LESSON MAKER PRO

Rocks Tell Time

Calculate ages from simulated isotope ratios

HIGH SCHOOL · ESS.2B.3

ESS.2B.3 "Use mathematical concepts to calculate the absolute age of Earth materials using actual or simulated isotope ratios."

NAME _____ DATE _____

COUNT THE HALF-LIVES

A parent isotope becomes a daughter isotope as it decays. If a mineral formed with no daughter atoms and none have entered or left, parent/(parent + daughter) is the fraction of parent atoms remaining. Count how many times that fraction has been halved, then multiply by the isotope's half-life.

WORKED EXAMPLE

A mineral has 1/16 of its original parent atoms left. The isotope's half-life is 35 million years. How old is the mineral?

1. Start with 1 whole: 1 → 1/2 → 1/4 → 1/8 → 1/16.
2. Four halvings mean four half-lives have passed.
3. 4 × 35 million years = 140 million years.

Answer: 140 million years

PRACTICE 6 problems

1 A mineral has 1/2 of its original parent atoms left. The half-life is 10 million years. How old is the mineral?

ANSWER _____

2 A mineral has 1/4 of its original parent atoms left. The half-life is 25 million years. How old is the mineral?

ANSWER _____

3 A mineral has 1/8 of its original parent atoms left. The half-life is 40 million years. How old is the mineral?

ANSWER _____

4 The table shows atoms in a mineral. The half-life is 9 million years. How old is the mineral?

ATOMS IN THE MINERAL

Isotope	Number of atoms
Parent	10
Daughter	30

ANSWER _____

5 A mineral has 1 parent atom for every 7 daughter atoms. The half-life is 300 million years. How old is the mineral?

ANSWER _____

6 The table shows atoms in two minerals that contain the same simulated isotope. Its half-life is 11 million years. How old is each mineral?

ATOMS IN TWO MINERALS

Mineral	Parent atoms	Daughter atoms
A	8	8
B	2	14

ANSWER _____

_____

APPLY IT Show your work

1 At a museum exhibit, a student dates volcanic ash found beside a dinosaur fossil. A simulated isotope in the ash has a half-life of 45 million years. The ash has 6 parent atoms for every 18 daughter atoms. How old is the ash?

WORK SPACE

ANSWER _____

2 A geology club is making a sign for a hiking trail. To date a lava flow along the trail, the club measures atoms of a simulated isotope in a mineral. The half-life is 400,000 years. Use the table to find the age of the lava flow.

ATOMS IN A MINERAL FROM THE LAVA FLOW

Isotope	Number of atoms
Parent	3
Daughter	21

ANSWER _____

CHALLENGE One step up

A mineral formed with 4 daughter atoms already in it. Today it has 4 parent atoms and 32 daughter atoms. None have entered or left since it formed. The parent isotope's half-life is 17 million years. How old is the mineral? Explain how you used the daughter count.

WORK SPACE AND ANSWER

Rocks Tell Time

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A mineral has 1/2 of its original parent atoms left. The half-life is 10 million years. How old is the mineral?	**10 million years**
2	A mineral has 1/4 of its original parent atoms left. The half-life is 25 million years. How old is the mineral?	**50 million years**
3	A mineral has 1/8 of its original parent atoms left. The half-life is 40 million years. How old is the mineral?	**120 million years**
4	The table shows atoms in a mineral. The half-life is 9 million years. How old is the mineral?	**18 million years**
5	A mineral has 1 parent atom for every 7 daughter atoms. The half-life is 300 million years. How old is the mineral?	**900 million years**
6	The table shows atoms in two minerals that contain the same simulated isotope. Its half-life is 11 million years. How old is each mineral?	**A: 11 million years; B: 33 million years**

PART 2 · APPLY IT

1. **90 million years** The parent fraction is 6/(6 + 18) = 1/4. Two half-lives have passed, so the age is 2 × 45 = 90 million years.
2. **1,200,000 years** The parent fraction is 3/(3 + 21) = 1/8, which means three half-lives have passed. The age is 3 × 400,000 = 1,200,000 years.

CHALLENGE

51 million years. Subtract the 4 original daughter atoms from 32, leaving 28 produced by decay. The parent fraction is 4/(4 + 28) = 1/8, so three half-lives have passed: 3 × 17 = 51 million years.

Accept equivalent time units, such as 1.2 million years for 1,200,000 years. In the challenge, students must exclude the 4 daughter atoms present at formation.