

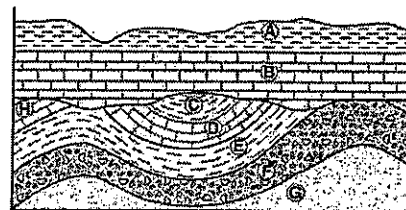
NAME: Key

GEOLOGIC HISTORY NOTES

Log onto YouTube and search for jocrisci channel.

GEOLOGIC HISTORY DIAGRAMS (Video 6.1)

1. Given a geologic cross section, you must be able to recognize folding, faulting, intrusions, unconformities, and tilting
2. What two characteristics make a fossil an index fossil?
3. What is the principle of superposition?
4. Given a geologic cross section, you must be able to use relative dating to construct an age sequence (oldest to youngest)
5. What is an unconformity and what does it represent?



RADIOMETRIC DATING (Video 6.2 ESRT 1d)

1. Given the proportions of the original isotope and the decay product, you must be able to calculate the age of the rock
 - a. A sample of wood that originally contained 100 grams of carbon-14 now only contains 25 grams of carbon-14. Approximately how many years ago was this sample part of a living tree?
2. Carbon 14 cannot be used to date an igneous rock from the Mesozoic Era. Give two (2) reasons explaining why.

GEOLOGIC TIME SCALE/GEOLOGIC MAPS (Video 6.3 ESRT 2, 3b, 8a, 8b, 8c)

1. The geologic time scale is a record of the major events in the history of the earth. By studying fossils, we have learned that life on this planet has undergone two major changes.
 - a. What are the two eons on the Geologic Time Scale?
 - b. How many millions of years ago did the Paleozoic Era begin?
 - c. During what period did the following first appear on Earth:
 - i. Earliest fish
 - ii. Eurypterids
 - d. During what period did the Acadian Orogeny occur?
 - e. During what period was the Palisades Sill intruded?
 - f. For what periods is the rock record completely preserved in New York State?
 - g. During which Epoch did the advance and retreat of the last continental ice occur?
2. Given a location in New York State, you must be able to determine its age in years, the eon, era, period, and epoch it belongs to, the rock type, and the fossil content
 - a. During which period were the rocks at each of the following cities formed?
 - i. Albany
 - ii. Binghamton
 - b. What kinds of rocks can be found at the following cities?
 - i. Niagara Falls
 - ii. Elmira

Geologic History Facts

- Video 6.1
1. In undisturbed strata, the bottom layer is / older (law of superposition)
 2. Sedimentary rocks are ALWAYS deposited in / horizontal layers and underwater (original horizontality)
 3. Any fault, fold, intrusion, that disrupts another layer is / always younger than the rock layer
 4. Contact metamorphism occurs when / molten rock partially melts the rock around it
 5. If an intrusion has no contact meta. (bald) on top it is / older and was an extrusion
 6. If an intrusion has contact meta. (hairs) on top it is / younger than the rock layer above it
 7. An unconformity was caused by / erosion and weathering (seen as the line that separates crazy layers from straight layers)
 8. Unconformities represent a / gap in the geologic record
 9. Volcanic ash good time marker because / it spreads out quickly over a large area
 10. Index fossils are / found over a wide area and existed for a short period of time (found only in one geologic layer on a diagram)
- Video 6.2 ESRT 1d
11. Radioactive (absolute) dating / compares percentage of unstable atoms to stable atoms to get age of rock
 12. Half life means / the time it takes for 1/2 the unstable atoms to decay into stable atoms (think hour glass, sand grains)
 13. The half life of a radioactive isotope cannot / be changed No Matter What! Radioactive elements decay forever!
 14. When calculating half using a T or T.O.M. chart remember to / add half life on the time (left) side and divide (÷) by 2 on the mass (right) side.
 15. Carbon 14 is used to date / RECENT organic remains (thousands of years ago)
 16. Uranium 238 is used date / old rocks (billions of years ago)
- Videos ESRT 8 a - 8c
17. Earth is / 4.6 billion years old (that is about when the sun and solar system formed)
 18. Precambrian time period is / 4 billion years long (most of earth's time, only simplest life forms existed)
 19. The geologic timescale is based on / fossil evidence
 20. Most life forms (99%) from the geologic past have / become extinct
 21. The atmosphere formed from / outgassing of volcanoes (CO₂, N₂, H₂O)
 22. Asteroid impacts are thought to cause / mass extinctions (dinosaurs died 65 mya)
- Vid 6.3 ESRT 2 & 3b
23. Landscapes are determined by the / climate, bedrock, and geologic structures
 24. Plateaus are classified by / high elevations and horizontal bedrock
 25. Humid (wet) landscapes have / smooth, rounded slopes (think around here)
 26. Arid (dry) landscapes have / steep slopes with sharp angles (think Grand Canyon)

Geologic History

Fact(s) to memorize: 1 - 4

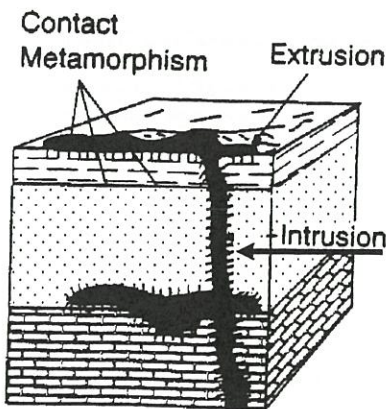
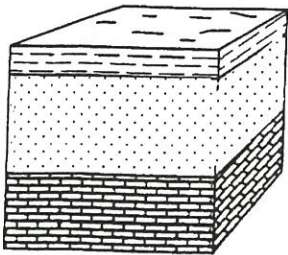


Relative Time

Index Fossils

Law of Superposition

Compares ages of rock layers based on objects around it. (Older/younger)



Absolute Time

Gives Age of a rock or fossil

Radioactive Elements

Carbon + uranium

Law of Superposition:

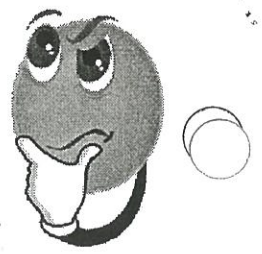
in undisturbed strata the bottom layer is the oldest.

Original Horizontality:

rock layers are deposited horizontally

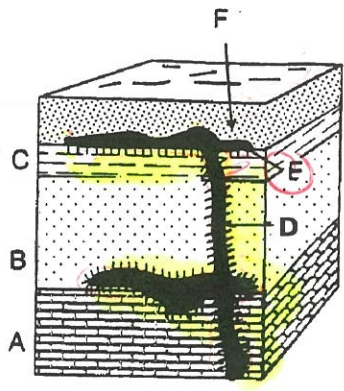
Uniformitarianism:

Cross Cutting:



Sequence of events:

- A) Deposition of A
- B) Deposition of B
- C) Deposition of C
- D) Igneous Intrusion of D
- E) Igneous Extrusion E
- F) Deposition of F



ROCK CORRELATION

Intrusion Magma seeps into cracks in rocks

Extrusion lava makes it outside of a rock layer

Folds, faults, tilting Fold [diagram] Tilt [diagram] Fault [diagram]

Unconformity

Volcanic Ash Falls

Overtured

Index Fossil Help date rock layers

2 things that make a good index fossil { lived for a short time, lived over a large area

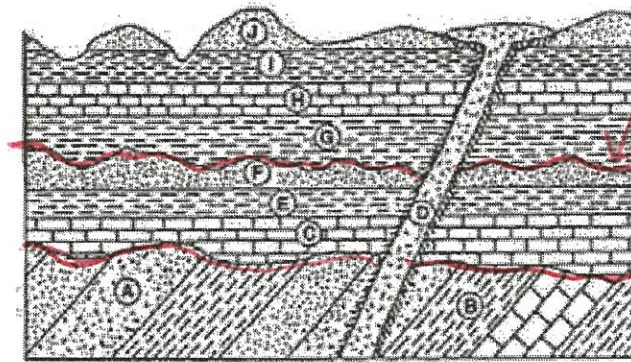
Sequence of Events Practice

Circle the oldest rock layer in the table below, based on the diagram.

Unconformity

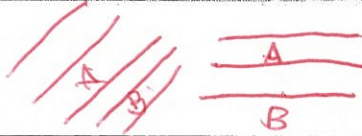


| | | | |
|----------|----------|----------|----------|
| H | <u>G</u> | E | <u>C</u> |
| A | <u>B</u> | J | <u>F</u> |
| <u>E</u> | D | D | <u>H</u> |
| D | <u>J</u> | <u>A</u> | D |
| I | <u>C</u> | <u>I</u> | J |
| <u>B</u> | C | <u>B</u> | I |
| <u>A</u> | F | <u>E</u> | F |



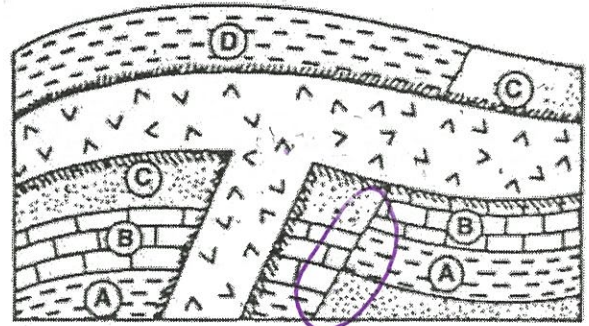
Key

- Sedimentary Rock
- Igneous Rock
- Contact Metamorphism



True or False: (T) or (F) Answer the following based on the diagram to the right

| | |
|---|----------|
| Rock layer C is older than rock Layer D | <u>T</u> |
| The intrusion is older than rock layer A and older than the fault | <u>F</u> |
| Rock layer B is limestone | <u>T</u> |
| The intrusion is older than rock layer C and younger than the fault | <u>F</u> |
| Folding of rock layers occurred prior to the igneous intrusion | <u>T</u> |
| The intrusion is younger than rock layer D and younger than the fault | <u>T</u> |
| The intrusion is older than rock layer B and older than the fault | <u>F</u> |
| The igneous intrusion is the youngest rock layer shown | <u>T</u> |

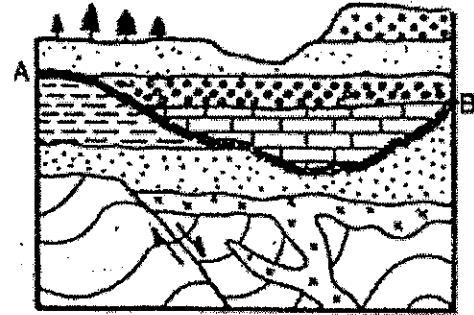


Key

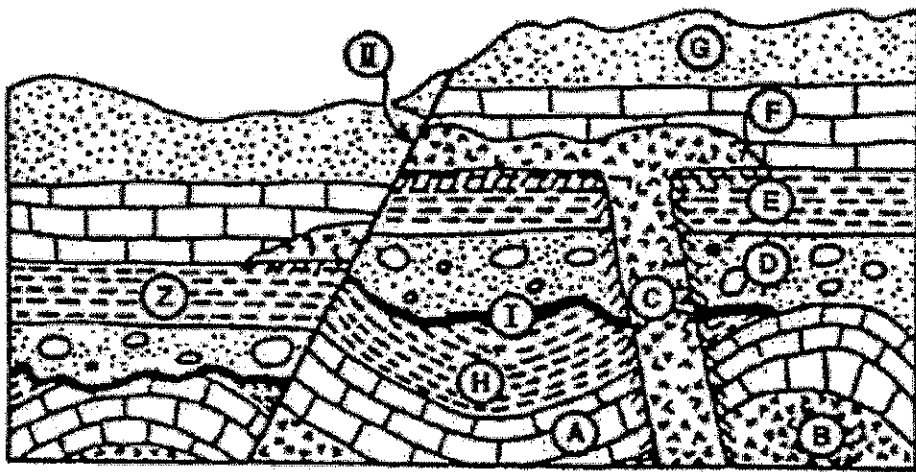
- Igneous Intrusion
- Sedimentary Rocks
- Contact Metamorphism

1. What process most directly caused the formation of the feature shown by line AB in the geologic cross section in the diagram to the right?



2. What is the name given to this formation?



Use the diagram below to complete following questions. The rock layers were not overturned.

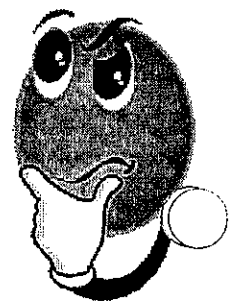


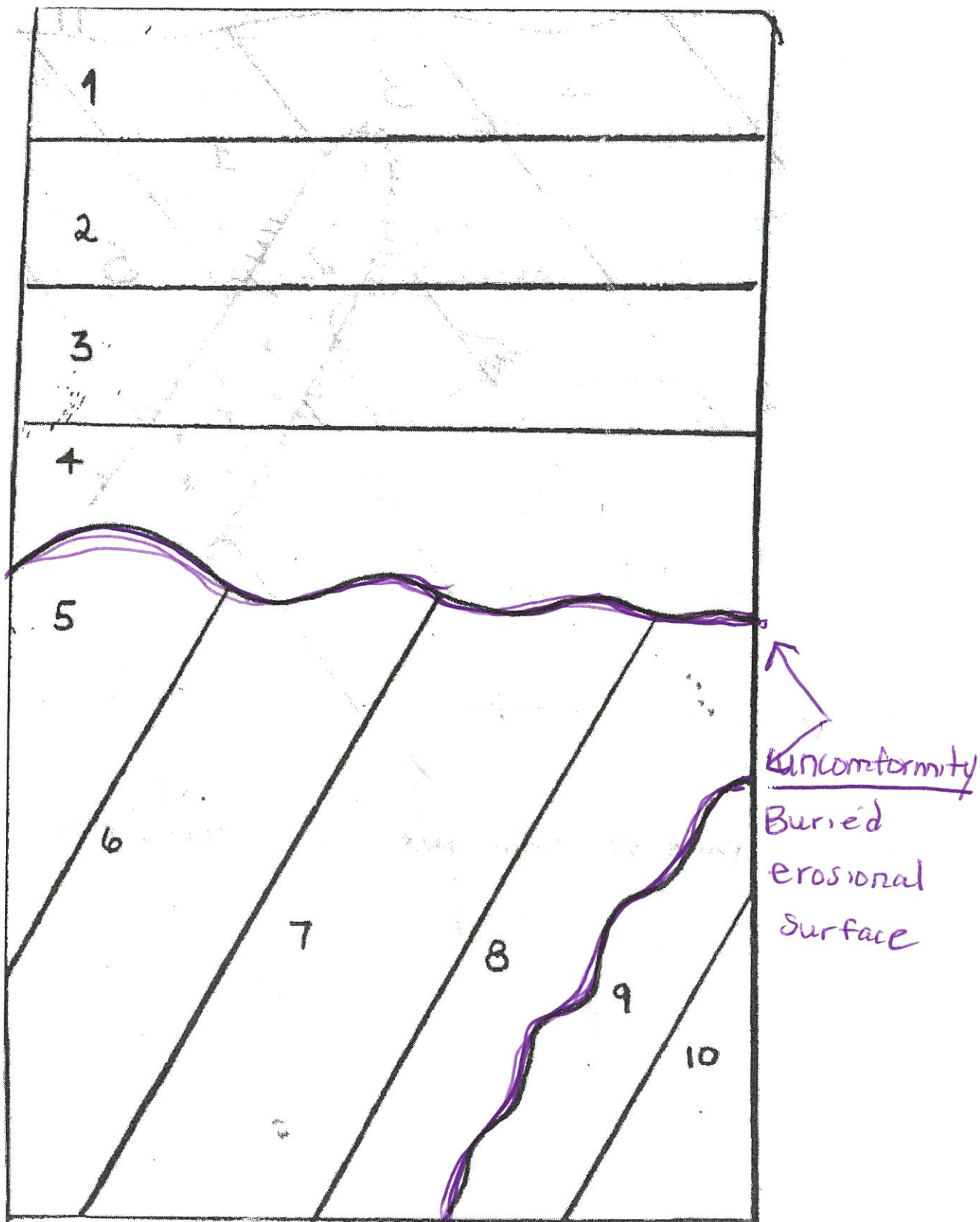
KEY

-  Igneous Rock
-  Contact Metamorphism

3. Rock layer A is younger than rock layer _____
4. Rock layer Z represents the same rock layer as _____
5. In which rock layers are fossils least likely to be found? _____ & _____
6. Would rock layer C be considered an intrusion or an extrusion? _____
7. Upon examination of rock layer C, would you infer the size of the crystals to be small in size or large in size? _____
8. Name the sedimentary rock layer G. _____
9. Name the sedimentary rock layer A. _____
10. What metamorphic rock would be found in layer E at the site of contact metamorphism? _____
11. What metamorphic rock would be found in layer A at the site of contact metamorphism? _____
12. What metamorphic rock would be found in layer D at the site of contact metamorphism? _____

Fact(s) to memorize: 1 - 11

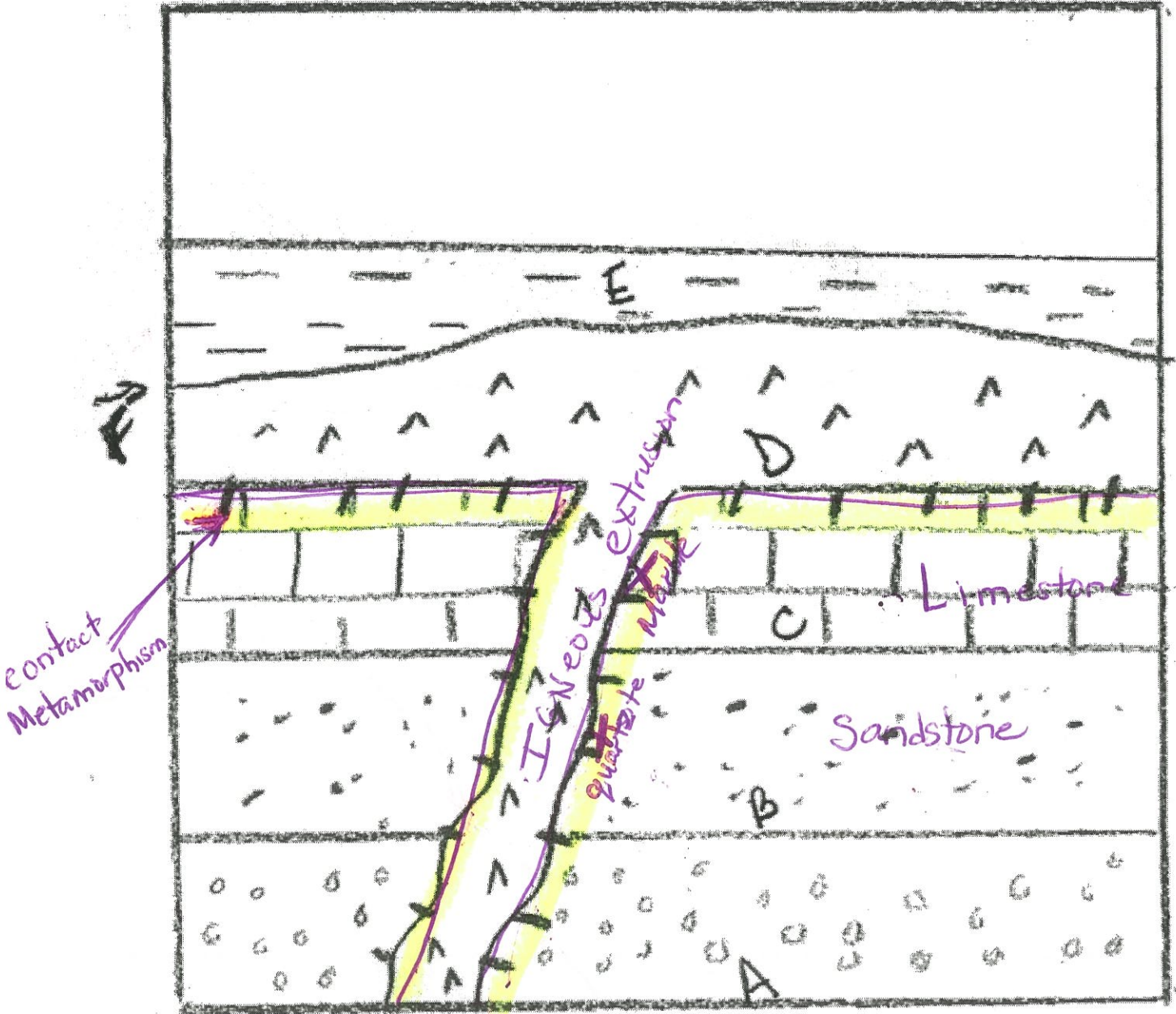


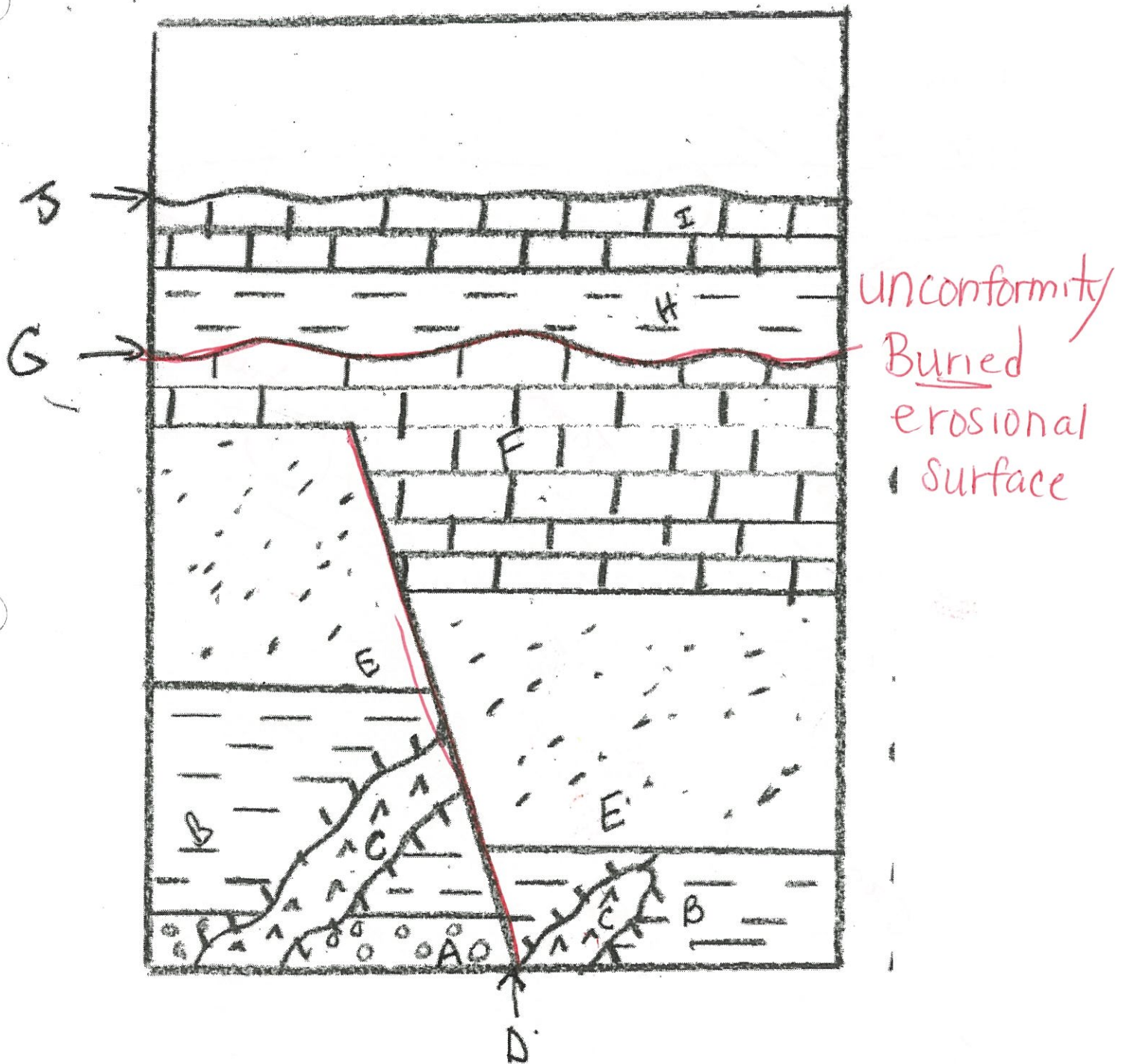


Put these events in order from oldest to youngest:
 Dep of 10, Dep of 9, unconformity, Dep of 8,
 Dep of 7, Dep of 6, Dep of 5, Tilt of 10-5,
 unconformity, Dep of 4, Dep of 3, Dep of 2, Dep of 1

Put these events in order from oldest to youngest:

Deposition of A, Deposition of B, Deposition of C, Extrusion of D
Deposition of E.

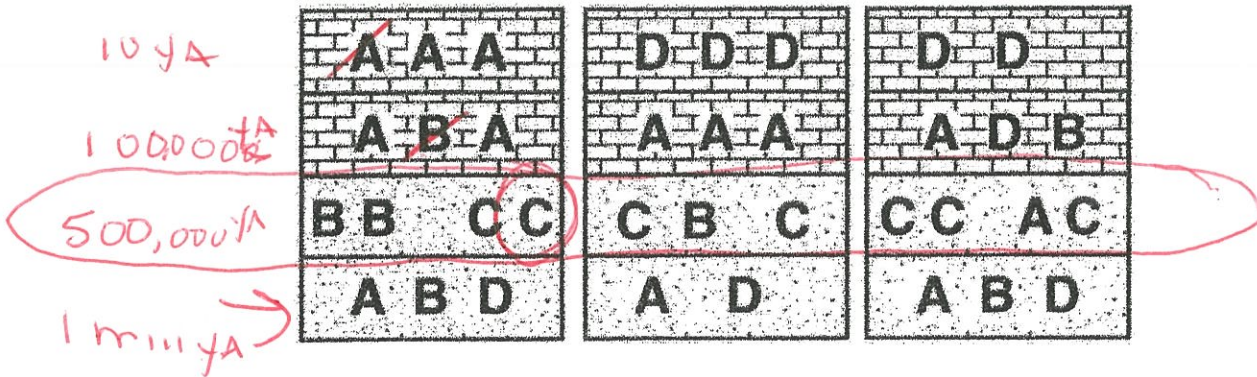




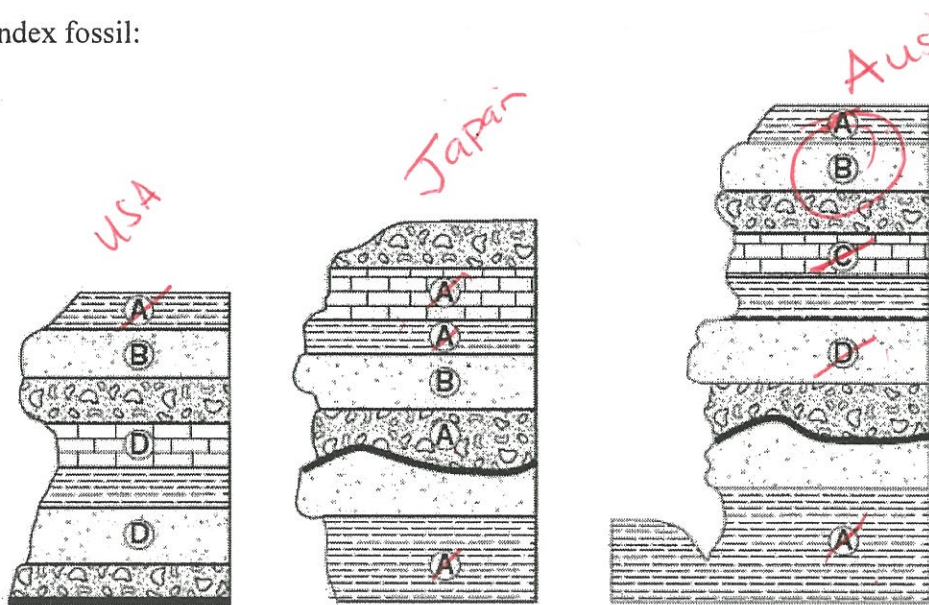
Put these events in order from oldest to youngest:
 Deposition of A, Deposition of B, Igneous Intrusion C,
 Deposition of E, Fault, Deposition of F, unconformity
 Deposition of H, Deposition of I, Erosion of I

Index Fossil and Rock Correlation

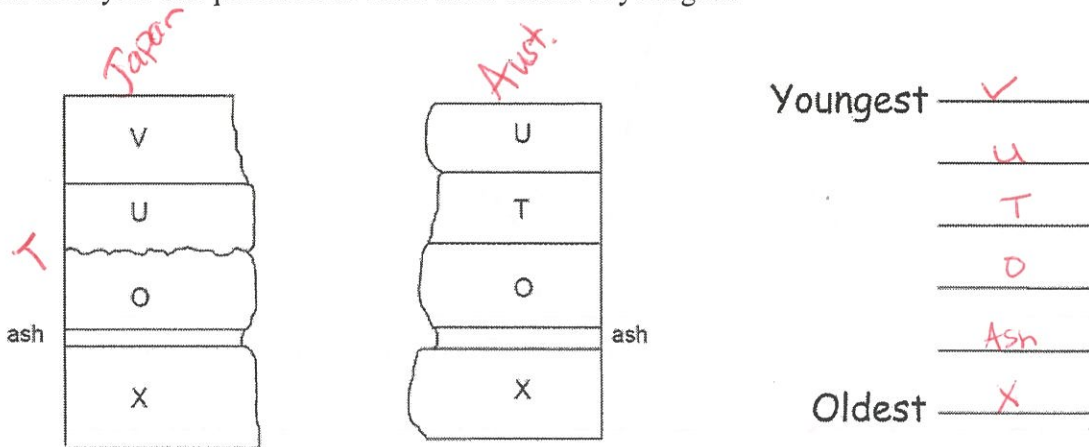
1. Circle the index fossil:



2. Circle the index fossil:

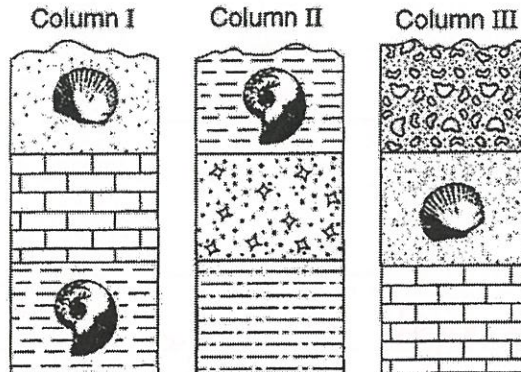


3. Match the layers and put them in order from oldest to youngest:

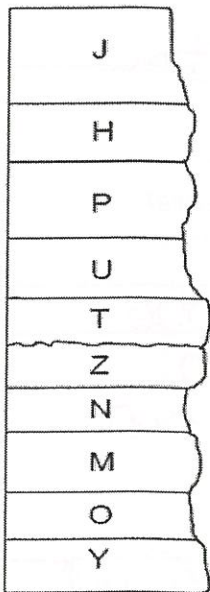


Index Fossil and Rock Correlation

4. Rock layers in outcrops located several miles apart. Two different index fossils are shown. What is the youngest layer, circle it?



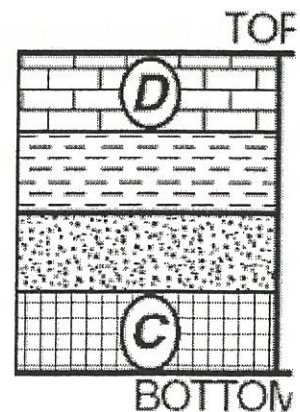
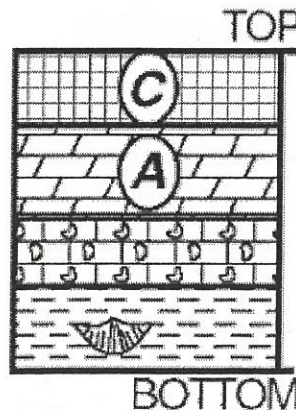
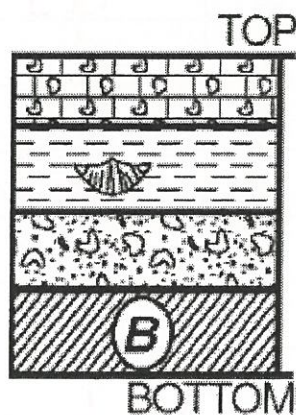
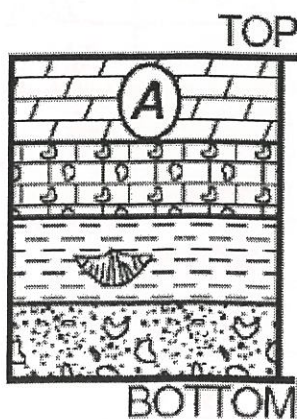
5. Put the layers in order:

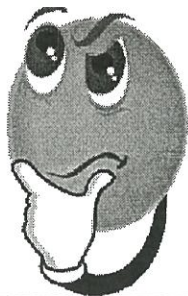


Friday 11

Youngest F
 J
 H
 P
 U
 T
 S
 Z
~~N~~
~~M~~
 O
Oldest Y

6. Use the index fossils and matching rock layers to circle the oldest layer of all four columns.





**ABSOLUTE TIME:
RADIOACTIVE DATING**

Actual Age

Half life - The length of time it takes for 1/2 of an isotope to decay

Decay Product The material created when the Parent material decays.

ESRT Front cover

| | Radioactive Isotope | Decay product | Half - life (years) | |
|---|---------------------|-----------------------------------|---------------------|-----------------|
| → | Carbon - 14 | Nitrogen ¹⁴ | 5,700 | 50,000 yrs or d |
| | Potassium - 40 | Ar ⁴⁰ Ca ⁴⁰ | 1,300,000,000 | |
| → | Uranium - 238 | Pb | 4,500,000,000 | 50,000 years ↑ |
| | Rubidium - 87 | Sr | 49,000,000,000 | |

1. The table to the right gives information about the radioactive decay of carbon-14. Part of the table has been left blank. Fill in each of the blank spaces and the answer the following questions.

- What is the percentage of original C-14 remaining after 2 half lives? $\frac{1}{4}$
- What is the percentage of decay product after 3 half-lives?
- As the amount of decay product increases, what happens to the amount of the original isotope? it decreases

| Half-life | Mass of Original C-14 Remaining (grams) | Number of Years | N |
|-----------|---|-----------------|-----------------|
| 0 | 1 g | 0 | 0 g |
| 1 | $\frac{1}{2}$ g | 5,700 | $\frac{1}{2}$ g |
| 2 | $\frac{1}{4}$ | 11,400 | $\frac{3}{4}$ g |
| 3 | $\frac{1}{8}$ | 17,100 | $\frac{7}{8}$ |
| 4 | $\frac{1}{16}$ | 22,800 | |
| 5 | $\frac{1}{32}$ | 28,500 | |
| 6 | $\frac{1}{64}$ | 34,200 | |

$$\frac{1}{8} + \frac{7}{8} = \frac{8}{8} (1)$$

$$\frac{1}{2} + \frac{1}{2} = 2 \quad \frac{2}{2} = 1$$

HALF-LIFE PROBLEMS

1. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 g of cesium-137 disintegrates over a period of 90 years, how many g of cesium-137 would remain?

| $\frac{1}{2}$ LIFE | mass remaining | # of years |
|--------------------|-----------------|------------|
| 0 | 1.0 g | 0 |
| 1 | $\frac{1}{2}$ g | 30 |
| 2 | $\frac{1}{4}$ g | 60 |
| 3 | $\frac{1}{8}$ g | 90 |



$\frac{1}{8}$ g

2. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 58 hours, how many mg of actinium-226 will remain?

| $\frac{1}{2}$ Life | Mass Remaining | # years Hours |
|--------------------|----------------|---------------|
| 0 | 100 mg | 0 |
| 1 | 50 mg | 29 |
| 2 | 25 mg | 58 |

25 mg

3. Sodium-25 was to be used in an experiment, but it took 3.0 minutes to get the sodium from the reactor to the laboratory. If 5.0 mg of sodium-25 was removed from the reactor, how many mg of sodium-25 were placed in the reaction vessel 3.0 minutes later if the half-life of sodium-25 is 60 seconds?

4. The half-life of isotope X is 2.0 years. How many years would it take for a 4.0 mg sample of X to decay and have only 0.50 mg of it remain?

| $\frac{1}{2}$ | MR | Years |
|---------------|------|-------|
| 0 | 4 mg | 0 |
| 1 | 2 mg | 2 |
| 2 | 1 mg | 4 |
| 3 | .50 | 6 |

6 years

5. Selenium-83 has a half-life of 25.0 minutes. How many minutes would it take for a 10.0 mg sample to decay and have only 1.25 mg of it remain?

| # of $\frac{1}{2}$ lives | M.R. | Number of Minutes |
|--------------------------|-------|-------------------|
| 0 | 10 mg | 0 |
| 1 | 5 mg | 25 min (+25) |
| 2 | 2.5 | 50 min |
| 3 | 1.25 | 75 min |

75

6. The half-life of Po-218 is three minutes. How much of a 2.0 gram sample remains after 15 minutes?

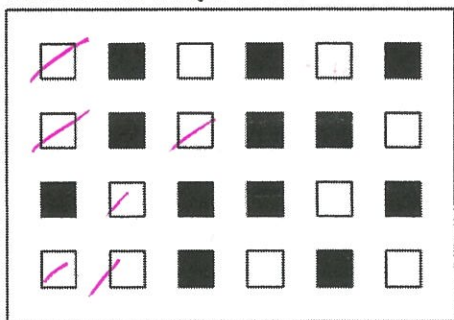
| # of $\frac{1}{2}$ lives | M.R. | Number of Minutes |
|--------------------------|-------|-------------------|
| 0 | 2.0 | 0 |
| 1 | 1.0 | 3 |
| 2 | .50 | 6 |
| 3 | .25 | 9 |
| 4 | .125 | 12 |
| 5 | .0625 | 15 |

$$\begin{array}{r} 5700 \\ \times 4 \\ \hline 22800 \end{array}$$

HALF LIFE QUESTIONS

- How old is a fossil that has radioactively decayed through 4 half-lives of carbon-14?
 - (1) 5,700 years
 - (2) 17, 100 years
 - (3) 22,800 years
 - (4) 28,500 years
- In the diagram below, how many boxes should be shaded to represent the additional decayed material formed during the second half-life?
 - (1) 12
 - (2) 6
 - (3) 3
 - (4) 0

Radioactive Sample After First Half-Life

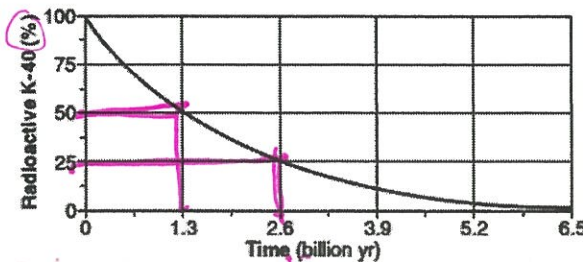


| Key | |
|-----|--------------------------------|
| | Undecayed radioactive material |
| | Decayed material |

Half-life of 4.6×10^9 years

- In the diagram to the right, analysis of a basalt rock sample shows that 25% of its radioactive K-40 remained undecayed. How old is the basalt?
 - (1) 1.3 billion years
 - (2) 2.6 billion years
 - (3) 3.9 billion years
 - (4) 4.6 billion years

The graph below shows the rate of decay of the radioactive isotope K-40 into the decay products Ar-40 and Ca-40.



- A sample of wood found in an ancient tomb contains 25% of its original carbon-14. The age of this wood sample is approximately?
 - (1) 2,800 years
 - (2) 5,700 years
 - (3) 11,400 years
 - (4) 17,100 years

100
50
25

- Which diagram to the right best represents the percentage of this radioactive isotope sample that will remain after two half-lives.

Sample before decay



| Key | |
|-----|---------------------|
| | Radioactive isotope |
| | Decay product |

Which diagram best represents the percentage of this radioactive isotope sample that will remain after 2 half-lives?



(1)



(2)



(3)



(4)

Life on Earth:



Handwritten lines for notes under the 'Life on Earth' heading.

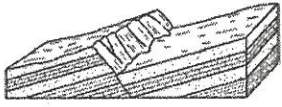
Geologic Time Scale

ESRT pages 8 & 9

Handwritten lines for notes under the 'Geologic Time Scale' heading.

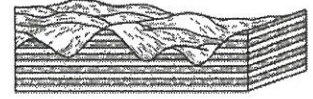
Reviewing the Geologic History of New York State:

1. What is the estimated time of origin of Earth? 4.6 Billion ^{4.6} _{4.1}
2. Name the two eons. Precambrian and Phanerozoic
3. Name the longest Eon. Precambrian ⁴
4. Approximately how long did the Precambrian last? 4.1 Bill ^{4.1} ~~millions~~ of years
5. Name the three Eras in the Phanerozoic eon. Cenozoic
Mesozoic Paleozoic
6. Name the two Eras in the Precambrian eon. Archean
Proterozoic
7. Name the three periods that were during the Mesozoic era? Cretaceous
Jurassic and Triassic
8. How many millions of years ago was the beginning of the Mesozoic? 251 MYA
9. How many millions of years ago was the end of the Silurian? 416 MYA
10. What is the division of the Geologic time scale based on? Life Events
11. Name the two epochs that the Neogene period is separated in to.
Pliocene and Miocene
12. What period is divided into the Pennsylvanian and Mississippian?
Carbiferous
13. Name the most recent period. Quaternary



Landscape Regions

Fact(s) to memorize: 23 - 26



Landscape Regions are determined by _____

Mountains (highlands) _____

Plateaus high flat mountains (Horizontal bedrock)

Lowlands (plains) _____

Arid Landscapes _____

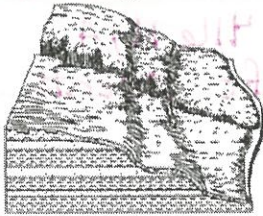
Humid Landscapes _____

- How old are the oldest rocks in New York State? _____
Hint: Oldest rocks are at the bottom of the bedrock map key; younger as you move up!
- In what landscape region are the oldest rocks located? _____
- In what landscape region do you live? _____
- Complete the following table using the Bedrock Geology of NYS map on page 3 ESRT:

| Location | Latitude | Longitude | Landscape Region |
|---------------|----------|-----------|------------------|
| Niagara Falls | | | |
| Rochester | | | |
| Mt. Marcy | | | |
| Massena | | | |
| Ithaca | | | |

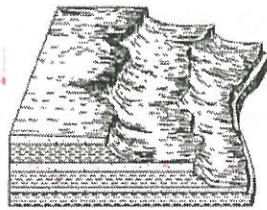
- Find the Finger Lakes. These lakes were created as glaciers scratched the bedrock. Based on the orientation of the lakes from what direction did the glaciers advance? _____
- Most of New York State is exposed to the same type of weathering/climate. What is the reason why there is so many different types of landscapes? _____

7. Humid **A**



Humid
Rounded
features



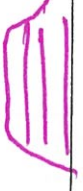
B



Arid
-Pointy, angular

Which landscape, A or B, is located in a humid climate? How can you tell? Which one is arid? Explain.

Directions: Please complete the chart and answer all the questions using pages 2 and 3 of your Earth Science Reference Tables.

| Landscape Region Name | Age of Bedrock (Silurian, Ordovician) | Bedrock Type (Sedimentary, Igneous, Metamorphic) | Bedrock Names (limestone, shale) | Mountain, Plateau, or Lowlands |
|---------------------------|--|---|-------------------------------------|---|
| 1. Allegheny Plateau | Devonian 416 MYA | Sedimentary | Sandstone shale, limestone |  Plateau |
| 2. Adirondack Mts | Mid Prot. | Metamorphic | marble, gneiss |  |
| 3. The Catskills | Devonian | Sedimentary | |  |
| 4. Erie-Ontario lowlands | | | | |
| 5. Tug Hill Plateau | | | | |
| 6. Taconic mts | | | | |
| 7. Atlantic Coastal plain | | | | |
| 8. | | | | |
| 9. | | | | |
| 10. | | | | |
| 11. | | | | |
| 12. | | | | |

Geologic History Review

Use the picture below to answer questions 1-3.

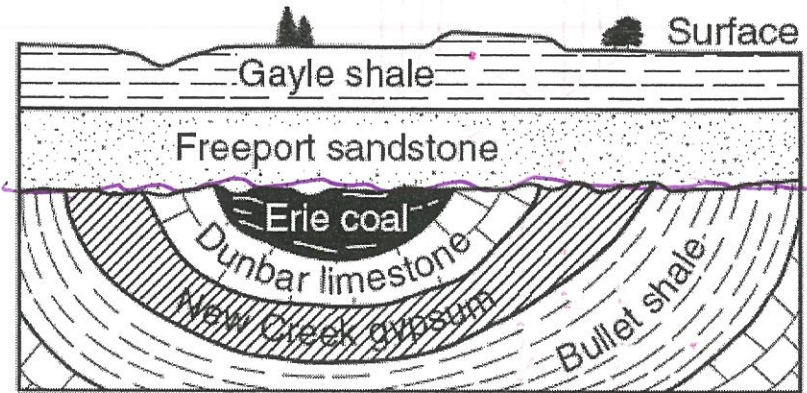
1. Label the unconformity.

2. Where did the Erie coal come from?

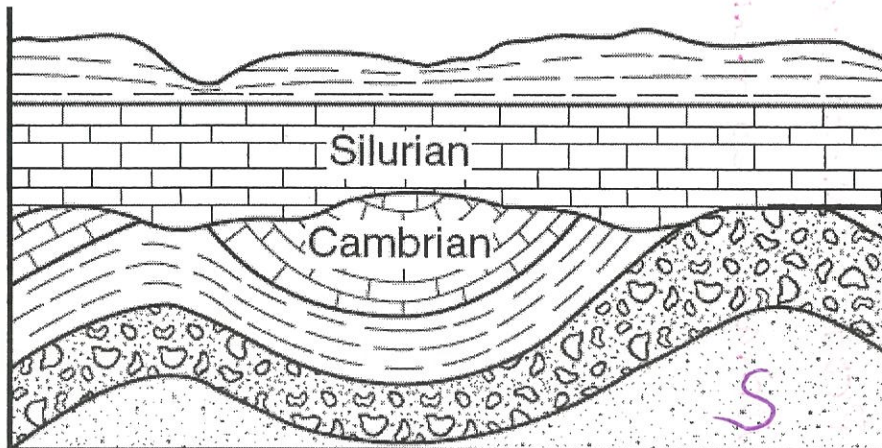
Plant Remains

3. What is the grain size of the Bullet and the Gayle shale?

less than .0004



Use the diagram below to answer questions 4-9.



4. Approximately how many million years ago did the unconformity form?

444-488 MYA

5. Name the nautiloid fossil that could be found in the limestone layer directly above the unconformity.

Filipitocephala

6. How can you tell from the picture that the conglomerate layer could be from the Precambrian?

That rock layer is below Cambrian.

7. Label the sandstone layer with an S.

8. What could have caused the bottom four layers to be folded?

9. Label the layer with the largest range in particle size with a C.

Use the diagram below to answer questions 10-15.

10. How can you tell layer C is an extrusion?

No lines on top

11. What is the crystal size of layer C?

fine

12. What is the grain size of layer A?

0.006 - 0.2

13. What is the composition of the limestone layer?

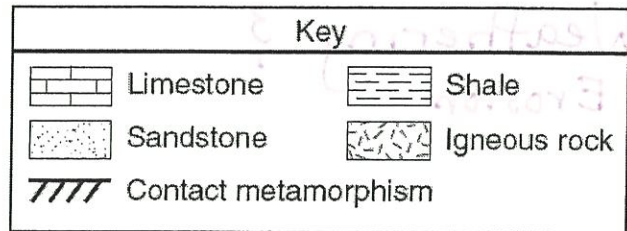
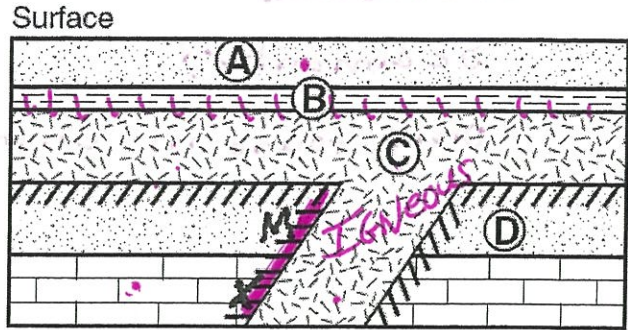
Calcite

14. Name the metamorphic rock at location X.

Marble

15. Name the metamorphic rock at location M.

Quartzite



Use the reading passage below to answer questions 16-18.

Fossil With Signs of Feathers Is Cited as Bird-Dinosaur Link

Paleontologists have discovered in China a fossil dinosaur with what are reported to be clear traces of feathers from head to tail, the most persuasive evidence so far, scientists say, that feathers predated the origin of birds and that modern birds are descendants of dinosaurs.

Entombed in fine-grained rock, the unusually well-preserved skeleton resembles that of a duck with a reptilian tail, altogether about three feet in length. Its head and tail are edged with the imprint of downy fibers. The rest of the body, except for bare lower legs, shows distinct traces of tufts and filaments that appear to have been primitive feathers. On the backs of its short forelimbs are patterns of what look like modern bird feathers.

Other dinosaur remains with what appear to be featherlike traces have been unearthed in recent years, but nothing as complete as this specimen, paleontologists said. Etched in the rock like a filigree decoration surrounding the skeleton are imprints of where the down and feathers appear to have been.

The 130-million-year-old fossils were found a year ago by farmers in Liaoning Province in northeastern China. After an analysis by Chinese and American researchers, the fossil animal was identified as a dromaeosaur, a small fast-running dinosaur related to velociraptor. The dinosaurs belonged to a group of two-legged predators known as advanced theropods . . .

excerpted from "Fossil With Signs of Feathers Is Cited as Bird-Dinosaur Link"
John Noble Wilford
New York Times, April 26, 2001

16. What period is the fossil the farmers found from?

Cretaceous

17. What type of rocks were these fossils probable found in?

Sedimentary

18. Why is the feathered dinosaur NOT considered an index fossil?

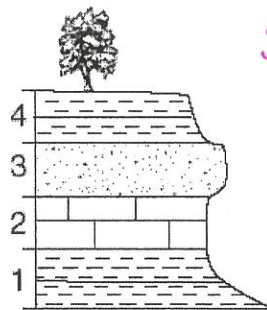
only found in China

1. lived for a short period of time

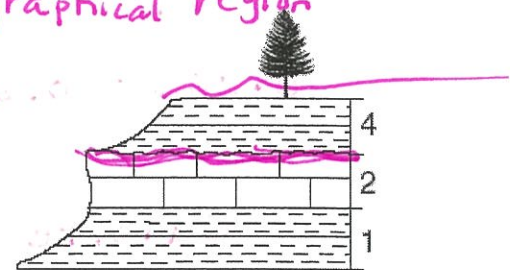
2. lived over a large geographical region

19. Explain why layer three is missing from outcrop 2.

Weathering
Erosion



Outcrop A



Outcrop B

Use the picture of the fossil to answer questions 20-22.

20. What geologic period is this fossil from?

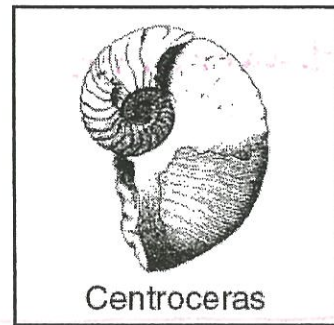
Devonian

21. Name another fossil found in the same bedrock.

Rhacops Phacops

22. Where do you think this animal lived when it was alive?

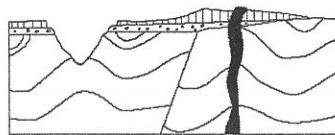
The water



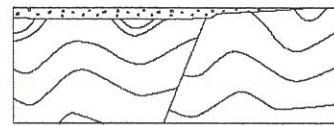
Centroceras

23. Put the following pictures in the correct order.

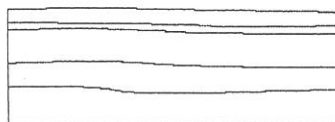
First B F D C E A



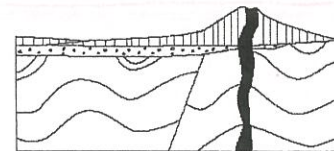
A



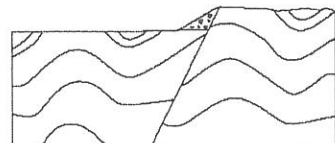
D



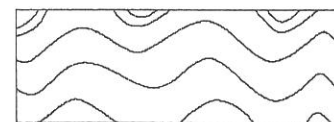
B



E



C

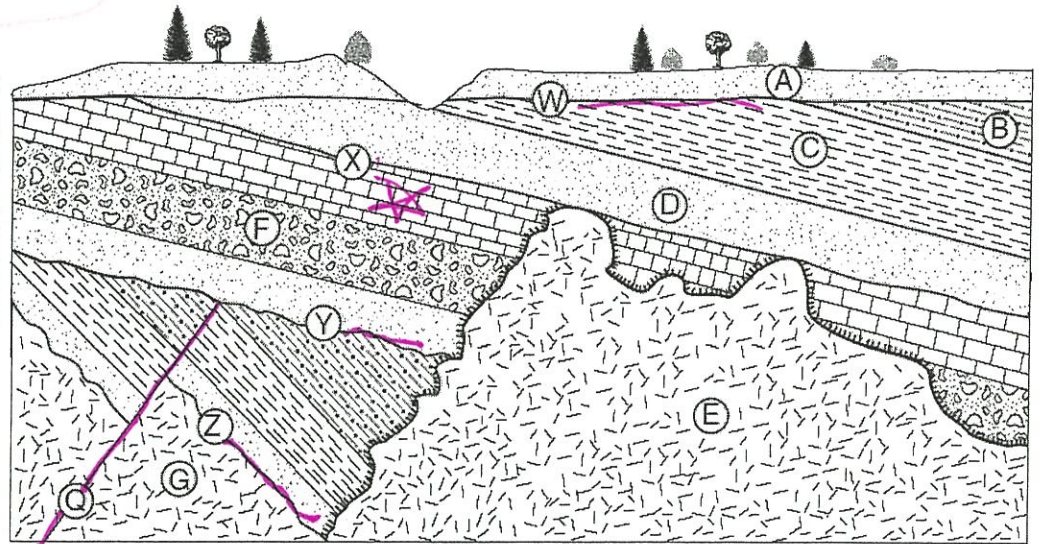
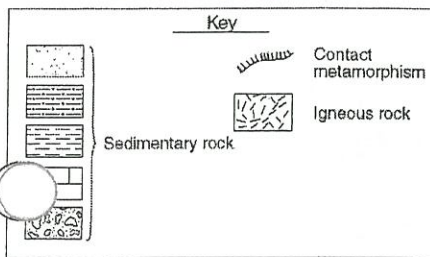


F

24. Fill in the following chart.

| Half-life | Mass of Original Carbon-14 Remaining (grams) | Number of Years |
|-----------|--|-----------------|
| 0 | 1 $\div 2$ | 0 |
| 1 | $\frac{1}{2}$ | 5,700 + 5700 |
| 2 | $\frac{1}{4}$ | 11,400 + 5700 |
| 3 | $\frac{1}{8}$ | 17,100 |
| 4 | $\frac{1}{16}$ | 22,800 |
| 5 | $\frac{1}{32}$ | 28,500 |
| 6 | $\frac{1}{64}$ | 34,200 |
| 7 | $\frac{1}{128}$ | 39,900 |

Use the following picture to answer questions 25-30.



25. What caused Q to occur?

Movement of the plates

26. What caused Y, Z and W?

Weathering + Erosion

27. Describe rock E.

Igneous Intrusion

28. Which letter has the greatest range in particle size?

F = Conglomerate

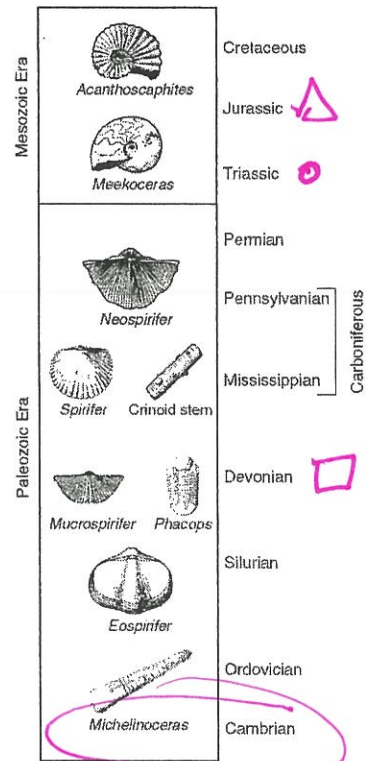
29. Label with a star the layer of rock that is composed of shells?

30. Describe another way you can determine this layer is limestone.

acid test

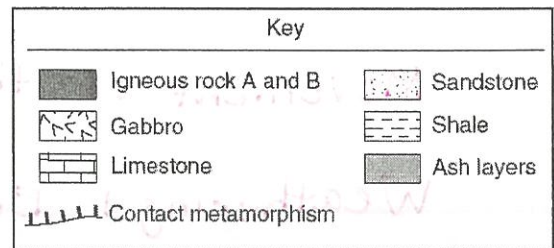
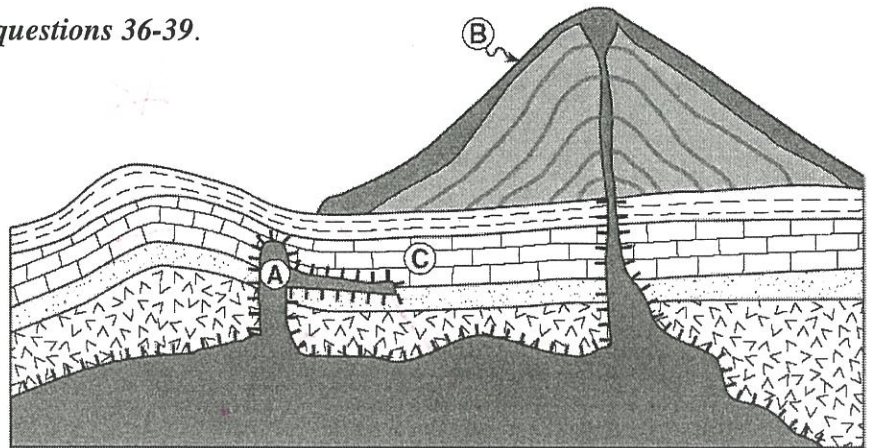
Use the picture to the right to answer questions 31-35.

31. Put a ▲ on the right side of the diagram to show when the dinosaurs were abundant.
32. Put a ■ on the right side of the diagram to show when *Platyceras* lived.
33. Put a ● on the right side of the diagram to show when PANGEA broke up.
34. Label where the PRECAMBRIAN would be.
35. Circle the period when you would have seen *Elliptocephala*.



Pre Cambrian

Use the picture below to answer questions 36-39.



36. How does the crystal size of rock B compare to the size of rock A?

A = Fine
B = Coarse

37. Which igneous rock will B probably be?

Obsidian, pumice...

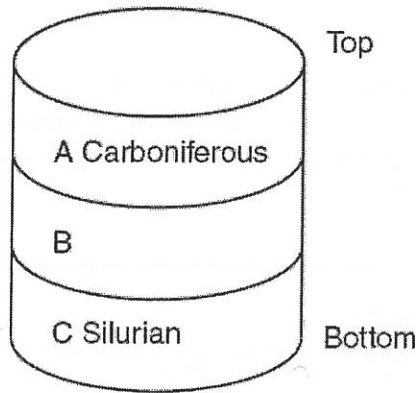
38. How can you tell this volcano erupted more than once?

The layers solidified each time

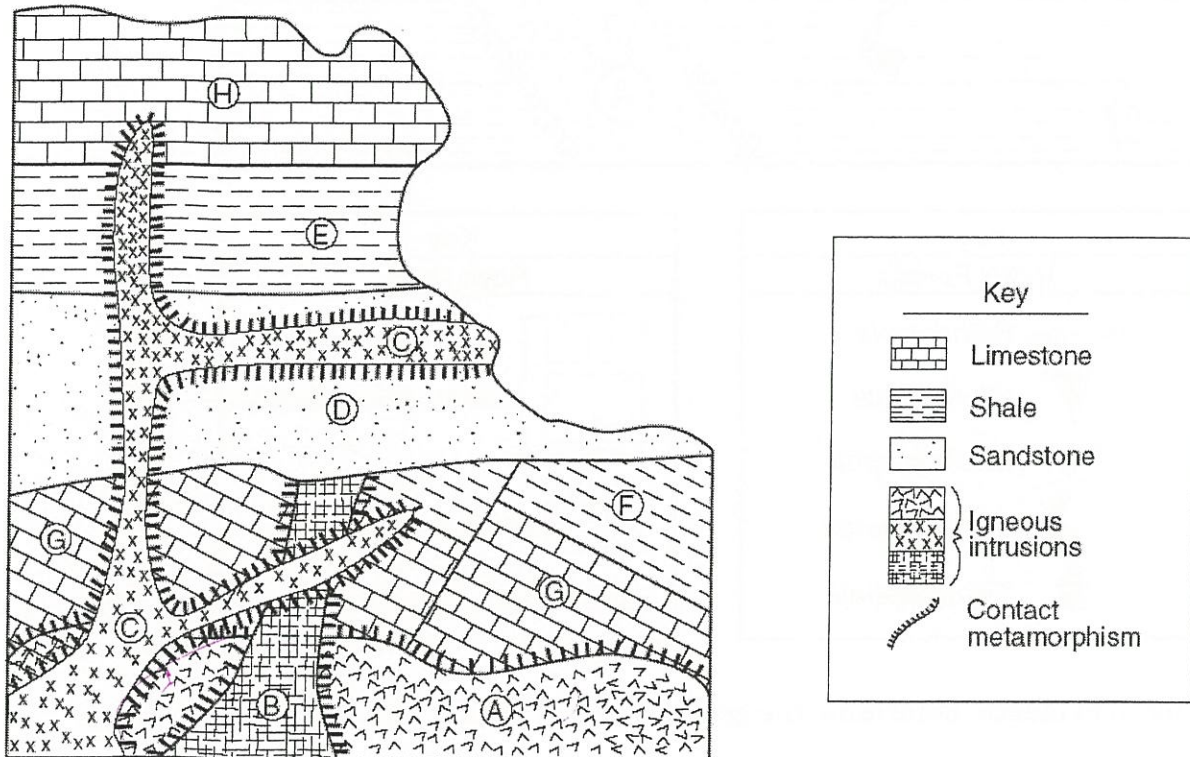
39. How can tell igneous rocks A and B are younger than the gabbro?

They went through them

40. Label the following diagram.



Use the picture below to answer questions 41-45.



I will give you two letters and you need to tell me which occurred first and why.

41. B and C... **B . C goes through B**

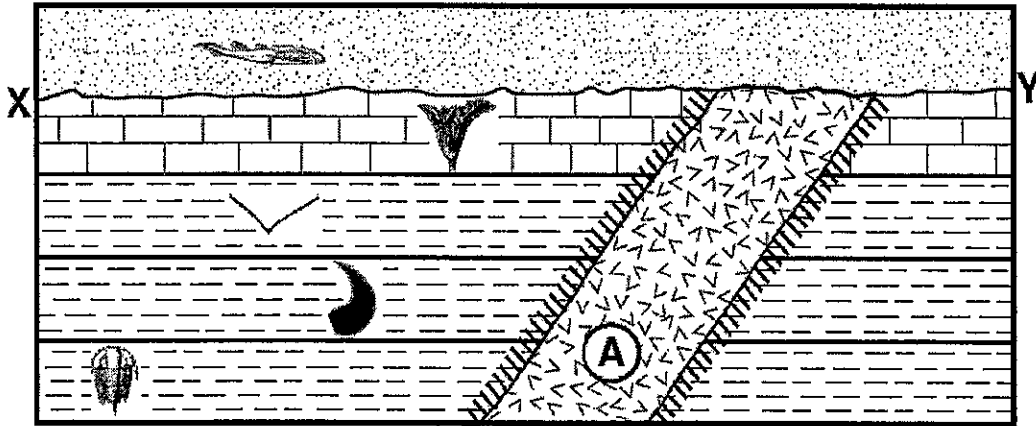
42. A and G... **G : Contact Metamorphism lines**

43. F and D... **F . D is above F**

44. C and E... **E . C goes through E**

45. C and A... **A C goes through it.**

Base your answers to questions 46 through 50 on the geologic cross section below and on your knowledge of Earth science. The cross section shows New York State index fossils in rock layers that have not been overturned. Rock unit *A* is an igneous intrusion and line *XY* represents an unconformity.



| Key | |
|---------------|-----------------------|
| Index Fossils | |
| | <i>Bothriolepis</i> |
| | <i>Ctenocrinus</i> |
| | <i>Dicellograptus</i> |
| | <i>Valcouroceras</i> |
| | <i>Elliptocephala</i> |

| Key | |
|------------|-------------------|
| Rock Units | |
| | Sedimentary rocks |
| | |
| | |

46. Based on fossil evidence, determine the geologic period during which the unconformity formed.
47. Identify the coral index fossil that would most likely be found in the same layer as the index fossil *Ctenocrinus*.
48. Each index fossil existed for a relatively short geologic time interval. State *one* other characteristic that each fossil must have to be considered an index fossil.
49. Describe the type of depositional environment in which the fossilized organisms lived.
50. Identify *one* piece of evidence shown in this cross section that indicates that the igneous intrusion, *A*, is older than the sandstone layer.