# Logarithmic Scale, Tables and Graphs

## Decay in the DOE complex?
## Using a Logarithmic Scale to Find Out More

The following questions are designed to give you practice using a logarithmic scale on a graph and to learn more about radioactive decay. These questions are based on figments of the imagination of a certified Dr. Egghead assistant. In order to answer the questions you will need to refer to both a graph on the decay of Plutonium-238, and a table on the radiological properties of plutonium. (See below.)

To answer some of the questions below, you will need the graph of the decay of Plutonium-238 and the table of the radiological properties of plutonium. You can print this out or not, as your heart desires.

OK! You're ready to begin. As with other on-line worksheets, we recommend you print this page out to make it easier to work with. Have fun!

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1. What are the units used on the y-axis of this graph?

2. What is 10,000 in scientific notation? What is it in E notation?

3. What is the mass, in kilograms, of 10,000 curies of Pu-238 (Hint: What is the specific activity of Pu-238)?

4. After one half-life, how many curies of the original Pu-238 remain?

5. How many years, or half-lives, must elapse for the original radioactivity of the Pu-238 to decay to 2,500 curies?

6. Using the graph please answer the following question. After 72 years about how many curies of the original plutonium-238 are left?

A real stumper!!!!
7. When does the mass of the original Pu-238 equal about 9 grams?

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## Answers on next page…

# Answers

1. Curies

2. (a) $1x10^4$ (b) 1E4

3. The specific activity of an isotope tells you how radioactive an isotope is per gram of the isotope. By looking at the table on the Radiological Properties of Plutonium, you can see that the specific activity for Pu-238 is:

17.3 Curies/gram

This is the same as:

1 gram of Pu-238 = 17.3 curies

So:

(10,000 Curies) x (1 gram of Pu-238/17.3 Curies) = 578 grams of Pu-238

Remember that 1,000 grams = 1 kilogram (refer to the table on prefixes and their meanings. )

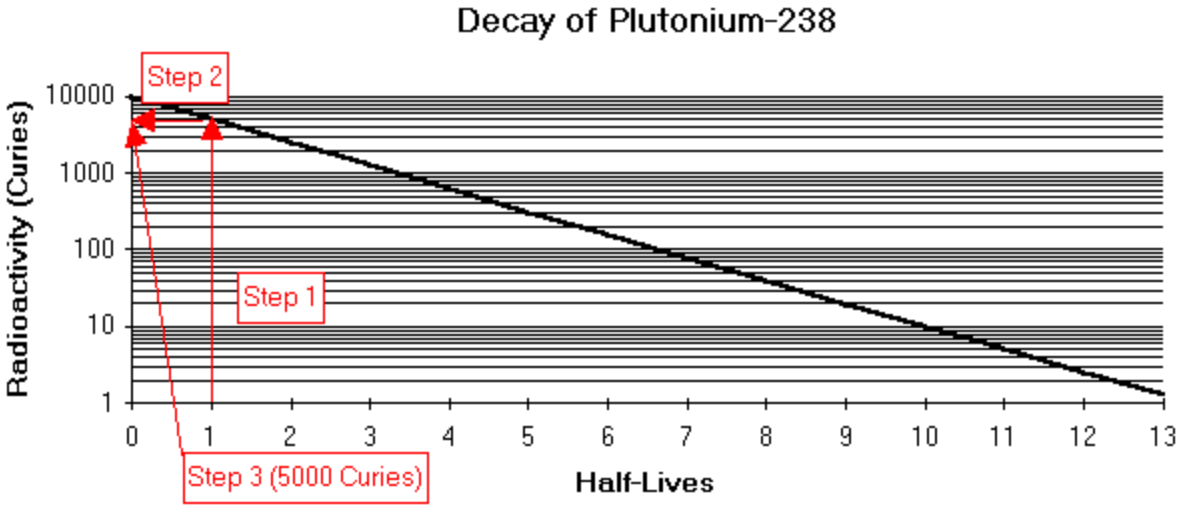
(578 grams) x (1 kg/1,000 grams) = 0.578 kg = $5.78 \times 10^{-1}$ kg of Pu-238

4. The definition of half-life is: The time in which half the atoms of a radioactive substance will have disintegrated, leaving half of the original amount.

Thus, assuming we started with 10,000 curies of Pu-238, after 87.7 years (one half-life of Pu-238) we would have:

(10,000 Curies) x (1/2) = 5,000 Curies

You can also determine this answer from drawing a line parallel to the y-axis through the X-value of 1 half-life (Step 1). Where this vertical line intersects (touches) the sloping line, draw a line parallel to the x-axis that intersects the y-axis (Step 2). The value of the Curies of Pu-238 is read off the y-axis (Step 3).




5. For each half-life that elapses 1/2 of the radioactivity is lost due to decay.

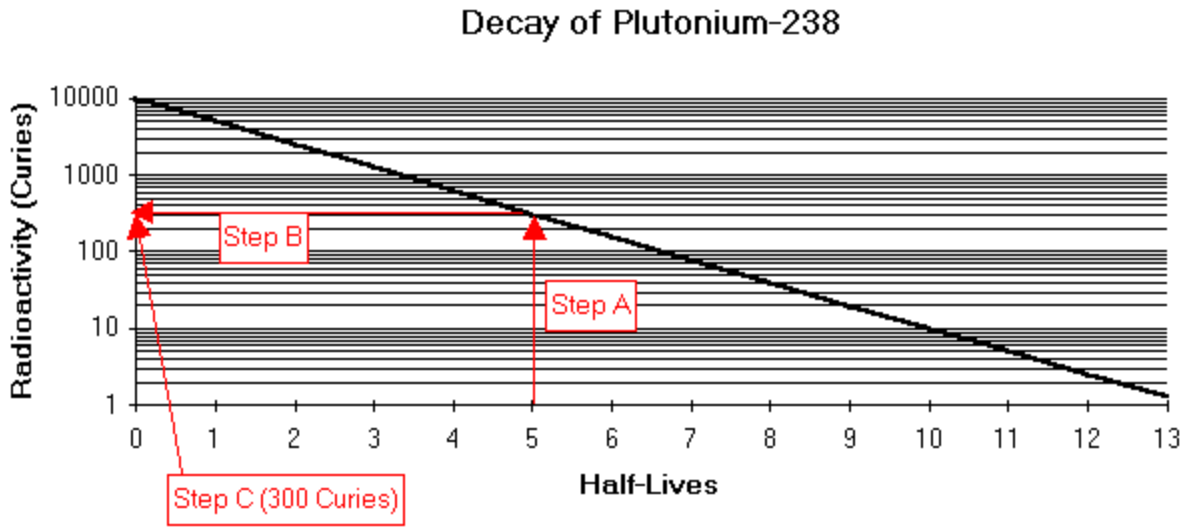
(2,500 Curies/10,000 Curies) = (1/4)

Therefore, after two half-lives (175.4 years) only 2,500 curies of Pu-238 is left of the original 10,000 curies.

6. First we need to convert 438.5 years into some number of half-lives of Pu-238. We know that the half-life of Pu-238 is 87.7 years. So:

(438.5 years) x (1 half-life/87.7 years) = 5 half-lives

Using the graph the quantity of curies of Pu-238 can be determined. The first step (Step A) is to draw a vertical line (parallel to the y-axis) through 5 (half-lives) on the x-axis. Where this vertical line intersects (touches) the sloping line, draw a line parallel to the x-axis that intersects the y-axis (Step B). The value of the Curies of Pu-238 is read off the y-axis (Step C). If you do these steps you determine that after 5 half-lives about 300 curies remain.




You can also calculate the answer:

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Half-lives:          1       2       3       4       5

(10,000 Curies) x (1/2)x (1/2)x (1/2)x (1/2)x (1/2)= 312.5 curies
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A real stumper!!!!

7. Remembering that the specific activity of Pu-238 is 17.3 Curies/gram we can solve the problem:

(17.3 Curies/gram) x (9 grams) = 156 Curies

You can use your answer from #6 and see that 156 curies is about 1/2 of 312.5 curies. Thus, it would take one half-life (87.7 years) to decay 312.5 curies to 156 curies of Pu-238. Since 438.5 years are required to decay 10,000 curies of Pu-238 to 312.5 curies, then:

438.5 years + 87.7 years = 526.2 years is the time it takes to decay 10,000 curies of Pu-238 to 156 Curies of Pu-238.

You could also determine this answer graphically by determining where 156 is on the y-axis, drawing a line parallel to the x-axis through this point, and then drawing a line parallel to the y-axis through the point of intersection of the first line and the sloping line. The intersection of the second line on the x-axis would be your answer in half-lives of Pu-238.