EARTH SCIENCE
Fox Lane High school

Name:_____Date: _____

UNIT TEN

Geologic Time and Earth History

*Dedicated to: _____

Name:_____Date: _____

ABSTRACT AND RATIONALE

The Earth is very old—4.5 billion years or more according to scientific estimates. Most of the evidence for an ancient Earth is contained in the rocks that form the Earth's crust. Within some of those rocks are the remains of life—plants and animals that evolved from organic structures that existed 3 billion years ago. Using radioactive dating process, the ages of these rocks and fossils can be calculated. Uniformitarianism, in geology, teaches us that many phenomenons within the Earth have operated with general uniformity through long periods of time.

TASK STATEMENT/PROBLEM BASED LEARNING/REAL WORLD PROBLEM:

The Finger Lakes Region of New York State is underlain by ancient rocks. Patterns of deposition and the existence of various fossils indicate that these rocks were deposited in a shallow sea that covered much of the central United States. Over 1200 meters (that's about ¾ of a mile!) of sedimentary rocks are deposited at that time .We can see continuous outcrops of over 100 meters of thickness in quarries (where stone is mined for building materials), in road cuts, and where rivers have cut deep gorges into the rocks.

You will correlate nine different outcrops from the area around Lake Cayuga to develop a complete 14 inch thick model of the rock layers (or STRATIGRAPHIC COLUMN) of the Devonian rocks columns in that area. Each inch of your model represents about 10 meters of outcrop.

ROCKS OF THE LAKE CAYUGA BASIN, NEW YORK

FORMATION	DESCRIPTION
Sherburne Shale	Shale at bottom with increasing sand toward top
Geneseo Shale	Black Shale about 10 meters thick
Tully limestone	Limestone about 3 meters thick
Moscow Shale	Shale with limestone base about 15 meters thick
Ludlowville Shale	Shale, about 25 meters thick
Skaneateles Shale	Shale with limestone cap, about 28 meters thick
Marcellus Shale	Mostly shale, black at base, then thin limestone, 4 meters of limestone at top. About 25 meters thick
Onandaga Limestone	Highly fossiliferous limestone over 25 meters thick
Oriskany Sandstone	Thin sandstone about 1.2 meters thick
Manlius Limestone	Finely layered limestone about 7.6 meters thick
Rondout Dolostone	Dolostone about 7.5 meters thick

Name:_____Date: _____
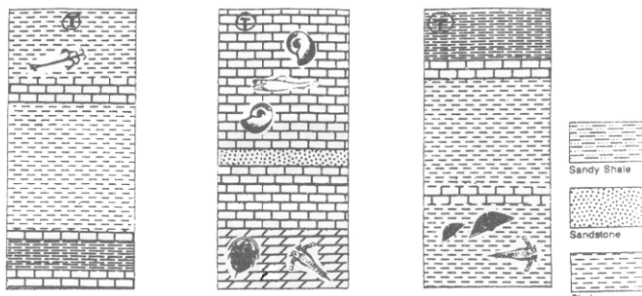
Anticipation Guideline (Studying the Past)

Read page#650-658 in your Earth Science Textbook. Base on the reading; **decide** whether or not each statement below is true (yes) or False (no). If the statement is no, please **indicate** the page# and line# where the correct answer is located in the text. In addition, be sure to **correct** the wrong word in the statement with the correct vocabulary. You may only fill out yes or no on one side of the table. The other side of the table will be done by you after hurricane topics.

| Your Hypothesis | | | True Answer | | |
Yes	No	Statements	Yes	No	Page# Line#
		Scientist use relative dating to help them determine the exact age of the rock			
		Principal of superposition allows the scientists to put the events randomly			
		Strata is structures of rocks			
		Igneous Intrusion is an example of cross cutting			
		Unconformity indicates where layers of rock are compressed			
		To see if two of the rocks from different locations are the same, geologists try to correlate rock layers			
		Index fossils are used to separate rock layers			
		Radioactive isotopes are used to do absolute dating			
		The rate at which the unstable atoms decay in full is called half life			

Name:_____Date: _____

Geologic Time Notes

PRINCIPAL OF UNIFORMITARIANISM: _____

TWO TYPES OF GEOLOGIC TIME

1. RELATIVE: _____

2. ABSOLUTE: _____

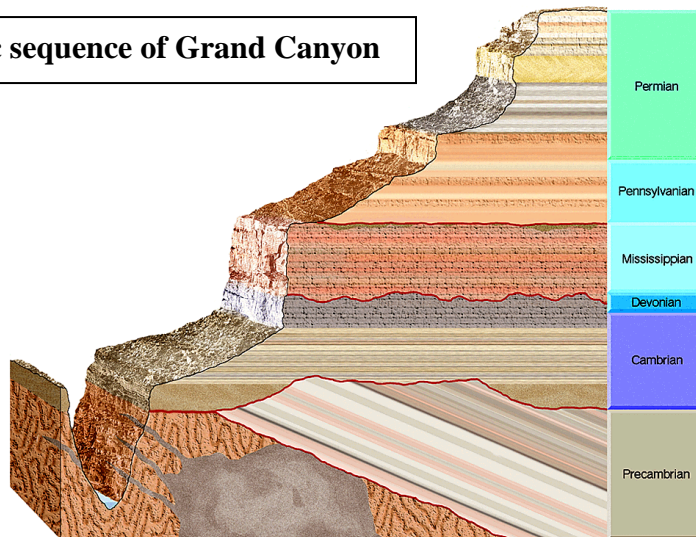FINDING **RELATIVE TIME**:

1. Superposition: _____
    A. Original Horizontality
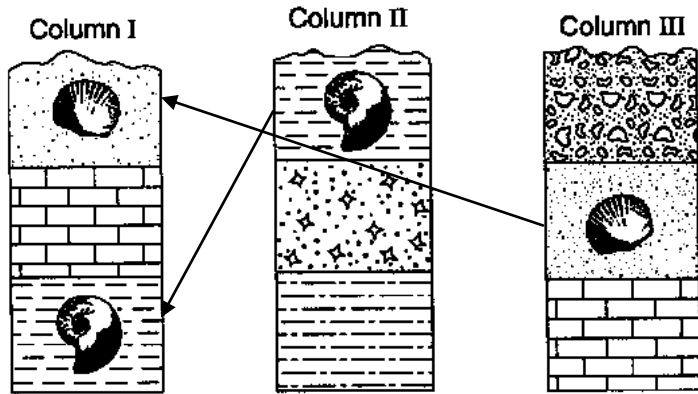
2. Cross Cutting: _____

3. Included fragments: _____

    A. Unconformity: _____
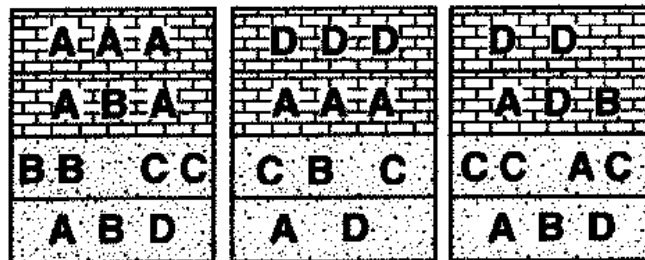
Example of geologic sequence of Grand Canyon

Permian

Pennsylvanian

Mississippian

Devonian

Cambrian

Precambrian

Name:_____Date: _____

4. Rock Correlation: _____

Column I   Column II   Column III

Example of Rock Correlation

5. Index Fossil: _____

A A A	D D D	D D
A B A	A A A	A D B
B B C C	C B C	C C A C
A B D	A D	A B D

FINDING **ABSOLUTE TIME**: _____

    A. Phenomenon of radioactivity: _____

    _____

    B. The rate of radioactive decay: _____
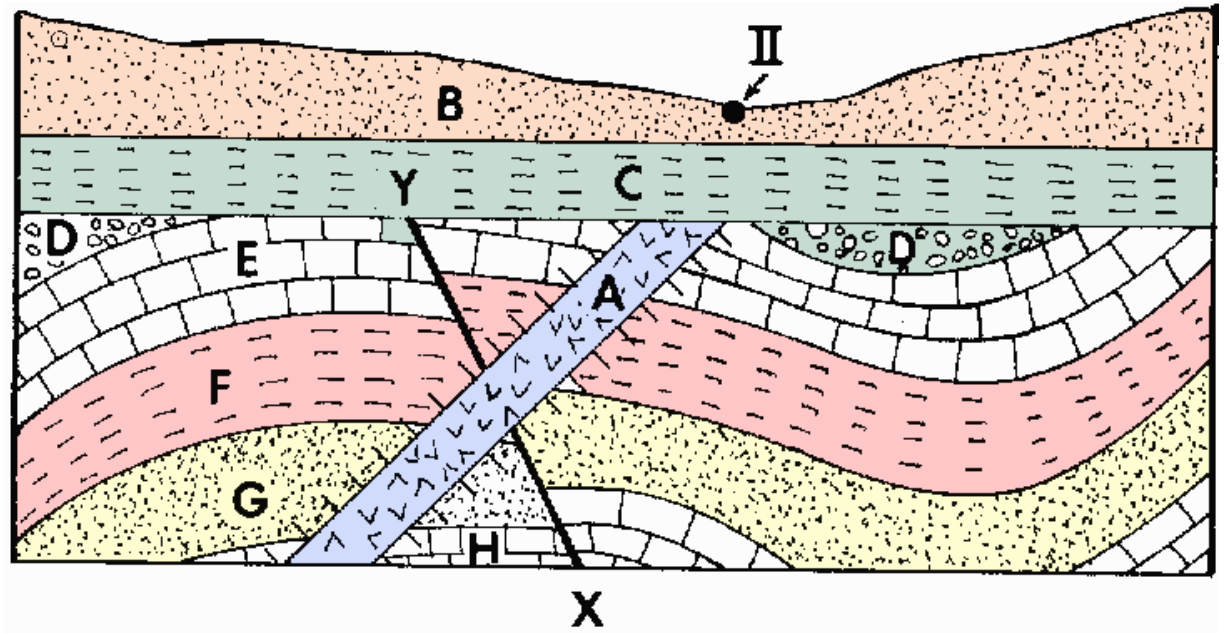
    C. The rate of radioactive decay is called: _____

Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$^{14}C \longrightarrow \, ^{14}N$	5.7×10^3
Potassium-40	$^{40}K \begin{array}{c} \nearrow \, ^{40}Ar \\ \searrow \, ^{40}Ca \end{array}$	1.3×10^9
Uranium-238	$^{238}U \longrightarrow \, ^{206}Pb$	4.5×10^9
Rubidium-87	$^{87}Rb \longrightarrow \, ^{87}Sr$	4.9×10^{10}

Radioactive Isotopes: _____

^{14}C

# of Half Life	% Remain and Fraction	Half Life Time

Name:_____Date: _____

Radioactive Decay Practice

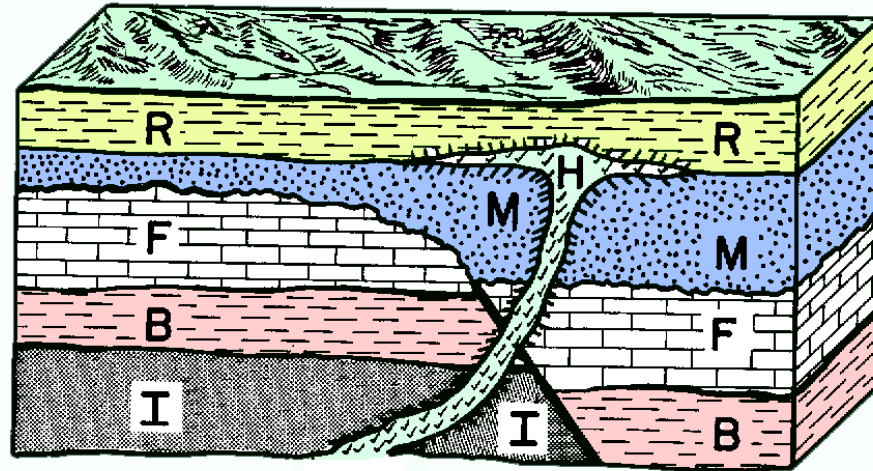| 0	1	2	3	4	5	6	7	8	9	10
100	50	25	12.5	6.25	3.125	1.5625	0.781	0.39	0.195	0.098
0	50	75	87.5	93.75	96.875	98.4375	99.2185	99.6085	99.8035	99.9
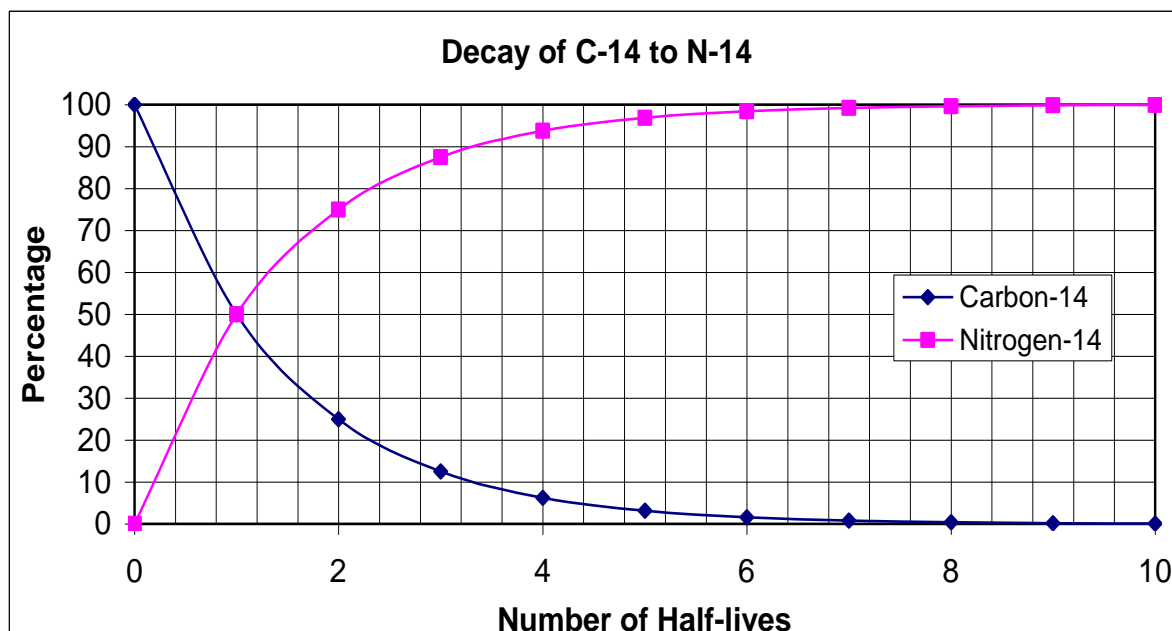
1. If a sample only contains 50g of Carbon14 and 50g of Nitrogen14, how many half-lives has it undergone? (assuming it started with 100g during 0 half life)

2. If a sample contains 25g of Carbon14 and 75g of Nitrogen14, how many half-lives has it undergone? (Assuming it started with 100g during 0 half life).

3. How old is a bone in which the Carbon14 in it has undergone 3 half-lives?

4. What percent of Carbon14 is left after 5 half-lives?

5. What happens to the amount of Nitrogen14 as the Carbon14 decays?

6. If a 20g of Carbon14 has a half-life of 5,700 years, what would be the half-life of a 40g sample?

Name:_____ Date: _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

                                         _____OLDEST

Name:_____Date: _____

_____

_____

_____

_____   _____

_____   _____

_____OLD

Radioactive Decay Data

Radioactive Elem.	Disintegration	Half -life	Uses
Carbon-14	C^{14} -> N^{14}	5.7×10^3	All organic material up to 100,000 years old
Potassium -40	K^{40} -> Ar^{40}	1.3×10^9	Dating of old rocks
Uranium -238	U^{238} -> pb^{206}	4.5×10^9	Dating of very old rocks
Rubidium-87	Rb^{87} -> Sr^{87}	4.9×10^9	Dating of the universe, the start of time

1) What is the total amount of U^{238} that will remain in a 1-gram sample of U^{238} after 4.5×10^9 years of radioactive decay?

2) A researcher has discovered an ancient settlement in Mexico. Which radioactive decay isotope would be used to date a piece of wood found in the area?

3) Why is Carbon 14 not usually used to accurately date objects more than 100,000 years old?

4) A rock sample contained 8-grams of potassium 40 when it formed. Today, it only contains 4-grams due to radioactive decay. How old is the rock?

5) A rock sample containing potassium 40 is calculated to be 3.9×10^9 years old. What fraction of the original potassium 40 remains?

1. The diagram below represents two geologic rock columns. The color and environment of deposition of each sedimentary rock are indicated beside the rock layers. Which rock layer in the West geologic column is most likely the same as rock layer X in the East column?
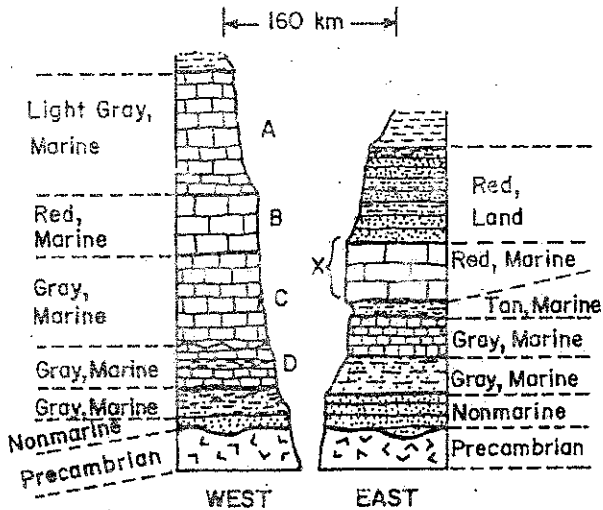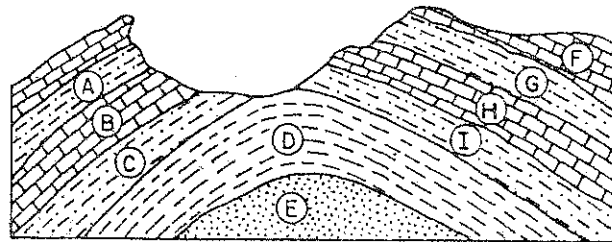

(1) A   (3) C
(2) B   (4) D

2. A layer of volcanic ash may serve as a time marker because the ash is
(1) generally deposited only on land
(2) composed of index fossils
(3) deposited rapidly over a large area
(4) often a distinct color

3. Base your answer to the following question on the diagram below which represents a cross section of an eroded fold that has *not* been overturned.

KEY
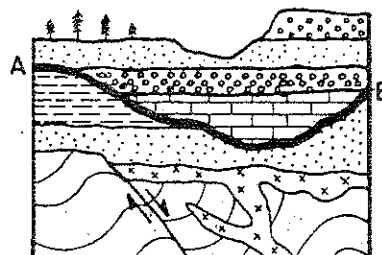- SANDSTONE
- LIMESTONE
- SILTSTONE
- SHALE

The fossils found in rock layer G will most closely resemble those found in rock layer
(1) A   (3) C
(2) I   (4) E

4. Why are ancient volcanic ash deposits important to geologists?
(1) They are easily dated using carbon-14.
(2) They form resistant rock layers containing fossils.
(3) They indicate areas where major earthquakes occurred.
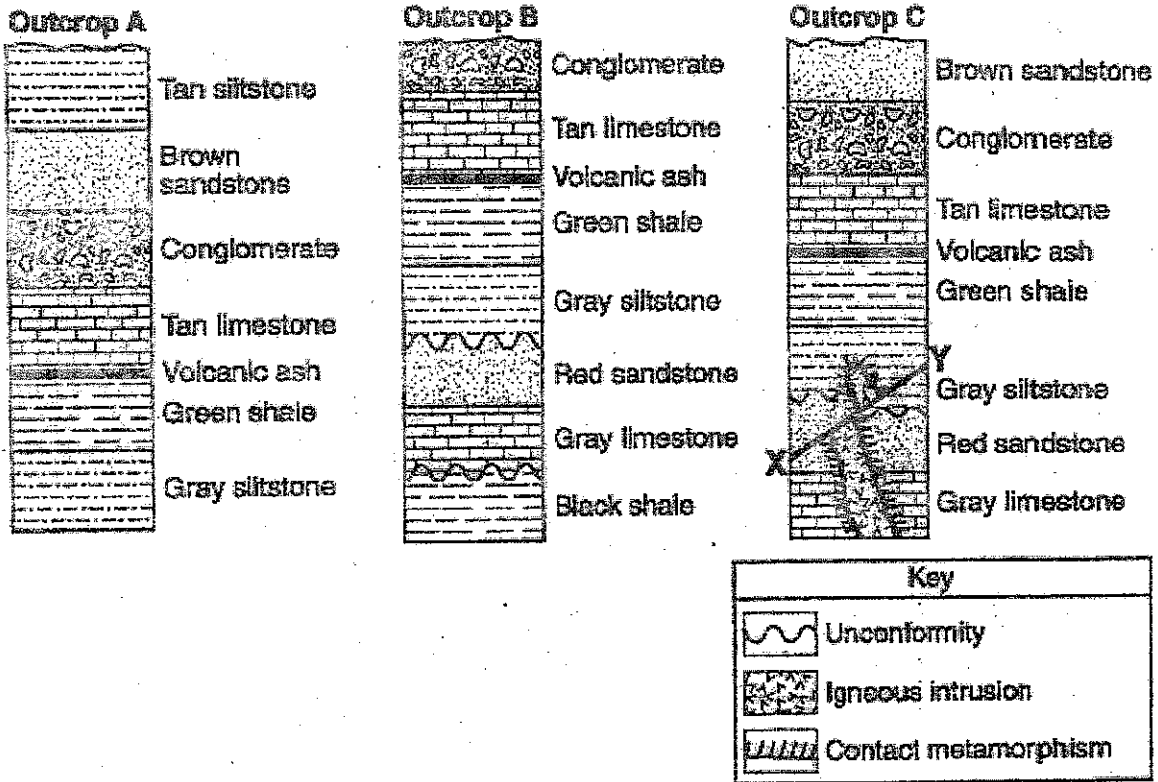(4) They serve as good geologic time markers.

5. What process most directly caused the formation of the feature shown by line AB in the geologic cross section below?

(1) erosion   (3) igneous intrusion
(2) faulting   (4) folding

8

6.

Outcrop A
- Tan siltstone
- Brown sandstone
- Conglomerate
- Tan limestone
- Volcanic ash
- Green shale
- Gray siltstone

Outcrop B
- Conglomerate
- Tan limestone
- Volcanic ash
- Green shale
- Gray siltstone
- Red sandstone
- Gray limestone
- Black shale

Outcrop C
- Brown sandstone
- Conglomerate
- Tan limestone
- Volcanic ash
- Green shale
- Gray siltstone
- Red sandstone
- Gray limestone

Key	
∿∿	Unconformity
▨	Igneous intrusion
⨅⨅⨅	Contact metamorphism

Which layer is the youngest?
1) Black Shale
2) Conglomerate
3) Tan Limestone
4) Brown Sandstone

7. Base your answer to the following question on the diagrams below. Diagram I shows part of a geologic map. Diagram II shows a geologic cross section taken along line *CD*. The rock layers shown have not been overturned. Numbers 1 through 5 represent locations on the surface bedrock.
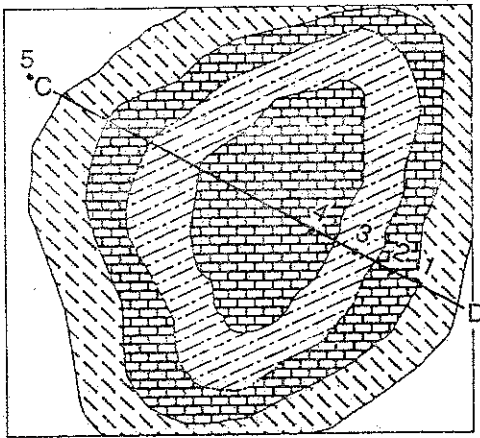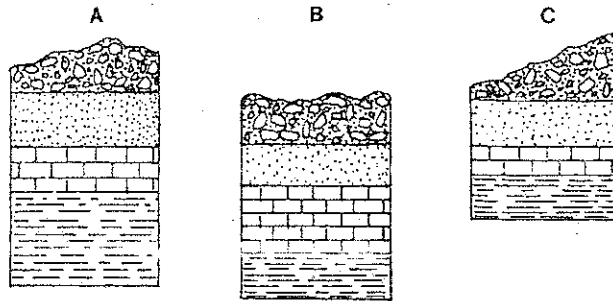
Diagram I

Diagram II

Which type of surface bedrock would most likely be found at location 5?

(1) shale   (3) chemical limestone

(2) sandstone   (4) siltstone

8. The diagram below represents cross sections of three rock outcrops approximately 100 kilometers apart. What would be the best method of correlating the rock layers of each outcrop?

(1) comparing rock types
(2) comparing mineral composition
(3) comparing index fossils
(4) comparing thickness of rock layers

9. What characteristics of fossils are most useful in correlating sedimentary rock layers?
(1) limited geographic distribution but found in many rock formations
(2) limited geographic distribution and limited to a particular rock formation
(3) wide geographic distribution but limited to a particular rock formation
(4) wide geographic distribution and found in many rock formations

1. According to the *Earth Science Reference Tables*, approximately how many years ago did the Palisades Sill form?
   (1) 195 million
   (2) 2 million
   (3) 570 million
   (4) 1,650 million

2. What is the estimated age of Earth?
   (1) 4.6×10^6 years
   (2) 4.6×10^7 years
   (3) 4.6×10^8 years
   (4) 4.6×10^9 years

3. According to the *Earth Science Reference Tables*, trilobite fossils may be found in Cambrian rocks. Which statement best explains why trilobite fossils are missing in Triassic rocks?
   (1) Trilobites became extinct before Triassic time.
   (2) Sedimentary rock did not form during Triassic time.
   (3) Widespread volcanic activity during Triassic time melted Triassic trilobite fossils.
   (4) Uplift and erosion destroyed Triassic trilobite fossils.

4. Which column best represents the relative duration of the major intervals of geologic history?
   (1)
   (2)
   (3)
   (4)
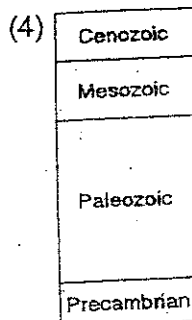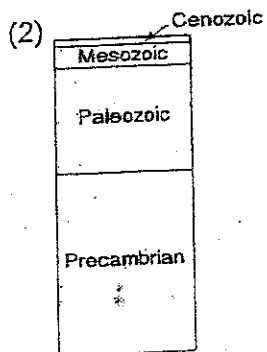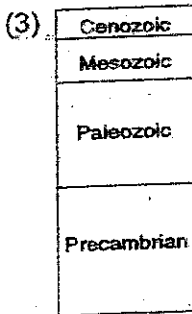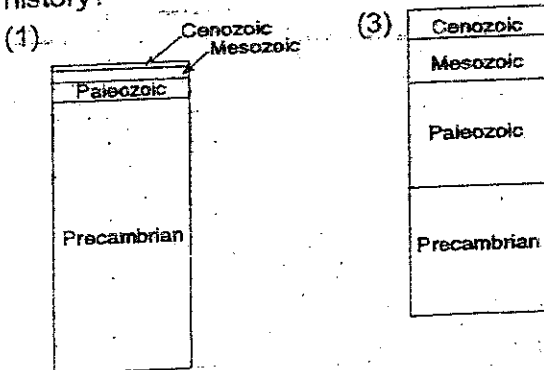
5. According to fossil evidence in the geologic record, which of these life-forms appeared on Earth most recently?
   (1) sharks
   (2) birds
   (3) flowering plants
   (4) placental mammals

6. New York State has no bedrock from which geologic time period?
   (1) Cambrian
   (2) Devonian
   (3) Permian
   (4) Cretaceous

7. A very large, circular, impact crater under the coast of Mexico is believed to be approximately 65 million years old. This impact event is inferred to be related to the
   (1) appearance of the earliest trilobites
   (2) advance and retreat of the last continental ice sheet
   (3) extinction of the dinosaurs
   (4) formation of Pangea

8. According to the *Earth Science Reference Tables*, which geologic event is associated with the Grenville Orogeny?
   (1) the formation of the ancestral Adirondack Mountains
   (2) the advance and retreat of the last continental ice sheet
   (3) the separation of South America from Africa
   (4) the initial opening of the Atlantic Ocean

9. According to the *Earth Science Reference Tables*, which geologic event most likely caused the Appalachian Mountains to form?
   (1) the melting of a subducted oceanic plate
   (2) the collision of North America and Africa
   (3) the eruption of an ancient volcanic mountain chain
   (4) the massive erosion and deposition of Mesozoic rocks

10. When did dinosaurs become extinct?
    (1) before the earliest birds
    (2) before the earliest mammals
    (3) at the end of the Cretaceous Period
    (4) at the end of the Cambrian Period

11. Which type of rock is most commonly found as an outcrop in the Allegheny Plateau in New York State?_____
    (1) sandstone   (3) basalt
    (2) gneiss   (4) slate

12. Which animals do scientists believe could have been hunted by humans, based on evidence such as stone spearpoints found embedded in the animals' bones?
    (1) dinosaurs   (3) armored fishes
    (2) mammoths   (4) trilobites

13. In order for an organism to be used as an index fossil, the organism must have been geographically widespread and must have
    (1) lived on land
    (2) lived in shallow water
    (3) been preserved by volcanic ash
    (4) existed for a geologically short time

14. The Geologic Time Scale has been subdivided into a number of time units called periods on the basis of
    (1) fossil evidence   (3) rock types
    (2) rock thicknesses   (4) radioactive dating

15. Fossils of two trilobite species from different geologic periods are illustrated below.
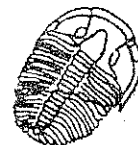
MIDDLE CAMBRIAN TRILOBITE   SILURIAN TRILOBITE

A comparison of these fossils provides evidence that these species may have
    (1) undergone evolutionary development
    (2) undergone metamorphism
    (3) experienced identical lifespans
    (4) experienced weathering and erosion

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6. Which graph best represents the relationship between the remaining mass of a radioactive element and time?

(1)

(3)

(2)

(4)
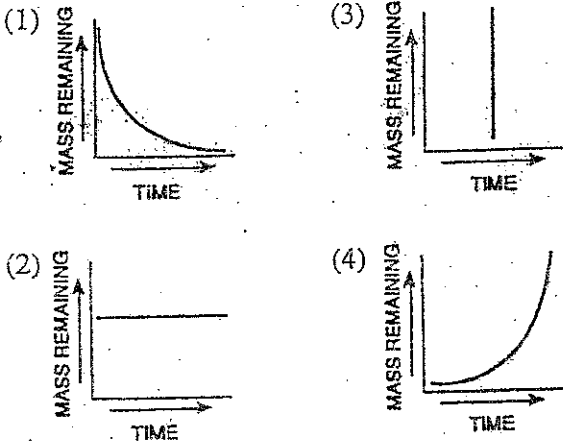
7. The table below gives information about the radioactive decay of carbon-14. Part of the table has been deliberately left blank for student use.

Half-life	Mass of Original Carbon-14 Remaining (grams)	Number of Years
0	1	0
1	$\frac{1}{2}$	5,700
2	$\frac{1}{4}$	11,400
3	$\frac{1}{8}$	17,100
4	$\frac{1}{16}$	
5		
6		
7		

After how many years will $\frac{1}{128}$ gram of the original carbon-14 reamin?

(1) 22,800 yr   (3) 34,200 yr

(2) 28,500 yr   (4) 39,900 yr

8. Base your answer to the following question on the *Earth Science Reference Tables*.

What is the approximate age of an igneous rock that contains only one-fourth of its original potassium-40 content due to radioactive decay?

19. Using radioactive dating methods and mathematical inferences, scientists have estimated the date of Earth's formation to be approximately

(1) 1.1×10^6 years ago   (3) 3.3×10^9 years ago

(2) 2.4×10^6 years ago   (4) 4.6×10^9 years ago .

20. The diagram below represents a clock used to time the half-life of a particular radioactive substance. The clock was started at 12:00. The shaded portion on the clock represents the number of hours one-half of this radioactive substance took to disintegrate.
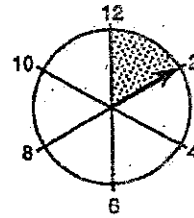
Which diagram best represents the clock at the end of the next half-life of this radioactive substance?

(1)

(3)

(2)

(4)
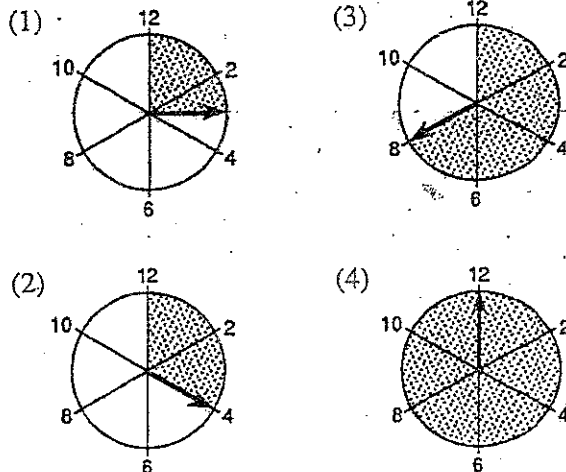
ESRT Review

(pages 8 & 9)

Earth History

THE GEOLOGIC TIME SCALE

1. The geologic time scale is based on _____ evidence.

2. There are four sub-divisions of geologic time (representing varying lengths of time), they are (1) _Eon_ ,
    (2) _Era_ , (3) _____ and (4) _____ .

3. What is the longest Eon? _____

4. The three major eras of time are the _____, _____ and
    _____. These are part of the Phanerozoic Eon.

5. What is the duration of the Mesozoic Era? _____

6. When did the Silurian Period start? _____

7. During what period of Earth history did the Naples Tree (Q) first appear? _____

8. What major event (with regard to life on Earth) marks the boundary between the Paleozoic and Mesozoic eras?

9. What period and epoch did the Catskill Delta form? _____

10. Approximately how long have humans been on Earth? _____

11. What is the age of the Earth? _____

12. How long ago did the dinosaurs become extinct? At the end of what Era? Which Period?

13. The Precambrian Eon is divided into the _____ & _____

14. Another name for the Carboniferous Period is _____ & _____

15. **Approximately** how many **years ago** did:

    a. the earliest insects appear? _____

    b. a mass extinction of many kinds of marine life occur? _____

    c. humans first appeared? _____

    d. stromatolites appear as first fossilized form of life? _____

    e. eurypterids reached their peak? _____

16. For which two periods of geologic time do we have NO evidence of rocks or fossils in NYS?

17. During **which period** of time did:

     a. the first dinosaur appear? _____

     b. the last dinosaur die out? _____

     c. Which **Era** therefore is known as the "Age of the Dinosaur?" _____

18. According to the column titled Important Geologic Events in NY:

     a. The Atlantic Ocean first split apart (sea floor spreading) about how many years ago? _____

     b. The Adirondack Mountains were uplifted how many years ago? _____

     c. The last continental ice sheet or glacier melted back north from NYS how many years ago? _____
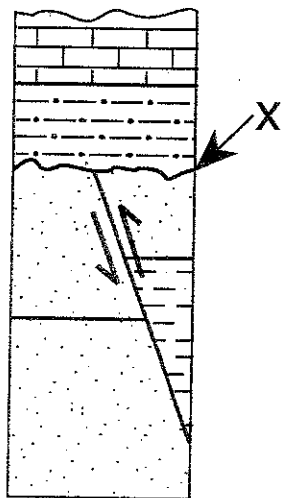
Base your answers to questions **1** through **3** on the geologic cross section below. The cross section shows an outcrop in which the layers have not been overturned. Rock units are labeled *A* through *E*.
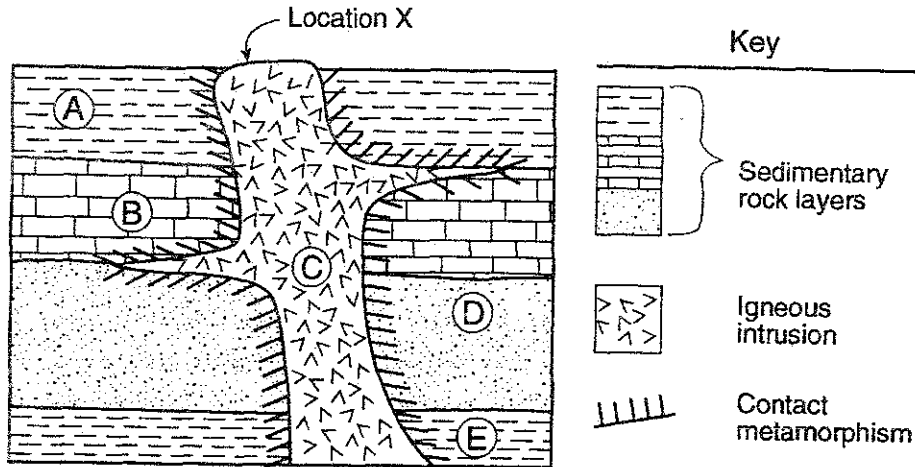
1. Using letters *A* through *E*, list the rock units in order from oldest to youngest.

2. State the name of the sediment that was compacted to form rock unit *A*.

3. State one observation about the crystals at location *X* that would provide evidence that igneous rock unit *C* was formed by very slow cooling of magma.

_____

13. The diagram below shows a cross section of New York State bedrock that has not been overturned. Line *X* represents an unconformity.
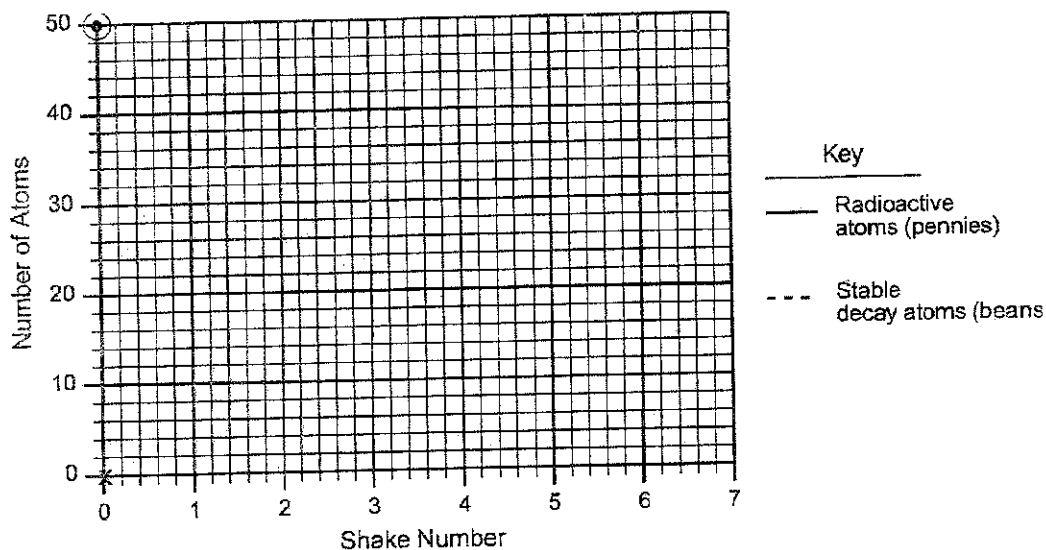

The index fossil *Eurypterus* is found in the limestone layer. What trilobite index fossil could be found in the shale layer?

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Base your answers to questions **4** and **5** on the table below, which shows the results of a student's demonstration modeling radioactive decay. To begin, the student put 50 pennies heads up in a container. Each penny represented one radioactive atom. The student placed a top on the box and shook the box. Each penny that had flipped over to the tails up side was replaced with a bean that represented the stable decay product. The student continued the process until all of the pennies had been replaced by beans.

Shake Number	Number of Radioactive Atoms (pennies)	Number of Stable Decay Atoms (beans)
0	50	0
1	25	25
2	14	36
3	7	43
4	5	45
5	2	48
6	1	49
7	0	50

Key

—— Radioactive atoms (pennies)

- - - Stable decay atoms (beans

4. On the grid provided on your answer paper, graph the data shown on the table by following the steps below.

    a Mark with a dot each number of radioactive atoms (pennies) after each shake. Surround each dot with a small circle. The zero shake has been plotted for you.
    b Connect all the dots with a solid line.
    c Mark with an *X* the number of stable decay atoms (beans) after each shake. The zero shake has been plotted for you.
    d Connect all the *X*'s with a dashed line.

5. Assume that each shake number represents an additional 100 years. State the half-life of the radioactive material in this model.

16.

Base your answers to questions **6** and **7** on the newspaper article below.

New Fossils Indicate Arctic Climate Used To Be Floridian

The frigid Arctic regions were as warm as present-day Florida some 90 million years ago, according to researchers who found fossils of a crocodile-like animal in northern Canada.

Six hundred miles from the North Pole, researchers from the University of Rochester found the fossilized remains of the champosaur, a toothy, 8-foot-long extinct crocodile.

"We found a whole collection of fossils, from both young and adults," said scientist John H. Tarduno.

"The champosaur is a cold-blooded animal that could not have survived in the current climate of the Canadian Arctic where the fossils were found," Tarduno said.

Temperatures at the fossil site now routinely drop to minus 60 degrees Fahrenheit in the winter. When the champosaur lived there 86 million to 92 million years ago, winter temperatures rarely dropped to freezing and summer readings of 80 degrees were common.

The cold-blooded champosaur depended on the environment for warmth and probably became immobile if the temperature was too cold. Most likely, the champosaur was too small to have migrated seasonally.

A field team from the University of Rochester found the fossils in a layer of sandstone located above a layer of basaltic lava.

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6. State the geologic time period in which the champosaur lived.

7. Explain why no champosaur fossils were found within the layer of basaltic lava.

_____

Geologic History Short Answer Questions

Base your answers to questions **8** through **10** on the paragraph below, which provides background information regarding recent fossil discoveries in Canada.

> Scientific evidence indicates that the earliest mammals may have evolved approximately 225 million years ago from an ancient reptile group called the therapsids. For millions of years afterward, early mammals and therapsids coexisted until the therapsids apparently became extinct 165 million years ago. However, geologists have recently found a fossil they believe to be a therapsid that is only 60 million years old. They found the fossil, which they have named *Chronoperates paradoxus* (paradoxical time-wanderer), near Calgary in Canada. This find suggests that for 105 million years after the apparent extinction of the therapsids, a few of the reptiles continued to live in a narrow geographic range in Canada.

8. According to fossil evidence, during which geologic period did the earliest mammals appear on Earth?

9. Explain briefly why *Chronoperates paradoxus* would not be a good index fossil.

10. State one method geologists could have used to determine that *Chronoperates paradoxus* lived 60 million years ago.

Base your answers to questions **11** and **12** on the cross section provided in your answer booklet. The cross section represents a portion of Earth's crust. Letters *A, B, C,* and *D* are rock units.
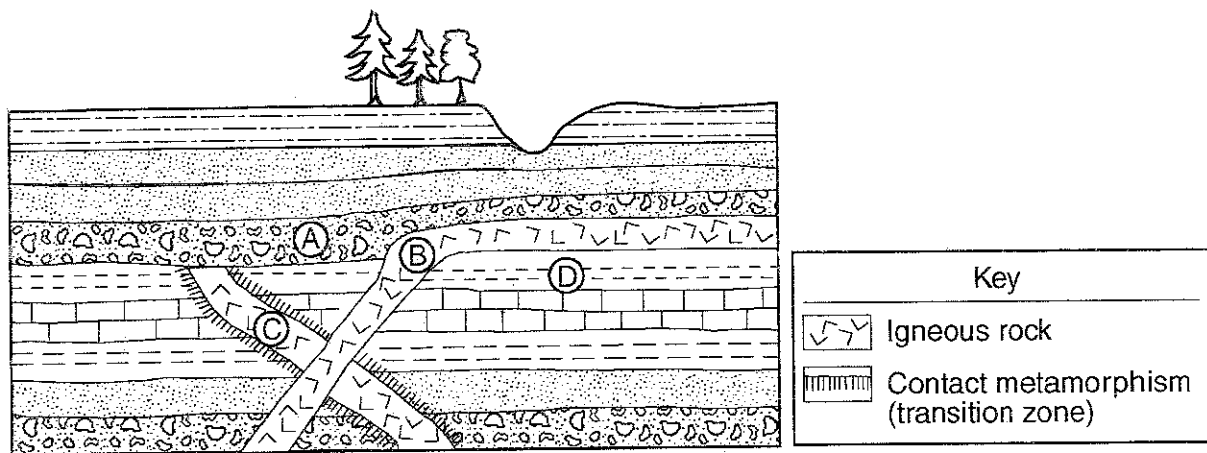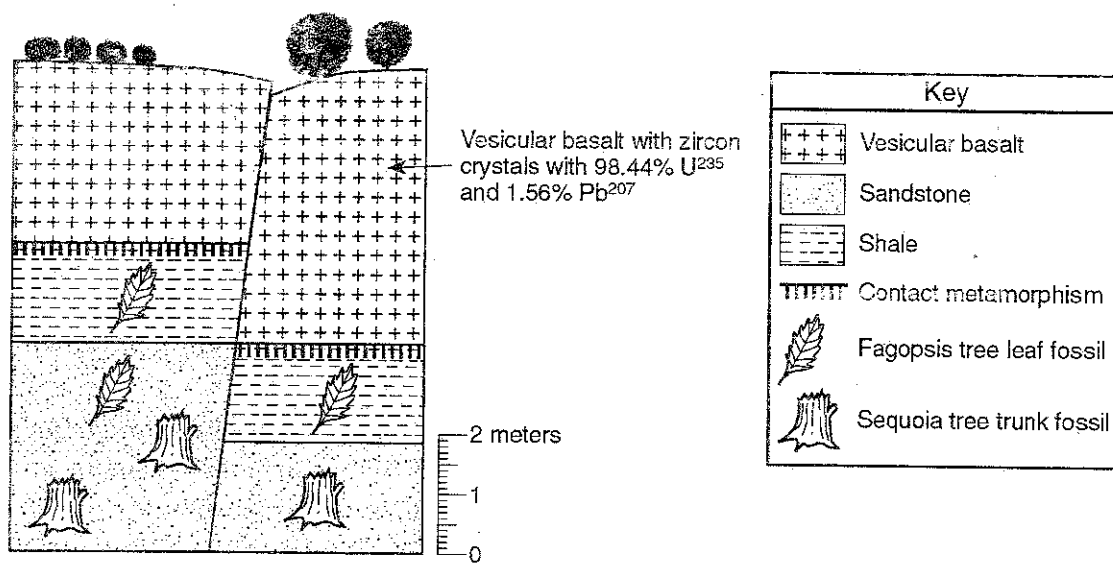

11. In relation to rock units *A* and *B* in the cross section, when was igneous rock *C* formed?

12. Describe one observable characteristic of rock *A* that indicates that rock *A* is sedimentary.

Geologic History Short Answer Questions

Base your answers to questions **14** and **15** on the geologic cross section and graph provided below, which represents an outcrop of various types of bedrock and bedrock features in Colorado.

Percent of U-235 Remaining	Percent Decayed to Pb-207	Half-Lives Elapsed
99.22	0.78	$\frac{1}{64}$
98.44	1.56	$\frac{1}{32}$
96.88	3.12	$\frac{1}{16}$
93.75	6.25	$\frac{1}{8}$
87.50	12.5	$\frac{1}{4}$
75.0	25.0	$\frac{1}{2}$
50.0	50.0	1
37.5	62.5	$1\frac{1}{2}$
25.0	75.0	2
12.5	87.5	3
6.25	93.75	4

Vesicular basalt with zircon crystals with 98.44% U^{235} and 1.56% Pb^{207}

Key: Vesicular basalt, Sandstone, Shale, Contact metamorphism, Fagopsis tree leaf fossil, Sequoia tree trunk fossil

14. On the cross section provided above, indicate with arrows the direction of movement on *both* sides of the fault.

15. According to this cross section, what is the amount of vertical movement of the shale along the fault? Express your answer to the *nearest tenth of a meter*
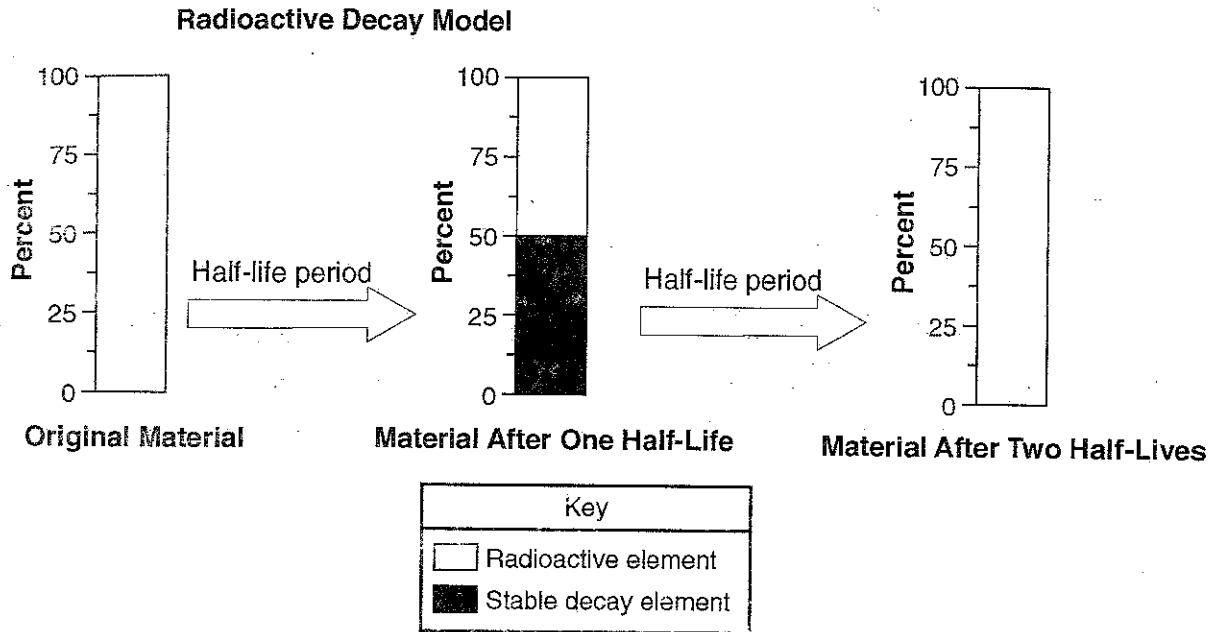
Base your answers to questions **16** through **19** on The geologic cross section below. Radioactive dating indicates that the granite intrusion is 279 million years old and the vesicular basalt is 260 million years old. The rock layers have not been overturned.
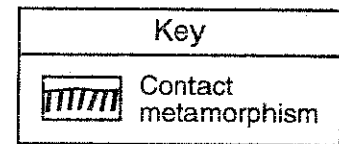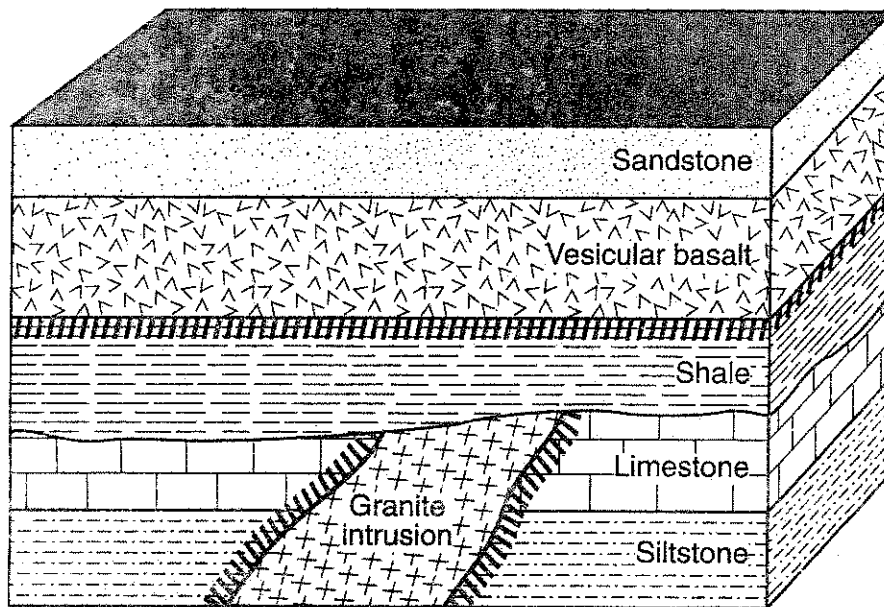
16. List the six rock units in the order from the oldest to the youngest.

17. During which geologic time period did the shale layer form?

18. The granite intrusion caused part of the limestone layer to undergo metamorphism. What metamorphic rock would most likely be found in this zone of contact metamorphism?

19. Describe the rate of cooling that must occur for magma to form vesicular basalt.

Base your answers to questions **20** and **21** on the diagram below, which represents a model of the radioactive decay of a particular element. The diagram shows the decay of a radioactive element into the stable decay element after one half-life period.

Radioactive Decay Model

Original Material   Material After One Half-Life   Material After Two Half-Lives

Key	
☐	Radioactive element
■	Stable decay element

20. On the diagram above labeled *Material After Two Half-lives*, shade in the amount of stable decay element present after the second half-life period.

21. If the radioactive element in this model is carbon-14, how much time will have passed after one half-life?

Rubric for Geologic Time and Earth History/Learning Objectives

INDICATORS	Novice	Apprentice	Practitioner	Expert
Geologic Time Scale	Understand the geologic time scale is divided into eons, eras, periods and epochs.	Explain how scientists organize the major events of Earth's past. Explain how Precambrian time and the Paleozoic Era differ.	☐ Understand the geologic time scale is based on fossil and rock records ☐ To identify common fossils and state their habitats. ☐ To describe the evolution of certain life form such as trilobites ☐ Explain what past conditions may have caused certain extinctions	*All practitioner plus* Explain how conditions on earth are currently changing and hypothesize future extinctions
Radioactive Dating	Understand the difference between relative time and absolute time	Name the methods used to measure relative time and absolute time Name the radioactive isotopes that are used to measure absolute time	☐ To understand the basic nuclear structure ☐ To distinguish between the different types of radioactive decays ☐ Compute the daughter nuclei for these decays. ☐ Use the concept of half -life to determine the age of radioactive samples	*All practitioner plus* Use diagrams to explain how a parent isotope of uranium becomes the daughter isotope lead via the process of radioactive decay Explain why the atomic number increases after beta decay.
Relative Dating	Explain what is relative time and how it's used to order past events	Define law of superposition Define cross cutting Define unconformity Define included fragments Define inclusion Define law of horizontality	☐ Describe the characteristics of a good index fossil ☐ Explain how index fossils can be used to determine relative age of a strata ☐ Explain how scientist use law of superposition to determine the relative age of rocks	*All practitioner plus* Students will successfully arrange different geologic events in a sequence. Explain fauna succession
Rock Correlation	Define rock correlation	Explain how rock correlation is used to determine the relative age of rocks	☐ Describe three methods that can be used to correlate two rock layers in two distant locations ☐ Student construct a stratigraphic column by correlating rock outcrops	*All practitioner plus* Students construct a stratigraphic column of Cayuga Lake Basin using information from 9 outcrops Identify the index fossils in this basin