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Date: _____

Period: 1 2 3 4 5 6 7

Absolute Dating

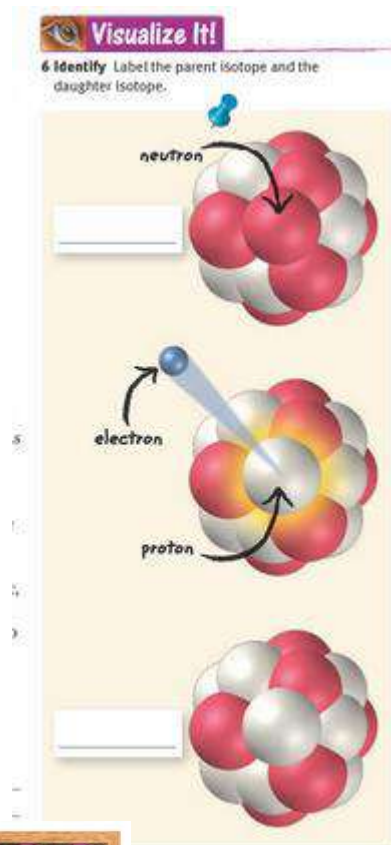
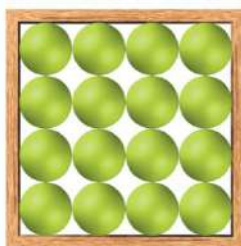
Essential Question: How is the absolute age of rock measured?

Vocabulary:

- **Absolute Dating:** any method of measuring the age of an object or event in years
- **Radiometric Dating :** a method of determining the absolute age of an object by comparing the relative percentages of a radioactive (parent) isotope and a stable (daughter) isotope
- **Radioactive Decay:** the process in which a radioactive isotope tends to break down into a stable isotope of the same element or another element
- **Half-Life:** the time required for half of a sample of a radioactive isotope to break down by radioactive decay to form a daughter isotope

How Can the Absolute Age of Rock be Determined?

1. Determining the actual age of an event or object in years is called absolute dating.
2. Using radioactive Isotopes
 - a) Isotopes: atoms of the same element with a different number of neutrons
 - b) Radioactive isotopes are isotopes that are unstable and break down into other isotopes by a process called **radioactive decay**.
 - c) The radioactive isotope is called the *parent isotope*, and the stable isotope formed by its breakdown is called the *daughter isotope*.
 - d) **Half-life** is the time needed for half of a sample of a radioactive element to undergo radioactive decay and form daughter isotopes.
 - After one half-life has passed, one-half of the parent isotope has changed into daughter isotopes.



3. By Radiometric Dating

- e) Scientists study the amounts of parent and daughter isotopes to date samples.
- f) Finding the absolute age of a sample by determining the relative percentages of a radioactive parent isotope and a stable daughter isotope is called **radiometric dating**.

What is the Best Rock for Radiometric Dating?

1. Igneous rocks are the best types of rock samples to use for radiometric dating.
2. When igneous rocks form, minerals in them often contain only a parent isotope and none of the daughter isotope.
3. This makes the isotope percentages easier to interpret and helps dating to be more accurate.

Sample Problems



Do the Math

Sample Problem

A crystal contains a radioactive isotope that has a half-life of 10,000 years. One-fourth (25%) of the parent isotope remains in a sample. How old is the sample?

Identify

- A. What do you know? Half-life = 10,000 years, parent isotope = 25%
- B. What do you want to find out? How old the sample is. So, you need to know how many half-lives have gone by since the crystal formed.

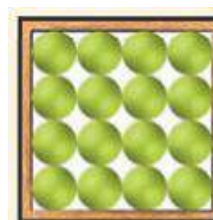
Plan

- C. Draw the parent-to-daughter isotope ratios for each half-life.

Solve

- D. The third drawing on the right shows a sample that contains 25% parent isotope. This amount is present after 2 half-lives have passed.
- E. Find the age of the sample. Because the half-life of the radioactive isotope is 10,000 years and 2 half-lives have passed, the age of the sample is:

$$2 \times 10,000 \text{ years} = 20,000 \text{ years}$$



0 years

Parent isotope = 16
 Daughter isotope = 0
 100% of the sample is parent isotope.



After 1 half-life

Parent isotope = 8
 Daughter isotope = 8
 50%, or $\frac{1}{2}$, of the sample is parent isotope.



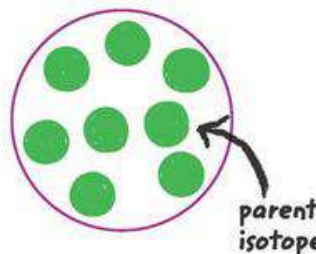
After 2 half-lives

Parent isotope = 4
 Daughter isotope = _____
 25%, or $\frac{1}{4}$, of the sample is parent isotope.

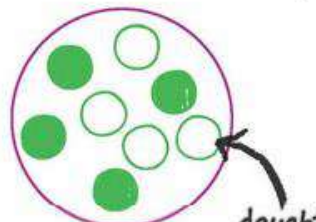


After 3 half-lives

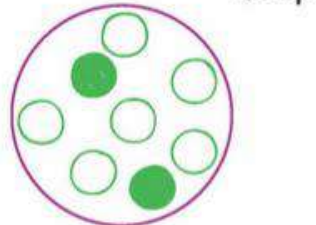
Parent isotope = _____
 Daughter isotope = _____
 12.5%, or $\frac{1}{8}$, of the sample is parent isotope.



parent isotope



daughter isotope



**Do the Math**

You Try It

8 Calculate A crystal contains a radioactive isotope that has a half-life of 20,000 years. You analyze a sample and find that one-eighth (12.5%) of the parent isotope remains. How old is the sample?

.....

Identify

A. What do you know? _____

B. What do you want to find out? _____

.....

Plan

C. Draw the parent-to-daughter isotope ratios on the right.

.....

Solve

D. Figure out how many half-lives have passed: _____

E. Find the age of the sample: _____

.....

Answer: _____

What are Some Radiometric Dating Methods?

1. Scientists use many different isotopes for radiometric dating.
2. The type of isotope used depends on the type of material being dated.
3. The half-life of the isotope used is also very important. It can't be too short or too long compared to the age of the sample.
4. Radiocarbon Dating
 - a) Radiocarbon dating is a method used for dating wood, bones, shells, and other organic remains.
 - b) All living things have a constant ratio of radioactive carbon-14 to carbon-12.
 - c) Once a plant or an animal dies, no more carbon is taken in. The ratio between the isotopes changes because carbon-14 undergoes radioactive decay.
 - d) The half-life of carbon-14 is 5,730 years. The number of half-lives of carbon-14 that have passed gives the absolute age.
 - e) Radiocarbon dating can be used to date organic matter only.
 - f) This method is used to date things that lived in the last 45,000 years.

5. Potassium-Argon Dating

- a) Potassium-argon dating is often used to date igneous volcanic rocks that are 100,000 years to billions of years old.

6. Uranium-Lead Dating

- a) Uranium-lead dating is based on measuring the amount of the lead-206 daughter isotope in a sample.
- b) Uranium-lead dating can be used to determine the age of igneous rocks that are between 100 million years and a few billion years old.

How is Radiometric Dating Used to Determine the Age of Earth?

- 1. Radiometric dating can be used to find the age of Earth. But there are no Earth rocks which can be directly studied that are as old as our planet.
- 2. Meteorites are small, rocky bodies that have fallen from space to Earth's surface. They are the same age as the solar system, including Earth.
- 3. The absolute age of meteorites and other rocks in the solar system is about 4.6 billion years.

How can Fossils Help to Determine the Age of Sedimentary Rock?

- 1. Sedimentary rock layers and the fossils within them cannot be dated directly.
- 2. But igneous rock layers on either side of a fossil layer can be dated radiometrically.
- 3. Once the older and younger rock layers are dated, scientists can assign an absolute age range to the sedimentary rock layer containing the fossils.
- 4. Using Index Fossils
 - a) *Index fossils* are fossils used to estimate the absolute age of the rock layers in which they are found.
 - b) Once the absolute age of an index fossil is known, it can be used to determine the age of rock layers containing the same fossil anywhere on Earth.
 - c) To be an index fossil, the organism from which it formed must have lived during a relatively short geologic time span.
 - d) Index fossils must be relatively common and must be found over a large area.

- e) Index fossils must also have features that make them different from other fossils.

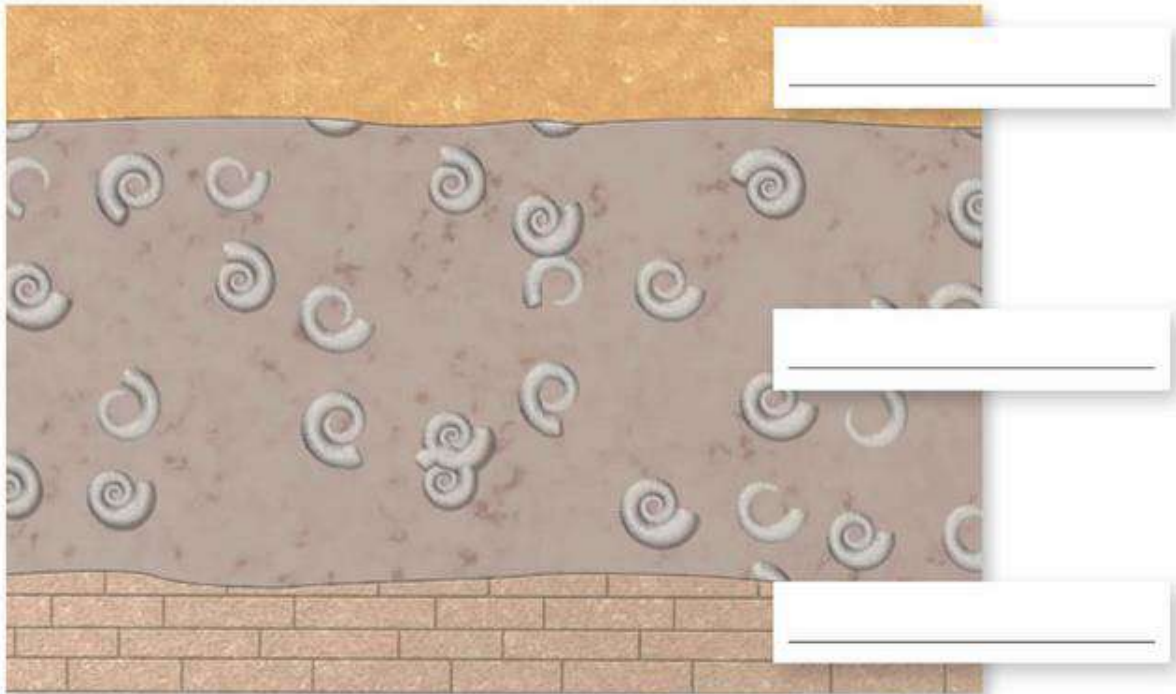
How are Index Fossils Used?

1. Index fossils act as markers for the time that the organisms were alive on Earth.
2. Index fossils can also be used to date rocks in separate areas.
3. The appearance of the same index fossil in rock of different areas shows that the rock layers formed at about the same time.



16 Infer *Tropites* fossils are found in the middle rock layer shown below. Place each of the following ages beside the correct rock layer: 215 million/500 million/100 million.

*Fossils of a genus of ammonites called **Tropites** are good index fossils.*



Essential Question Review:

- How is the absolute age of rock measured?
