HALF-LIFE CALCULATIONS

Name _____

Half-life is the time required for one-half of a radioactive nuclide to decay (change to another element). It is possible to calculate the amount of a radioactive element that will be left if we know its half-life.

Example: The half-life of Po-214 is 0.001 second. How much of a 10 g sample will be left after 0.003 seconds?

Answer: Calculate the number of half-lives:

$$0.003 \text{ seconds} \times \frac{1 \text{ half-life}}{0.001 \text{ second}} = 3 \text{ half-lives}$$

After 0 half-lives, 10 g are left.
After 1 half-life, 5 g are left.
After 2 half-lives, 2.5 g are left.
After 3 half-lives, 1.25 g are left.

Solve the following problems.

1. The half-life of radon-222 is 3.8 days. How much of a 100 g sample is left after 15.2 days?

_____

2. Carbon-14 has a half-life of 5,730 years. If a sample contains 70 mg originally, how much is left after 17,190 years?

_____

3. How much of a 500 g sample of potassium-42 is left after 62 hours? The half-life of K-42 is 12.4 hours?

_____

4. The half-life of cobalt-60 is 5.26 years. If 50 g are left after 15.8 years, how many grams were in the original sample?

_____

5. The half-life of I-131 is 8.07 days. If 25 g are left after 40.35 days, how many grams were in the original sample?

_____

6. If 100 g of Au-198 decays to 6.25 g in 10.8 days, what is the half-life of Au-198?

_____

HALF-LIFE OF RADIOACTIVE ISOTOPES

Name _____

1. How much of a 100.0 g sample of ^{198}Au is left after 8.10 days if its half-life is 2.70 days?

_____

2. A 50.0 g sample of ^{16}N decays to 12.5 g in 14.4 seconds. What is its half-life?

_____

3. The half-life of ^{42}K is 12.4 hours. How much of a 75$\bar{0}$ g sample is left after 62.0 hours?

_____

4. What is the half-life of ^{99}Tc if a 50$\bar{0}$ g sample decays to 62.5 g in 639,000 years?

_____

5. The half-life of ^{232}Th is 1.4×10^{10} years. If there are 25.0 g of the sample left after 2.8×10^{10} years, how many grams were in the original sample?

_____

6. There are 5.0 g of ^{131}I left after 40.35 days. How many grams were in the original sample if its half-life is 8.07 days?

_____

Name _____ Date _____ Class _____

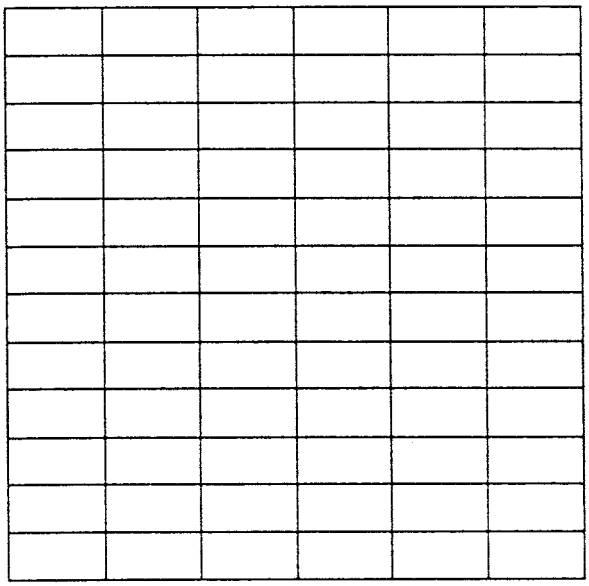
CHAPTER 26 Text Reference: Section 26-3

Practice Problems

1. A radioisotope's half-life is 1.000 min.

a. Given that the initial mass of a sample of this radioisotope is 12.00 g, calculate the mass of the radioisotope *that has not decayed* after 1.00 min, 2.00 min, 3.00 min, 4.00 min, 5.00 min, and 6.00 min.

b. Use the information you have just calculated to draw a graph of mass of radioisotope remaining *versus* time.



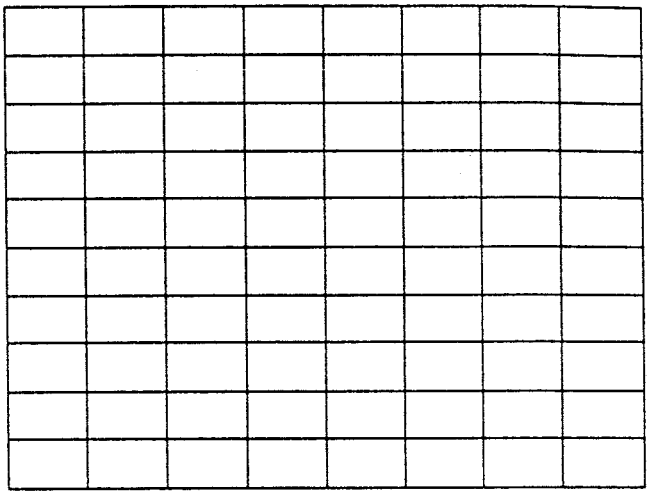
c. By interpolation of this graph, estimate the grams of radioisotope left after 1.5 min.

d. By interpolation, estimate the amount of time that must elapse in order for 1.0 g of the radioisotope to be present.

2. The initial mass of a sample of a certain radioisotope is 100.0 g. After 1.0 hour, 80.0 g of it remains; after 2.0 hours, 64.0 g remains; after 4.0 hours, 41.0 g remains; and after 6.0 hours, 26.2 g remains.

a. On the grid at the top of the next column, use this information to draw a graph of mass of radioisotope remaining versus time.

b. Use the graph to estimate the half-life of the radioisotope. (Hint: Find the x-value at which half of the initial mass of the radioisotope remains.)



c. Use your answer to **b** to calculate the amount of time required for 25 g of the radioisotope to remain. Determine the same quantity by interpolation.

d. By extrapolation of the graph, find the mass of radioisotope remaining after 8.0 hours.

For questions 3–8, calculate the mass number and atomic number of the missing particle (X), given that each of these quantities must be conserved in order to produce a balanced nuclear equation. Then, referring to a table of atomic numbers of the elements, determine the chemical symbol of the missing particle. Finally, indicate whether alpha or beta decay is occurring.

3. $^{234}_{90}\text{Th} \rightarrow X + {}^{0}_{-1}\text{e}$

4. $X \rightarrow {}^{214}_{82}\text{Pb} + {}^{4}_{2}\text{He}$

5. $^{210}_{83}\text{Bi} \rightarrow {}^{210}_{84}\text{Po} + X$

6. $^{226}_{88}\text{Ra} \rightarrow X + {}^{4}_{2}\text{He}$

7. $^{230}_{90}\text{Th} \rightarrow {}^{226}_{88}\text{Ra} + X$

8. $X \rightarrow {}^{234}_{92}\text{U} + {}^{0}_{-1}\text{e}$

D. Half-Life Determinations

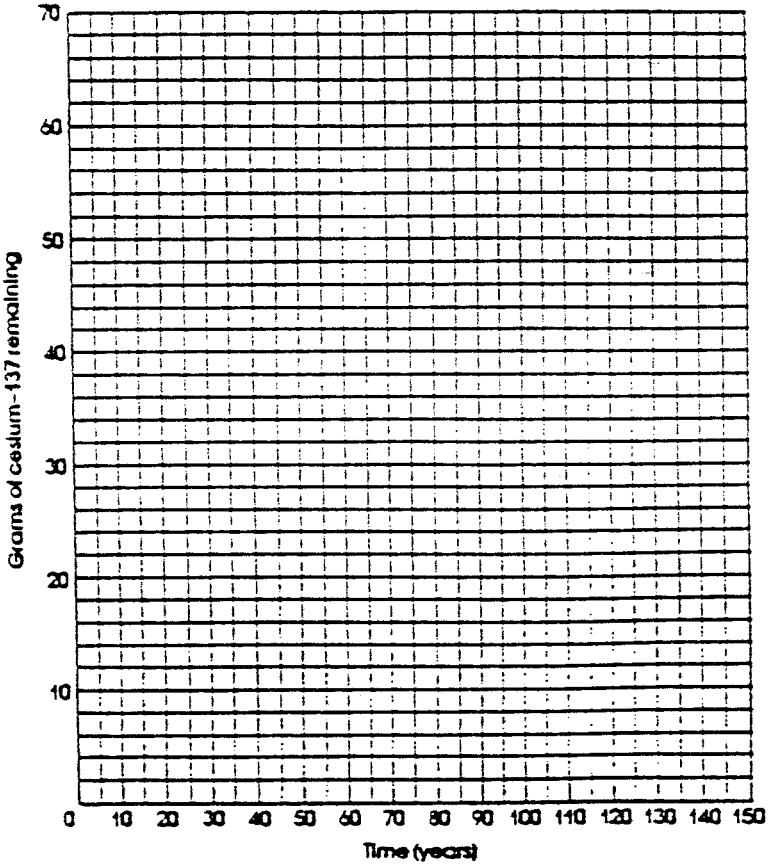
Cesium-137 is a radioactive isotope produced during fission reactions. It undergoes beta decay into barium-137, as illustrated below.

$$^{137}_{55}Cs \rightarrow {}^{137}_{56}Ba + {}^{0}_{-1}e$$

The half-life for this disintegration is approximately 30 years. This is the amount of time required for half the atoms in a sample to undergo decay. Assume that a 64-gram sample of Cs-137 is analyzed every 30 years for a 150-year period. Determine the grams of cesium and barium present in each sample and record these data in the table below. (Assume that the two nuclides have equal atomic mass.)

TIME	GRAMS OF CESIUM-137	GRAMS OF BARIUM-137
0 years	64 grams	0 grams
30 years	_____	_____
60 years	_____	_____
90 years	_____	_____
120 years	_____	_____
150 years	_____	_____

Plot the above data on the following grid.



1. How long will it take for all the cesium-137 to decay into barium-137?

_____

_____

_____

Name: _____ Date: _____

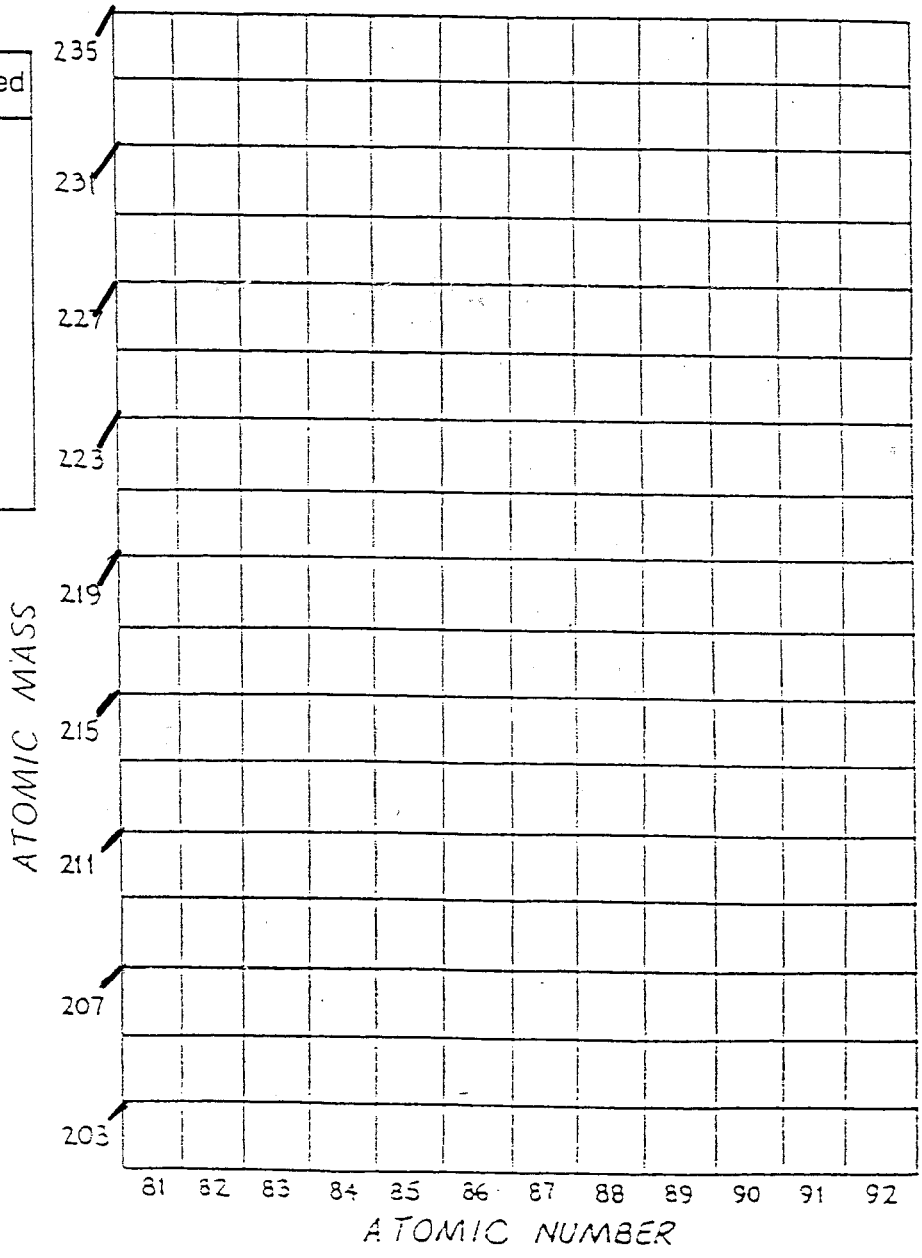
CONCEPTUAL **Physical Science** PRACTICE SHEET

Chapter 15: Radioactivity

Natural Transmutation

Draw in a decay-scheme diagram below, similar to the one on page 603 of your text. In this case you begin at the upper right with U-235 and end up with a different isotope of lead. Use the table at the left and identify each element in the series by its chemical symbol.

Step	Particle Emitted
1	Alpha
2	Beta
3	Alpha
4	Alpha
5	Beta
6	Alpha
7	Alpha
8	Alpha
9	Beta
10	Alpha
11	Beta
12	Stable



What isotope is the final product? _____