resource](#).

### READING:

**A. Information about Uranium and EPA Standards**  
<http://www.epa.gov/radiation/radionuclides/uranium.html>

**B. Information about Nuclear Radiation**  
<http://science.howstuffworks.com/nuclear.htm>

**C. The Mathematics Behind Half-Life and Exponential Decay**  
**Formulas for calculating exponential decay can be found [here](#).**  
**For more information on the mathematics of radioactive decay:**  
<http://math.usask.ca/emr/seil.html>  
<http://math.usask.ca/emr/examples/expdeceg.html>

### HALF LIVES AND DECAY CONSTANTS:

The following table gives some values of half-lives and decay constants.

Notice that short half-lives go with large decay constants - a radioactive material with a short half-life will obviously lose its radioactivity rapidly.

ISOTOPE	HALF LIFE	DECAY CONSTANT (s <sup>-1</sup> )
Uranium 238	4.5x10	5.0x10
Plutonium 239	2.4x10	9.2x10
Carbon 14	5570 years	3.9x10
Radium 226	1622 years	1.35x10
Free neutron 239	15 minutes	1.1x10
Radon 220	52 seconds	1.33x10
Lithium 8	0.84 seconds	0.825
Bismuth 214	1.6x10	4.33x10
Lithium 8	6x10	1.2x10

**PROBLEM SET:**

1. The half-life of cobalt-60 is 5.26 years.  
How many half-lives have passed in 10.52 years?
2. 12.5% of a radioactive sample are left.  
How many half-lives have passed?
3. After 3 half-lives, how much of a 400 gram sample of radioactive uranium remains?
4. After 4 half-lives 10 grams of uranium remains.  
How much uranium did you start with?
5. How old is an artifact if four half-lives have occurred and the half-life of carbon-14 is 5730 years?
6. How much time has passed if carbon-14 has a half-life of 5730 years and 2 half-lives have passed?
7. A rock that originally had a mass of 1.00 gram of uranium-238 now has only 0.50 grams. How old is the rock if the half-life of uranium-238 is 4.5 billions of years.
8. The radioisotope radon-222 has a half-life of 3.8 days. How much of a 10 g sample of radon-222 would be left after 15.2 days?
9. A piece of wood found in an ancient burial mound contains only half as much carbon-14 as a piece of wood cut from a living tree growing nearby. If the half-life for carbon-14 is 5730 years, what is the approximate age of the ancient wood?
10. Iodine-131 has a half-life of 8 days. If the amount of iodine-131 in a sample is 8 g, how much iodine-131 will remain after 32 days?

**GENERAL PRACTICE:****Exponential and Logarithmic Equations** [review](#)

Solve each equation for  $x$ . Round each answer to three decimal places.

1.  $4^x = 6$

2.  $5^x = 2$

3.  $12^{4x} = 1020$

4.  $7^{3x} = 2400$

5.  $2^{x+1} - 5 = 22$

6.  $5x + 12^x = 5x + 7$

7.  $2^{x+1} = 2^{2x+3}$

8.  $3^{x+3} = 9^{x+1}$

Solve each log equation by using log properties and rewriting as an exponential equation.

9.  $\log_3 x + \log_3 5 = 2$

10.  $2 \log x = \log 8 + \log 5 - \log 10$

11.  $\log_9 x = \frac{3}{2}$

**FURTHER RESOURCES:****Interactive game about radiometric dating**

<http://phet.colorado.edu/en/simulation/radioactive-dating-game>

**Information about the Goiania accident in Brasil**

[http://www-pub.iaea.org/mtcd/publications/pdf/pub815\\_web.pdf](http://www-pub.iaea.org/mtcd/publications/pdf/pub815_web.pdf)

**Information about the Chernobyl accident in the Ukraine**

<http://www.livescience.com/39961-chernobyl.html>

**Radioactive Decay: A Chemistry Perspective from Khan Academy**

<https://www.khanacademy.org/science/chemistry/radioactive-decay>

**Further practice with exponential decay and logs**

[http://go.hrw.com/resources/go\\_sc/ssp/HK1MSW35.PDF](http://go.hrw.com/resources/go_sc/ssp/HK1MSW35.PDF)