Senior High School

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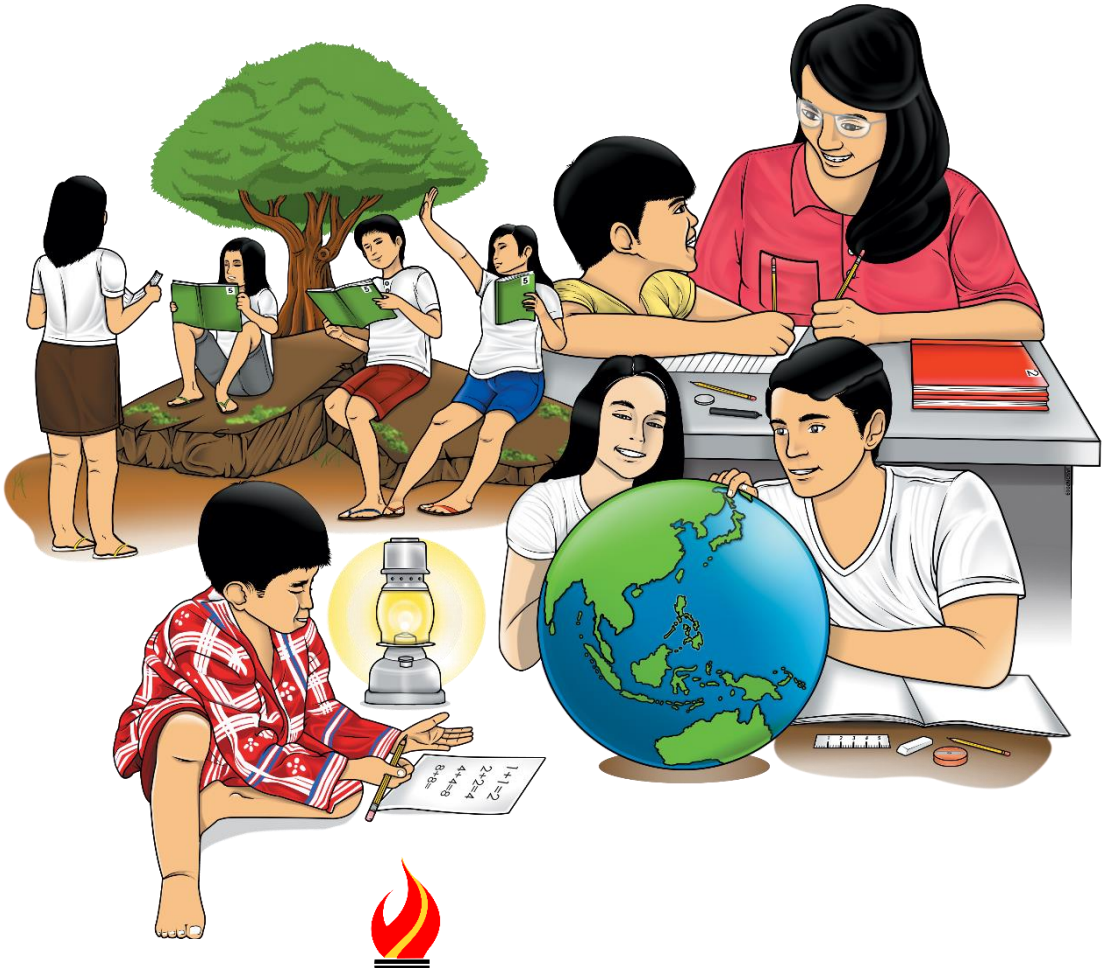
Earth Science for STEM

Quarter 2 – Module 10: Different Methods of Determining the Age of Stratified Rocks



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Quarter 2 – Module 10: Different Methods of Determining the Age of the Stratified Rocks

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

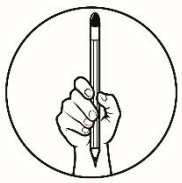
Thank you.

What I Need to Know

In this lesson, the learner will describe the different methods of determining the age of stratified rocks. To achieve this learning competency, the learner should identify the main difference between the methods.

After going through this lesson, you are expected to:

1. identify the methods of determining the age of stratified rocks;
2. distinguish the difference between absolute dating and relative dating;
3. apply the techniques in determining the age of stratified rocks; and
4. make a timeline of important events in life.



What I Know

Read and analyze the following questions. Choose and write the letter that best describes the following statements on a sheet of paper.

1. What do geologists use to figure out if a rock is older or younger than another rock?
   A. EM dating
   B. Relative dating
   C. Radiometric dating
   D. Amino acid dating

2. Which is true about absolute dating?
   A. Breakdown isotopes
   B. Arrange the historical remains in order of their ages
   C. Depends on the traces of radioactive isotopes found in fossils
   D. Determine the age by comparing the historical remaining to the nearby layers

3. Which absolute dating technique depends on the traces of radioactive isotopes found in fossils?
   A. Amino acid
   B. Radiometric
   C. Dendrochronology
   D. Thermoluminescence

4. What is the process of breaking down isotopes?
   A. Half-life
   B. Isotopes
   C. Radioactive decay
   D. Radioactive metric dating

5. What do we call the atoms of the same element with the same number of protons but different number of neutrons?
   A. Isotopes
   B. Absolute dating
   C. Relative Dating
   D. Radioactive Decay

6. What term describes absolute dating?
   A. Exact
   B. Close
   c. Adjacent
   d. Relevant

7. Which shows the approximate age of a rock?
   A. Color
   B. Shape
   c. Texture
   d. Fossil index

8. In a canyon, where is the youngest rock located?
   A. Top
   B. Side
   c. Middle
   d. Bottom

9. Which of the following statements is TRUE?
   A. Rock layers are undisturbed
   B. Deposition of evenly distributed sediments
   C. The layers are gone after folding
   D. Rock layers are older than faults found in them

10. What is a gap in the rock sequence?
   A. Break
   B. Fault
   c. Uplift
   d. Unconformity

11. What is the time needed for one-half of the parent atoms to turn into daughter atoms?
   A. Half-life
   B. In-behalf
   c. Half-way
   d. Better-half

12. Which technique uses the half-life of atoms to figure out their age in the rock layers?
   A. Amino acid
   B. Radiometric
   c. Dendrochronology
   d. Thermoluminescence

13. What method has helped scientists to determine the exact age of Earth?
   A. Official dating
   B. Relative dating
   c. Absolute dating
   d. Complete dating

14. Which of the following is true?
   A. The half-lives of all radioactive isotopes are the same.
   B. The amount of parent atom remaining does not affect the decay of the isotope.
   C. As the number of parent atoms decreases, the number of daughter atoms increases.
   D. As the number of parent atoms decreases, the number of daughter atoms also decreases.

15. Which is one of the most popular and widely used types of a radioactive isotope?
   A. Carbon
   B. Potassium
   c. Phosphorus
   d. Uranium

Lesson 10 Different Methods of Determining the Age of Stratified Rocks

Stratified rocks are consisting of different layers in their structure. Determining the age of these rocks help geologists to come up with records of the past. They used methods - relative dating and absolute dating which provide a scientific basis for understanding the evolution of Earth over time.

What's In

Do the activity below and answer Guide Questions in your answer sheet.

Procedures:

A. Look for a broken rock sample outside your house.
B. Observe its structure. You may use a magnifying lens if available.

Guide Questions:

1. Are there layers in its structure? If there's any, what do you call this type of rock?

   _____

   _____

2. How was this rock formed?

   _____

   _____

Notes to the Teacher

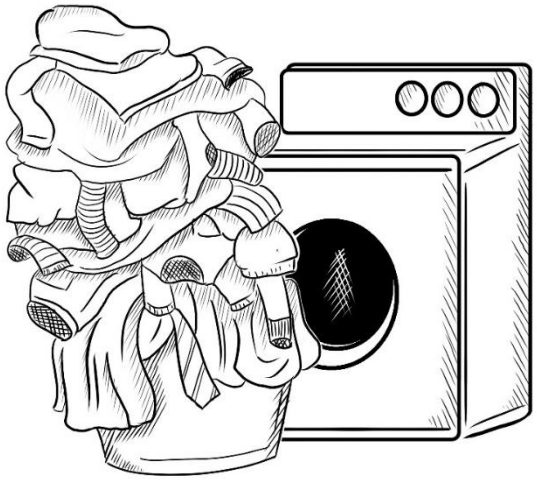
For a better understanding of the lesson in this module, you may present a video on the methods of determining the age of stratified rocks. The set of activities provide a clear picture of the difference between the methods discussed in this module.

What's New

A. The following are activities you usually do. Write the exact time you do this routine. Write your answer in your answer sheet.

1. Checking of social media account _____
2. Cleaning the house _____
3. Eating your lunch _____
4. Doing homework _____
5. Praying _____

B. Analyze the given illustration then answer the questions that follow. Write your answers on a separate sheet of paper.



1. How are the clothes arranged in the laundry basket?
   _____
2. How long does it take for you to accumulate this overflowing laundry pile?
   _____
3. What similarities between the arrangement of laundry pile and the layers of particles found in the rock sample (as shown in the previous activity) did you observed?
   _____
4. Which type of rock can be compared to the laundry pile in the basket? Explain your answer.
   _____

What is It

In the previous activity, you were asked to draw and describe the arrangement of the layers of stratified rocks. Do you have any idea what stratified rocks are?

Stratified rocks are layered rocks formed due to the deposition of items such as sand and silt near the riverbeds, forming layers on top of each other. Like the arrangement of the dirty clothes in the laundry basket, stratified rocks are made up of sandstone, siltstone, and shale formed over a period in the process of stratification.

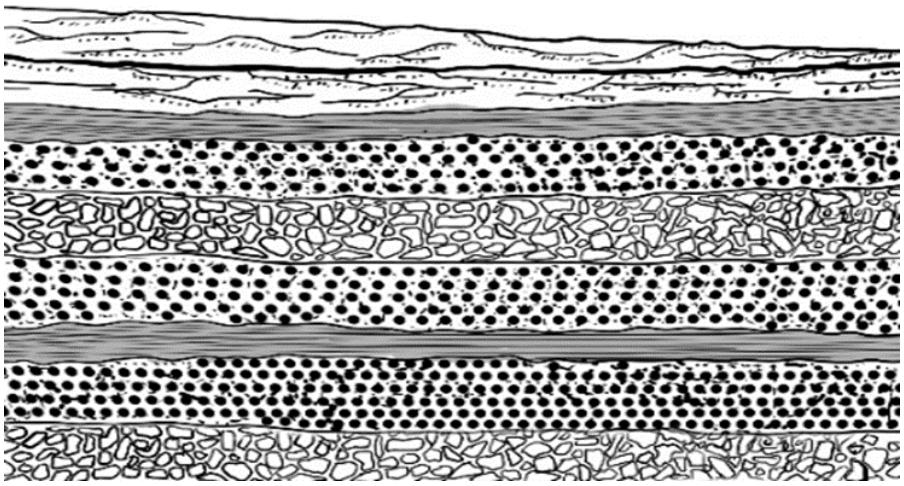


Figure 1. Stratified Rock

The layers of stratified rocks shown in the given illustration were formed million years ago. Like fossils and other geological specimens, the age of stratified rocks can be determined using two major geological dating methods called relative and absolute dating.

The main difference between absolute and relative dating is that absolute dating is a technique to determine the numerical age of a rock or a fossil, while relative dating is a technique that determines the relative age. Furthermore, absolute dating can be done with the use of radiometric dating, whereas relative age is determined for other layers.

Absolute dating and relative dating are two techniques used in geology to evaluate the age and the period of a fossil or rock.

What is Relative Dating

Relative dating is the technique used to determine the age by comparing the historical remains to the nearby layers. It is a less advanced technique when compared to absolute dating. Some methods used in relative dating are stratigraphy, biostratigraphy, and cross-dating.

1. **Stratigraphy**: This technique assumes that the lowest layer is the oldest while the topmost layer is the youngest layer. It is one of the oldest methods of relative dating.

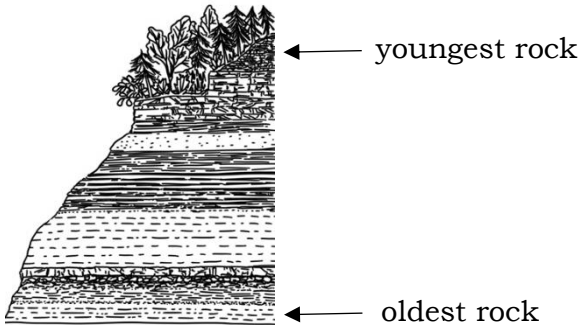


Figure 2. Stratigraphy

2. **Biostratigraphy**: In this technique, the faunal deposits such as fossils of dead animals are used to establish a strategy for dating. It is an extended version of the stratigraphy.

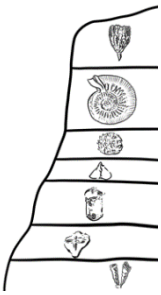


Figure 3. Biostratigraphy

3. **Cross dating**: In this method, the fossils of one layer are compared with another layer with known dating.

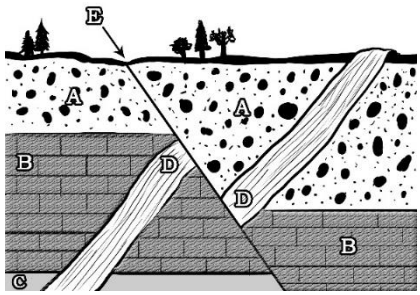


Figure 4. Cross-section of sedimentary layers
(A-C) igneous intrusion, (D) cross-section, (E) fault.

The principle of cross-cutting relationships states that a fault or intrusion is younger than the rocks that it cuts through. The fault labeled 'E' cuts through all three sedimentary rock layers (A, B, and C) and also cuts through the intrusion (D). So, the fault must be the youngest formation that is seen. The intrusion (D) cuts through the three sedimentary rock layers, so it must be younger than those layers.

The principle of superposition states that the oldest sedimentary rock units are at the bottom, and the youngest are at the top. Based on this, layer C is the oldest, followed by B and A.

What is Absolute Dating

In geology, absolute dating is a technique that determines the exact numerical age of a historical remaining. Since it evaluates the exact age of the sample, absolute aging is also called **numerical dating**. The four techniques used in absolute dating are radiometric dating, amino acid dating, dendrochronology, and thermoluminescence.

1. **Radiometric dating**: It determines the age of the sample by measuring the amount of a particular radioactive isotope present in the sample. The age can be determined by the rate of decay of that isotope. The type of radioactive isotope used depends on the type of sample. One of the most popular and widely used types of a radioactive isotope in this type of technique is carbon-14.
2. **Amino acid dating**: The change in the protein content of a biological sample can be used to determine the age. A particular form of living being may have a defined protein content in their bodies that deteriorates with time.
3. **Dendrochronology**: The number of annual growth rings of a dicot is used in this technique to determine the age of the tree.

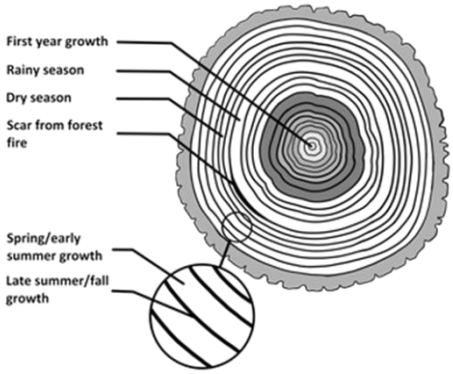


Figure 5. Dendrochronology

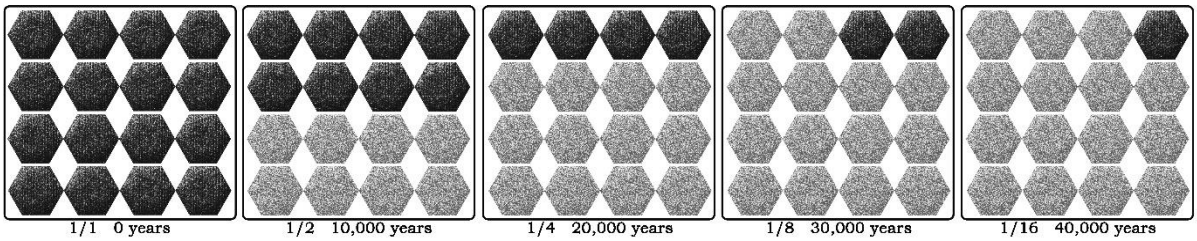
4. **Thermoluminescence**: This technique determines the final period during which the object absorbs light, emitting electrons. The age is determined for the emissions.

Scientists can learn the age of a rock by counting the number of parent and daughter atoms. A half-life is the time needed for one-half of the parent atoms to turn into daughter atoms. Different atoms have different half-lives. Some have half-lives are more than 4 billion years; others have half-lives of only 6,000 years. Scientists figure out which atom would be best to use to determine the exact age of a rock.

The atoms of some chemical elements have different forms, called isotopes. These break down over time in a process scientist call radioactive decay. Potassium-40 is one of the radiometric dating isotopes. Potassium-40 has a 1.3 billion-year half-life. It breaks down into argon and calcium. Geologist measures argon as a daughter substance Uranium-238 is a radioactive isotope that decays to lead-206 after a

certain amount of time. Uranium-238 has a half-life of 4.5 billion years. Rocks older than 10 million years can be dated using uranium-lead dating.

Figure 6. Radiometric Dating



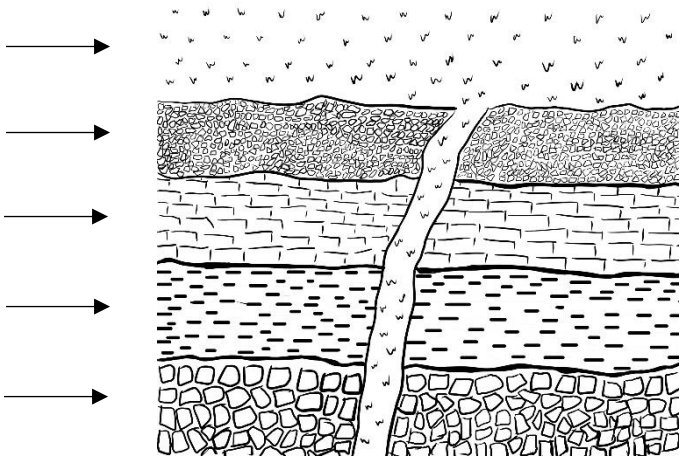
Legend: Black Shaded Hexagon- parent isotopes
Grey Shaded Hexagon- daughter isotopes

Although absolute dating and relative dating are methods used by geologists to determine the age of rock, their functions vary. Absolute dating determines the exact age of ancient specimens while relative dating gives the order of age of several samples. Consequently, absolute dating is a quantitative measurement while relative dating is a qualitative measurement. The precision of measurement also differs; in absolute is it high while low precision is relative. Absolute dating works well for igneous and metamorphic rocks. Meanwhile, relative dating works well for sedimentary rocks since it is composed of several layers of unconsolidated fragments. Lastly, absolute dating is expensive and takes time while relative dating is less expensive and efficient.

Source: https://pediaa.com/difference-between-absolute-and-relative-dating/

What's More

Use the stratigraphic superposition to show the formation of sedimentary and volcanic rocks. Draw the illustration on your paper and label each layer, 1, being the oldest and 5, as the youngest.



Radiometric Dating Activity

Study Table A and use it as the basis in determining the exact age of the parent and daughter atom in Table B. Write your answer on a sheet of paper.

Table A

	0	10,000 years	20,000 years	30,000 years
Parent isotope	16 mg	8 mg	4 mg	2 mg
Daughter isotope	0 mg	8 mg	12 mg	14 mg

Table B

	Parent isotope (mg)	Daughter isotope (mg)
Rock forms	20	0
10,000 years		
20,000 years		

Guide Questions:

1. What happens to the amount of parent isotope and daughter isotope over time?

   _____

2. Based on your answer in Table B, which determines the age of a rock? Why did you say so?

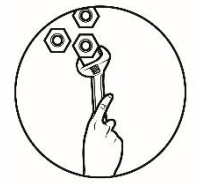
   _____

What I Have Learned

Complete the table using the descriptions inside the box. Write your answers on a separate sheet of paper.

Quantitative	Precision is high	Arranges fossils in order
Numerical age	Qualitative	Expensive & takes time
Less expensive	Precision is low	Works better for igneous and metamorphic rocks
Works better for sedimentary rock\s		

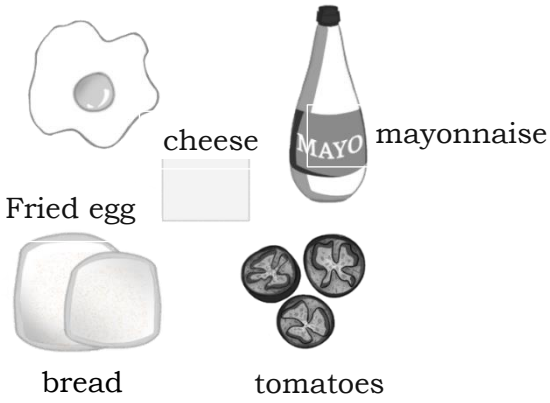
Absolute Dating	Relative Dating



What I Can Do

Analyze the situation and answer the given questions. Write your answers on a sheet of paper.

A. Suppose you were asked to prepare a yummy sandwich for a snack, arrange the ingredients in order.



Layer	Ingredients
6	
5	
4	
3	
2	
1	

1. How did you arrange the ingredients?

   _____

2. Based on your arrangement, which ingredient represents the topmost layer and the lowest layer?

   _____

3. In determining the age of stratified rock, which technique assumes that the lowest layer is the oldest while the topmost layer is the youngest?

   _____

B. Make a timeline of five important events in your life. Highlight the dates and the accomplishments. Write it in chronological order.

   _____

Assessment

Read and analyze the following questions. Write the letter the best answer in your paper.

1. What technique explains that the lowest layer is the oldest while the topmost layer is the youngest just like the clothes in the laundry basket?
   A. Dendrochronology
   B. Absolute dating
   c. Relative dating
   d. Stratigraphy

2. Which method evaluates the exact age of the sample?
   A. Total dating
   B. Relative dating
   c. Absolute dating
   d. Comparative dating

3. Which type of dating method can be used on rock layers by applying the law of superposition?
   A. Radioactive dating
   B. Radiometric dating
   c. Absolute dating
   d. Relative dating

4. Which of the following indicates the relative age of a rock layer?
   A. The thickness of the layer
   B. The chemical make-up of the rock
   C. The distance of the layer over the Earth
   D. The position of the layer compared to other layers

5. How can the absolute age of rock be determined?
   A. Matching the half-life
   B. Comparing the samples
   C. Calculating it to another ratio
   D. Measuring the amount of isotope and calculating the half-lives passed

6. How many half-lives have passed if a rock contains 25% isotopes and 75% daughter isotopes?
   A. One (1) half-life
   B. Two (2) half-lives
   c. Three (3) half-lives
   d. Four (4) half-lives

7. Which of the following describes relative dating?
   A. Precision is high
   B. Quantitative extent
   C. Arranges fossils in order
   D. Works better for metamorphic rocks

8. What does the number of daughter atoms indicate?
    A. The more daughter atoms, the older the rock is
    B. The daughter atoms remain after 10 half-lives.
    C. The higher the percentage, the older the rock is
    D. A shorter half-life means more accurate age.

9. Which is true about absolute dating?
    A. Precision is low
    B. Quantitative measurement
    C. Less expensive and efficient
    D. Works better for sedimentary rocks

10. Which is true in a series of sedimentary rocks?
    A. The upper layer is composed of older rocks.
    B. The lower layers are placed before older rocks.
    C. The bottom layer is the oldest, and the top layer is the youngest.
    D. The bottom layer is the youngest, and the top layer is the oldest.

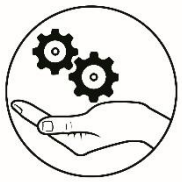
11. What happens when the isotopes decay?
    A. Parent isotopes become half
    B. Parent isotopes become a team
    C. Parent isotopes become a parent
    D. Parent isotope become a daughter

12. What is the importance of dating?
    A. Determines the age of fossils
    B. Defines the sample of fossils
    C. Identifies the number of fossils
    D. Regulates the particles in fossils

13. What is the extended version of the stratigraphy?
    A. Cross dating
    B. Biostratigraphy
    C. Amino acid dating
    D. Thermoluminescence

14. What is the meaning of the statement: You can't break a rock if it does not exist?
    A. Rock layers are not undisturbed.
    B. Rock layers are older than the faults found in them.
    C. Igneous intrusions are younger than the rock that they cut through.
    D. Fossils are generally the same age as the rock layers in which they are found.

15. What can you conclude about relative and absolute dating?
    A. Absolute dating arranges the fossils in order while relative dating determines the numerical age.
    B. Absolute dating compares the age while relative dating arranges the fossils in an order.
    C. Absolute dating is the technique that determines the exact age of a historical remain while relative dating gives the order of age of several samples.
    D. Absolute dating is the technique that gives the order of age of several samples while relative dating determines the exact age of a historical remain.



Additional Activities

Analyze the quotation and write a reflection about it. Write your answer on a sheet of paper.

"Remember to celebrate a milestone as you prepare for the road ahead."

Congratulations! You have successfully finished Lesson 10. You may now proceed to Lesson 11. Read in advance about the use of relative and absolute dating to determine the subdivisions of the geologic time scale. Also, recall your elementary and junior high school discussions on this topic. Good luck in the next level.

Answer Key

What I Know

1. D
2. C
3. B
4. C
5. A
6. A
7. D
8. A
9. D
10. D
11. A
12. B
13. C
14. C
15. A

What's More

A. 5

4

3

2

1

10,000 years	10	10
20,000 years	5	15

The number of parent isotopes decreases while the number of daughter isotopes increase.

The amount of daughter isotope produced.

Assessment

1. D
2. C
3. D
4. D
5. D
6. B
7. C
8. A
9. B
10. C
11. A
12. A
13. B
14. B
15. C

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