LESSON MAKER PRO

Clues in Atoms

Use isotope ratios to estimate age.

HIGH SCHOOL · PS.4.e

PS.4.e "Analyze and interpret data to explain how radioactive decay changes a radioactive isotope over time and explain how the age of an object can be estimated by the ratio of radioactive isotopes contained within the object's atoms."

NAME _____ DATE _____

THE ISOTOPE CLOCK

After one half-life, half of the radioactive parent atoms remain. If an object began with no daughter atoms and none have entered or left, its starting parent count equals its current parent count plus its daughter count. Count how many times the parent amount was halved, then multiply by the half-life.

WORKED EXAMPLE

A mineral began with no daughter atoms. Its half-life is 7 years. Use the table to find its age.

ATOMS IN THE MINERAL

Time	Parent	Daughter
At formation	96	0
Now	24	72

1. Halve the starting parent count: 96 → 48 → 24.
2. That is 2 half-lives.
3. 2 × 7 = 14 years.

Answer: 14 years

PRACTICE 4 problems

1 An isotope starts with 100 parent atoms and no daughter atoms. It now has 25 parent atoms. Its half-life is 3 years. How old is it?

ANSWER _____

2 A mineral has 30 parent atoms and 90 daughter atoms made by decay. Its half-life is 5 years. How old is it?

ANSWER _____

3 A rock has 18 parent atoms and 18 daughter atoms made by decay. Its half-life is 9 million years. How old is it?

ANSWER _____

4 A crystal has 15 parent atoms and 105 daughter atoms made by decay. Its half-life is 4 million years. How old is it?

ANSWER _____

APPLY IT Show your work

1 A museum dates volcanic ash just above a fossil. The isotope's half-life is 11 million years. Use the table to find the ash's age. Is the fossil older or younger than the ash?

ATOMS IN THE ASH

Atom type	Count
Parent	35
Daughter made by decay	105

ANSWER _____

2 A space museum tests rock melted by a meteorite impact. Since it cooled, 8 parent atoms remain and 120 daughter atoms have formed by decay. If the half-life is 13 million years, how long ago did it cool?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Both samples began with no daughter atoms, and all their daughter atoms came from decay. Which sample is older, and by how many million years? Explain using the parent fractions and half-lives.

TWO ROCK SAMPLES

Sample	Half-life (million years)	Parent	Daughter
A	6	21	63
B	5	9	63

WORK SPACE AND ANSWER

ANSWER KEY

Clues in Atoms

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	An isotope starts with 100 parent atoms and no daughter atoms. It now has 25 parent atoms. Its half-life is 3 years. How old is it?	**6 years**
2	A mineral has 30 parent atoms and 90 daughter atoms made by decay. Its half-life is 5 years. How old is it?	**10 years**
3	A rock has 18 parent atoms and 18 daughter atoms made by decay. Its half-life is 9 million years. How old is it?	**9 million years**
4	A crystal has 15 parent atoms and 105 daughter atoms made by decay. Its half-life is 4 million years. How old is it?	**12 million years**

PART 2 · APPLY IT

1. **The ash is 22 million years old. The fossil is older than the ash.** The ash began with 140 parent atoms; 35 remain, so 2 half-lives have passed. The fossil lies below the ash, so it is older if the layers have not been disturbed.
2. **52 million years ago** The rock began with 128 parent atoms. Halving 128 four times gives 8, so 4 × 13 = 52 million years.

CHALLENGE

B is older by 3 million years. A has 21/84 = 1/4 of its parent atoms left, so its age is 2 × 6 = 12 million years. B has 9/72 = 1/8 left, so its age is 3 × 5 = 15 million years.

All ages assume the samples began with no daughter atoms and remained closed to parent and daughter atoms. For the challenge, accept any explanation that correctly finds both ages and compares them.