

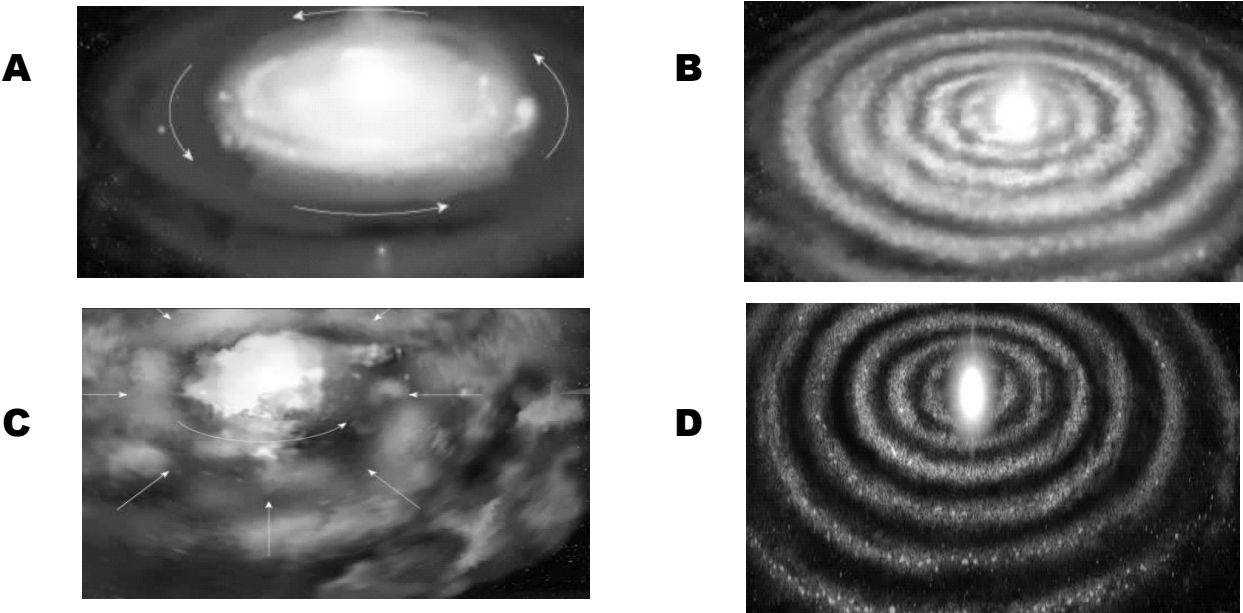
**PART I**  
**Total Value: 75%**

**Instructions:** Shade the letter of the correct answer on the computer scorable answer sheet provided.

1. Which branch of Earth Science is correctly matched with its field of study?

	Branch of Earth Science	Field of Study
(A)	geochemistry	minerals
(B)	geomorphology	mass extinctions
(C)	paleontology	seismic waves
(D)	petrology	landforms

2. Which sequence of events produced the solar system according to the Nebular Hypothesis?



- (A) A, B, D, C
- (B) A, D, C, B
- (C) C, A, B, D
- (D) C, B, D, A

3. Which is an internal heat source that contributed to Earth’s layered structure?

- (A) convection currents
- (B) hot spots
- (C) radioactive decay
- (D) seismic waves

4. Which represents the entire Earth from the core to the surface?

- (A) asthenosphere
- (B) crust
- (C) geosphere
- (D) mantle

5. Which processes are responsible for Earth's layers?

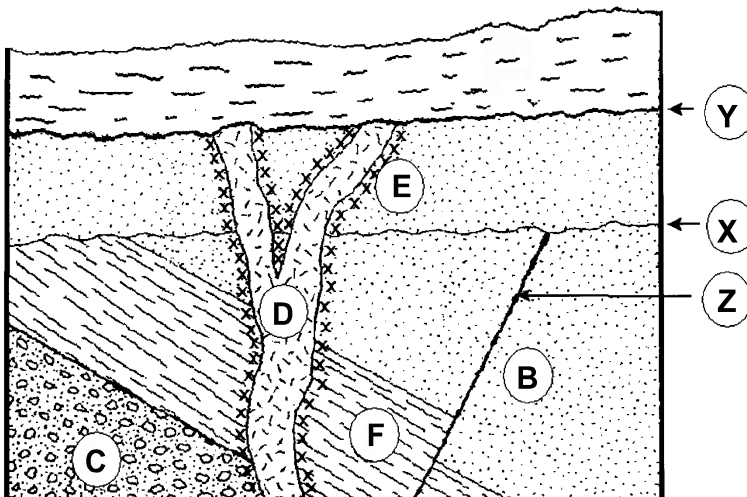
1. Heat from particle collisions
2. Regional metamorphism
3. Gravitational forces
4. Compaction and cementation

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

6. Which states that in an undisturbed sequence of sedimentary layers, the oldest layer is on the bottom and they get progressively younger upwards?

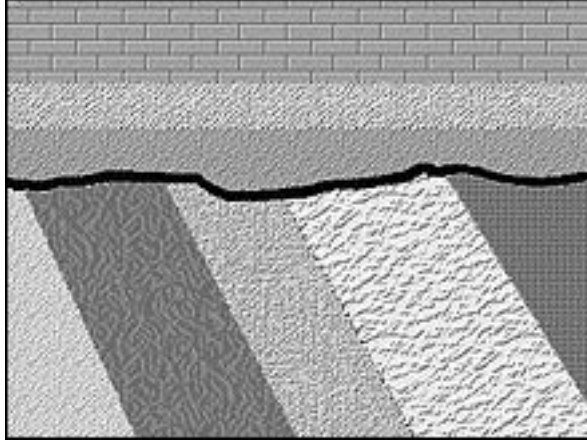
- (A) horizontality
- (B) inclusions
- (C) superposition
- (D) uniformitarianism

7. Which sequence, from oldest to youngest, is correct for the geologic cross-section below?



- (A) C, F, B, X, Z, E, D Y
- (B) C, F, B, Z, X, E, D, Y
- (C) Y, D, E, X, Z, B, F, C
- (D) Y, E, D, Z, X, B, F, C

8. Which feature is shown in the diagram below?



- (A) correlation  
(B) inclusions  
(C) metamorphism  
(D) unconformity
9. Which is used to measure relative time?
- (A) cross-cutting relationships  
(B) growth rings  
(C) radioactive dating  
(D) varves
10. Based on the information below, which age in years represents when sediment deposition began?

18 alternating light and dark sedimentary layers exist above a volcanic ash layer at the bottom of a glacial lake.

- (A) 9  
(B) 18  
(C) 36  
(D) 72
11. Based on the information below, what is the age of the piece of granite in millions of years?

- contains 25 grams of uranium 235
- contains 175 grams of lead 207
- the half life of uranium 235 is 713 million years

- (A) 713  
(B) 1426  
(C) 2139  
(D) 2842

12. Based on the information below, which represents the original amount of grams of parent material?

A rock is found to contain 1/16 of parent material. It presently contains 5 grams of the parent material.

- (A) 10
  - (B) 20
  - (C) 40
  - (D) 80
13. Which would have the greatest likelihood of being preserved as a fossil?
- (A) bird
  - (B) flower
  - (C) jellyfish
  - (D) worms
14. Which fossil is correctly matched with its method of formation?

	Fossil	Method of Formation
(A)	bones	mold and cast
(B)	coprolites	carbonization
(C)	foot prints	trace
(D)	frozen remains	petrification

15. Mistaken Point, Newfoundland contains fossils dated at 600 million years. Which segment of geologic time corresponds to the age when these fossils would have formed?
- (A) Cenozoic
  - (B) Mesozoic
  - (C) Paleozoic
  - (D) Precambrian

16. Which represents the progression of life forms as inferred by fossil evidence?
- (A) invertebrates → fish → reptiles → mammals
  - (B) invertebrates → mammals → reptiles → fish
  - (C) mammals → fish → invertebrates → reptiles
  - (D) mammals → invertebrates → fish → reptiles

17. Which geologic time frame is correctly matched with the dominate life form?

	Age	Dominant Life Form
(A)	Cenozoic	fish
(B)	Mesozoic	mammals
(C)	Paleozoic	amphibians
(D)	Precambrian	reptiles

18. At which geologic boundary did the mass extinction of marine species, including trilobites, occur?
- (A) Cretaceous-Tertiary
  - (B) Cretaceous-Triassic
  - (C) Permian-Tertiary
  - (D) Permian-Triassic

19. In which mineral group does pyrite (FeS) belong?

- (A) halides
- (B) oxides
- (C) sulfates
- (D) sulfides

20. Based on the description below, which type of mineral does the geologist have?

A geologist has a sample that looks like quartz. It has a rhombohedral shape and demonstrates double refraction. She places a drop of acid on it and notices bubbles forming.

- (A) calcite
  - (B) chalcopryite
  - (C) diamond
  - (D) fluorite
21. Which identification test is most useful to distinguish between the minerals talc and quartz?
- (A) colour
  - (B) hardness
  - (C) magnetism
  - (D) taste
22. Which mineral is identified using the property of taste?
- (A) calcite
  - (B) gypsum
  - (C) halite
  - (D) quartz
23. Which is a similarity between diamond and graphite?
- (A) atomic arrangement
  - (B) cleavage direction
  - (C) economic use
  - (D) elemental composition

24. Based on the information below, which rock type(s) would a geologist expect to find?

The discovery of a planet reveals no atmosphere or liquid water and plate tectonic activity has been occurring.

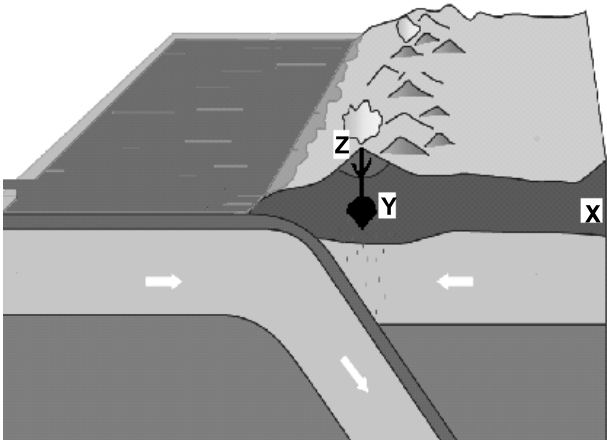
- (A) igneous only
  - (B) igneous and metamorphic
  - (C) metamorphic only
  - (D) sedimentary and metamorphic
25. Which rock is felsic and forms from magma?

- (A) basalt
- (B) gabbro
- (C) granite
- (D) rhyolite

26. Which rock has the slowest cooling rate?

- (A) andesite
- (B) basalt
- (C) gabbro
- (D) rhyolite

27. If the magma chamber in the diagram below is granitic and the continental crust at “X” is granite, which type of metamorphic rock would be found at “Y” and which extrusive igneous rock would form during an eruption occurring at “Z”?



	Metamorphic Rock at “Y”	Extrusive Igneous Rock at “Z”
(A)	gneiss	basalt
(B)	gneiss	rhyolite
(C)	marble	basalt
(D)	marble	rhyolite

28. Which rock has an aphanitic texture?
- (A) diorite
  - (B) gabbro
  - (C) granite
  - (D) rhyolite
29. Quartz sandstone is held together with a cement that causes the rock to appear red. Which is the chemical composition of the cement?
- (A)  $\text{CaCO}_3$
  - (B)  $\text{Fe}_2\text{O}_3$
  - (C)  $\text{MnO}$
  - (D)  $\text{SiO}_2$
30. Which rock type consists of angular particles formed from gravel deposited close to the source of weathering?
- (A) breccia
  - (B) conglomerate
  - (C) sandstone
  - (D) shale
31. Which involves the sub-processes of compaction and cementation?
- (A) convection
  - (B) crystallization
  - (C) lithification
  - (D) segregation
32. Which rock type forms in a shallow marine environment?
- (A) intrusive igneous
  - (B) metamorphic
  - (C) plutonic igneous
  - (D) sedimentary
33. Which is a chemical sedimentary rock type?
- (A) conglomerate
  - (B) limestone
  - (C) sandstone
  - (D) siltstone
34. Which is an evaporite?
- (A) breccia
  - (B) conglomerate
  - (C) gypsum
  - (D) sandstone
35. Which rock contains the remains of shelled organisms?
- (A) coquina
  - (B) gypsum
  - (C) halite
  - (D) travertine

36. Which is associated with the process of metamorphism?
- (A) anthracite
  - (B) bituminous
  - (C) lignite
  - (D) peat
37. Which is the correct sequence for the formation of coal?
- (A) lignite, anthracite, peat, bituminous
  - (B) lignite, peat, anthracite, bituminous
  - (C) peat, bituminous, lignite, anthracite
  - (D) peat, lignite, bituminous, anthracite
38. Which element is extracted from the mineral galena?
- (A) aluminum
  - (B) copper
  - (C) lead
  - (D) zinc
39. Which is the correct match between parent rock and metamorphic rock?

	Parent Rock	Metamorphic Rock
(A)	black shale	schist
(B)	granite	marble
(C)	limestone	quartzite
(D)	quartz sandstone	gneiss

40. Which texture is shown in the metamorphic rock below?



- (A) aphanitic
- (B) foliated
- (C) phaneritic
- (D) vesicular



41. Which causes a pre-existing rock to experience change when exposed to high heat, chemically-active fluids and low pressure?
- (A) cementation
  - (B) contact metamorphism
  - (C) folding
  - (D) regional metamorphism

42. Which Earth material is correctly matched with its economic use?

	Earth Material	Economic Use
(A)	gypsum	wallboard
(B)	halite	baby powder
(C)	sphalerite	road salt
(D)	talc	zinc

43. Based on the statement below, which is the correct match between mineral and rock type?

Beneath a circular lake is a carrot-shaped deposit of ultramafic composition.

	Mineral	Rock Type
(A)	diamond	gabbro
(B)	diamond	kimberlite
(C)	gold	gabbro
(D)	gold	kimberlite

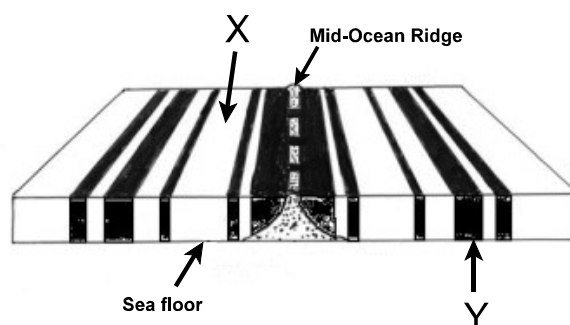
44. Which sediment type is found in a very low velocity environment?

- (A) gravel with angular fragments
- (B) gravel with rounded fragments
- (C) mud
- (D) sand

45. Which is the most recent supercontinent?

- (A) Appalachians
- (B) Iapetus
- (C) Pangaea
- (D) Rodinia

46. Which scientists contributed to Plate Tectonics Theory through their work on magnetic reversals?
- (A) Hess and DuToit
  - (B) McKenzie and Lepichon
  - (C) Vine and Matthews
  - (D) Wegener and Wilson
47. Which Earth layer contains convection currents that cause plate movement?
- (A) asthenosphere
  - (B) inner core
  - (C) lithosphere
  - (D) outer core
48. At which location did the Himalayan mountains form?
- (A) convergent plate boundary
  - (B) divergent plate boundary
  - (C) hot spots under oceans
  - (D) rift valleys
49. Which is associated with an oceanic to oceanic collision?
- (A) folded mountains
  - (B) island arc
  - (C) mid-oceanic ridge
  - (D) volcanic arc
50. Based on the information below, which is true of letters “X” and “Y”?

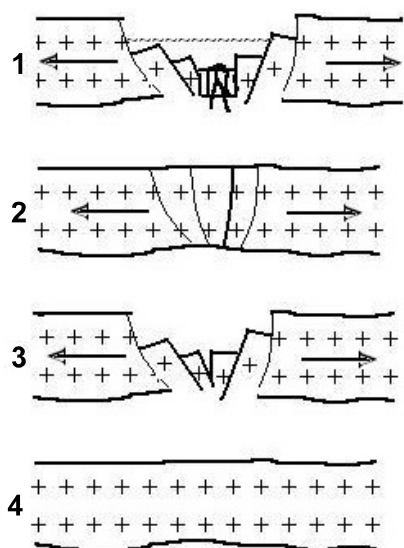


- (A) different age, different polarity
  - (B) different age, same polarity
  - (C) same age, different polarity
  - (D) same age, same polarity
51. Which plate tectonic evidence is described in the information below?

As igneous rocks cool at mid oceanic ridges, the iron-rich minerals align to the Earth's poles.

- (A) deep-ocean drilling
- (B) hot spots
- (C) paleomagnetism
- (D) Wadati-Benioff Zone

52. Which sequence correctly illustrates the evolution of a divergent plate boundary?



- (A) 1, 2, 3, 4
  - (B) 1, 3, 2, 4
  - (C) 4, 2, 1, 3
  - (D) 4, 2, 3, 1
53. Which is the correct sequence of plate tectonic activity from past to present?
- (A) Atlantic Ocean → Rodinia → Iapetus → Pangaea
  - (B) Iapetus → Pangaea → Rodinia → Atlantic Ocean
  - (C) Pangaea → Atlantic Ocean → Rodinia → Iapetus
  - (D) Rodinia → Iapetus → Pangaea → Atlantic Ocean
54. Which rock type is most easily deformed by stresses in Earth’s crust?
- (A) igneous plutonic
  - (B) igneous volcanic
  - (C) metamorphic
  - (D) sedimentary

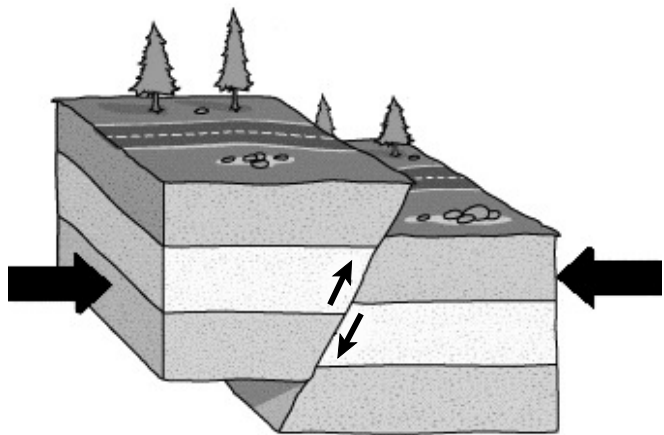
55. Which type of stress and faulting occurs at convergent plate boundaries?

	Stress	Faulting
(A)	shear	normal
(B)	shear	reverse
(C)	tension	normal
(D)	tension	reverse

56. Which results from shear forces?

- (A) anticline and syncline
- (B) dip-slip faults
- (C) horst and graben
- (D) strike-slip faults

57. Based on the diagram below, which fault is matched correctly with its corresponding stress?



	fault	Stress
(A)	normal	compression
(B)	normal	tension
(C)	reverse	compression
(D)	reverse	tension

58. Which wave is the fastest and moves in a push-pull motion?
- (A) L  
(B) primary  
(C) S  
(D) surface
59. Which layer of Earth is liquid and blocks the movement of S-waves?
- (A) crust  
(B) inner core  
(C) mantle  
(D) outer core
60. Based on the information below, which earthquake showed the greatest amplitude and by how much?

An earthquake in Japan registered 7.5 on the Richter scale and another earthquake in Mexico measured 6.5.

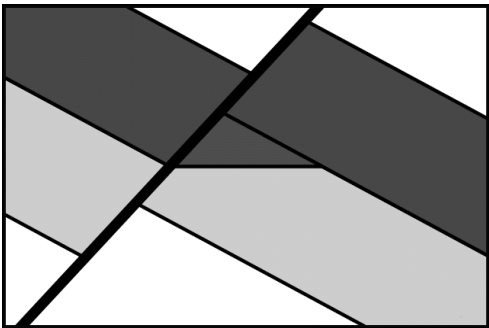
- (A) Japan by 10 times  
(B) Japan by 30 times  
(C) Mexico by 10 times  
(D) Mexico by 30 times

61. Which is needed to find the epicenter of an earthquake?
- (A) amount of destruction
  - (B) amplitude of waves
  - (C) energy released
  - (D) time between P- and S- arrivals
62. Which rock type is associated with a divergent plate boundary?
- (A) andesite
  - (B) basalt
  - (C) granite
  - (D) rhyolite
63. Which volcanic structure is matched correctly with its characteristic and eruption style?

	Volcanic Structure	Characteristic	Eruption Style
(A)	ash and cinder	pyroclastics only	explosive only
(B)	composite	lava flows only	explosive and quiet
(C)	lava plateaus	pyroclastics only	quiet only
(D)	shield	lava flows only	explosive and quiet

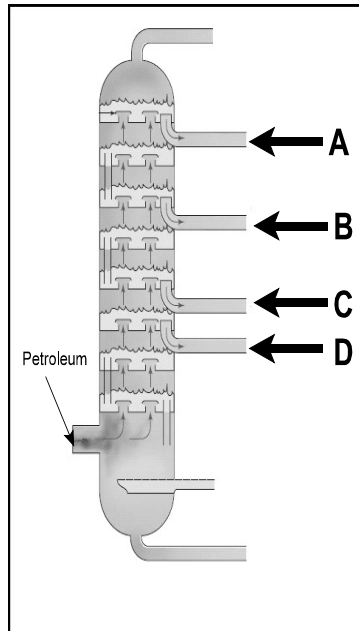
64. Which type of volcanism created Hawaii?
- (A) fissure
  - (B) hotspot
  - (C) ridge
  - (D) subduction
65. Which process produces copper mineralization in veins around granitic intrusions?
- (A) hydrothermal
  - (B) layered magmatic
  - (C) metamorphism
  - (D) placer
66. Which is an exploration technique?
- (A) cracking
  - (B) floatation
  - (C) reforming
  - (D) seismic records
67. Which technique involves percolation and dissolving away the valuable mineral from the ore?
- (A) distillation
  - (B) gravity separation
  - (C) heap leaching
  - (D) remote sensing

68. Which two factors are essential to the formation of petroleum?
- (A) decomposing material; anaerobic conditions  
 (B) decomposing material; rapid burial by fine-grained material  
 (C) organic matter; anaerobic conditions  
 (D) organic matter; slow burial by coarse-grained material
69. Which is the correct order for the evolution of organic matter to petroleum?
- (A) catagenesis → diagenesis → metagenesis  
 (B) catagenesis → metagenesis → diagenesis  
 (C) diagenesis → catagenesis → metagenesis  
 (D) diagenesis → metagenesis → catagenesis
70. Under which conditions has kerogen matured enough to produce crude oil that migrates into traps?
- (A) deep burial, high temperature, high pressure  
 (B) deep burial, low temperature, low pressure  
 (C) shallow burial, high temperature, high pressure  
 (D) shallow burial, low temperature, low pressure
71. Which rock type would have high porosity and high permeability?
- (A) granite  
 (B) quartzite  
 (C) sandstone  
 (D) shale
72. Which petroleum trap would be formed by a simple fold?
- (A) anticline  
 (B) fault  
 (C) salt dome  
 (D) stratigraphic
73. Based on the diagram below, which is the correct match between the force and petroleum trap produced?



	Force	Petroleum Trap
(A)	compressional	salt dome
(B)	compressional	stratigraphic
(C)	tensional	anticline
(D)	tensional	fault

74. Which involves heat, pressure and the use of catalysts?
- (A) distillation
  - (B) floatation
  - (C) prospecting
  - (D) reforming
75. At which location in the distillation column would you collect the lowest boiling point hydrocarbons?



- (A) A
- (B) B
- (C) C
- (D) D

**PART II**  
**Total Value: 25%**

**Instructions:** Complete all items in this section. Your responses should be clearly presented in a well-organized manner.

Value

2%

76. Based on the information below, answer the question that follows.

A recently discovered planet in our solar system has been found to be a mass of entirely solid rock. Several large deposits of pure nickel and iron were found near the surface. Advanced seismic records showed that there are several large regions of silicate minerals at depth.

How does this planet differ in structure from present day Earth? Explain a process that must occur for this planet to acquire Earth's structure.

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2%

77.(a) A sample was radioactively dated to be 2139 million years old. If the half-life of the radioactive isotope used is 713 million years and the rock originally contained 260 grams of parent isotope, what is the amount of parent isotope presently in the rock? (Show calculations below)



Value  
3%

(b) Based on the information below, answer the question that follows.

“The Earth has been covered by giant combinations of continents, called supercontinents, many times in its past, and it will be again one day in the distant future. The next predicted supercontinent . . . may form when the Americas and Asia both drift northward to merge, closing off the Arctic Ocean . . .”

Charles Q. Choi, Our Amazing Planet

Identify and explain a concept that scientists could use to support the idea suggested in the above quotation.

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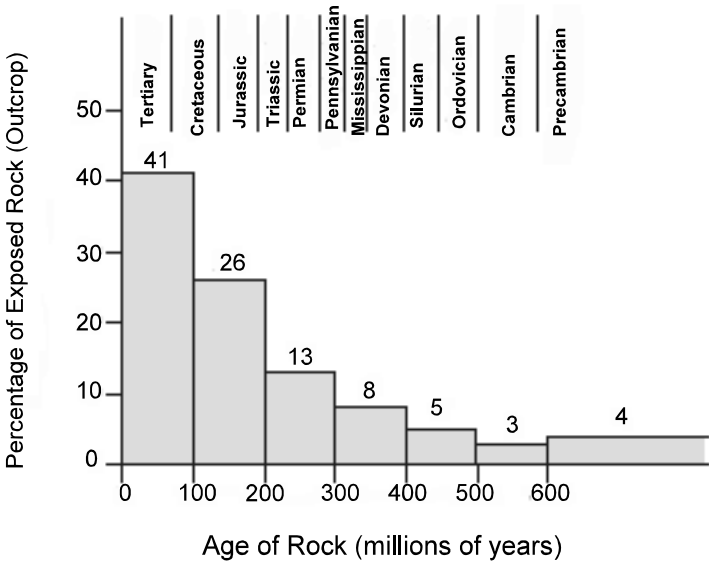
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2%

78.(a) The graph below shows the relationship between the age of sedimentary rocks and the percentage of exposed rock (outcrop) on Earth’s surface. With reference to the rock cycle, describe two reasons that account for over 40% of the sedimentary rocks on Earth's surface being younger than 100 million years.



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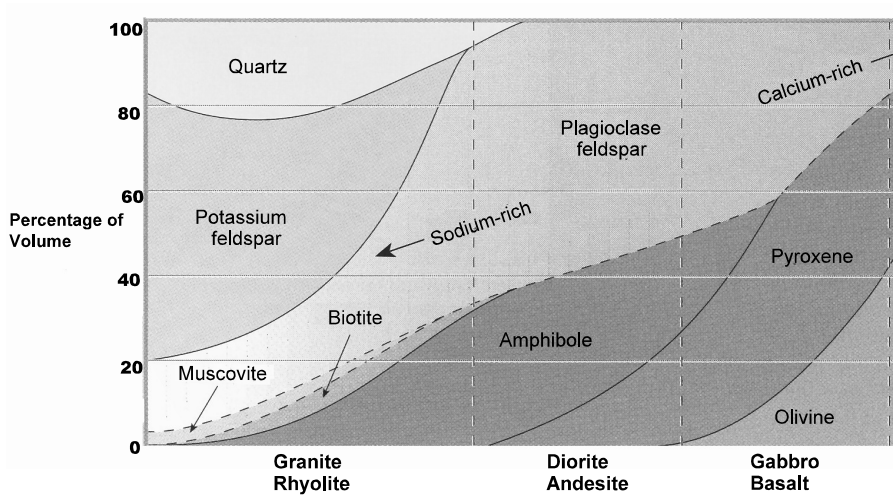
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Value

(b) Use the diagram below to aid in answering the questions that follow.



1%

(i) Which magma composition allows for the crystallization of muscovite mica and potassium feldspar?

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1%

(ii) Which rock type forms from a lava composition that is rich in olivine, pyroxene and calcium-rich plagioclase feldspar?

\_\_\_\_\_

3%

(c) Place the following chemical formulae in the chart below under the corresponding mineral groups.

CaCO<sub>3</sub>

SiO<sub>2</sub>

Fe<sub>2</sub>SiO<sub>4</sub>

Al<sub>2</sub>O<sub>3</sub>

Fe<sub>3</sub>O<sub>4</sub>

CaMg(CO<sub>3</sub>)<sub>2</sub>

Silicate	Carbonate	Oxide

**Value**

2%      79.(a) Using a labelled diagram, illustrate the formation of a thrust fault. Include the type of plate boundary where this could form.



2%      (b) Explain the relationship between subduction and the formation of both types of metamorphic rocks.

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2%      (c) Describe two pieces of evidence that support the Theory of Continental Drift.

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Value  
2%

80.(a) Based on the information below, answer the question that follows.

A petroleum company drilled an exploration well and they encountered the sedimentary rocks of shale, conglomerate and shale with increasing depth. Only water was encountered in the conglomerate.

Explain two reasons why the exploration well was unsuccessful.

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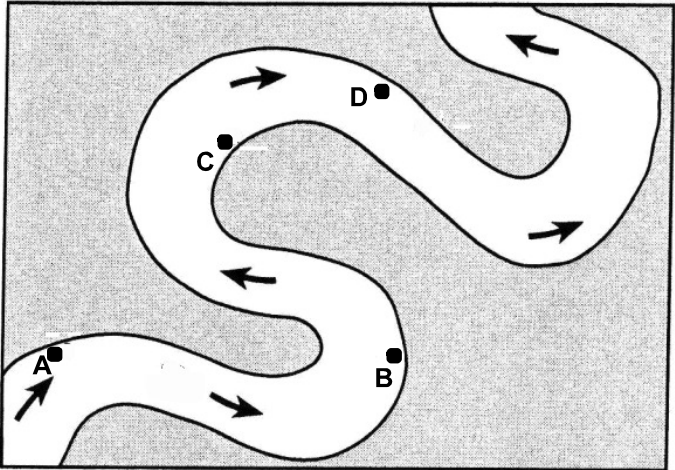
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3%

(b) Which letter represents a location in the river where a placer deposit would most likely form? Explain two reasons to support your choice.



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