Part I
Total Value: 60%

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

1. Which branch of Earth Science studies fossils?

   (A) hydrology
   (B) mineralogy
✔ (C) paleontology
   (D) seismology

2. Which principle states that all geological features on Earth could be explained by present day processes operating over long periods of time?

   (A) catastrophism
   (B) correlation
   (C) superposition
✔ (D) uniformitarianism

3. Geologic evidence collected during the 1960's favored the idea of Plate Tectonics over other competing ideas. As a result, to what status was Plate Tectonics elevated?

   (A) hypothesis
   (B) law
   (C) paradigm
✔ (D) theory

4. The Appalachian Mountains are believed to have formed between 570-245 million years ago. Which era of geologic time does this represent?

   (A) Mesozoic
✔ (B) Paleozoic
   (C) Phanerozoic
   (D) Proterozoic

5. Analysis shows a trilobite sample contains 12.5% parent material and 87.5% daughter material. How many half lives have passed since the trilobite died?

   (A) 2
✔ (B) 3
   (C) 4
   (D) 5

6. Which gas is most abundant in our atmosphere?

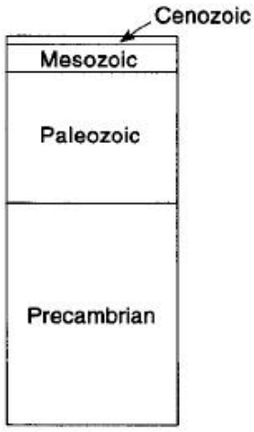
   (A) carbon dioxide
✔ (B) nitrogen
   (C) oxygen
   (D) water vapour

7. In which zone of the atmosphere is the concentration of ozone naturally the greatest?

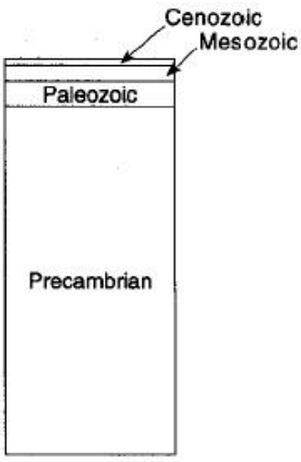
   (A) mesosphere
✓ (B) stratosphere
   (C) thermosphere
   (D) troposphere

8. Which represents the relative lengths of time of the major intervals of geologic history?

(A)



✔ (B)



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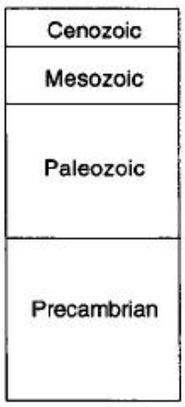


(D)

9. What causes a cone of depression in the water table?

(A) drought
(B) excessive precipitation
✔ (C) excessive pumping
(D) flooding

10. Where is most of Earth's freshwater located?

✔ (A) glacial ice
(B) ground water
(C) oceans
(D) rivers

11. Which of Earth's spheres includes solid rock?

(A) atmosphere
(B) biosphere
(C) hydrosphere
✓ (D) geosphere

12. Which factors were most responsible for the differentiation of Earth into layers?

(A) Earth's rotation, meteorite impact, radioactive decay
(B) Earth's rotation, volcanic outgassing, density
(C) gravity, convection currents, Earth's rotation
✔ (D) gravity, radioactive decay, density

13. Which layer of Earth is matched with its major component?

(A) crust - nickel and iron
(B) inner core - granitic rock
(C) mantle - granitic rock
✔ (D) outer core - nickel and iron

14. What is the boundary between Earth's crust and mantle?

(A) lithosphere
✔ (B) Moho
(C) transform
(D) troposphere

15. During which month would atmospheric CO_2 levels be the highest in North America?

(A) January
(B) July
✔ (C) May
(D) November

16. To which group does $Ca_2Al_2SiO_7$ belong?

(A) carbonates
(B) oxides
✔ (C) silicates
(D) sulfides

17. Which mineral is the main source of iron?

(A) galena
(B) gypsum
✔ (C) hematite
(D) sphalerite

18. What is cleavage?

(A) resistance of a mineral to scratch
(B) resistance of a mineral to weathering
(C) splitting of mineral along irregular fractured surfaces
✔ (D) splitting of mineral along smooth parallel surfaces

19. Which best describes how a fine grained igneous rock, with embedded large crystals, forms?

(A) Hydrothermal fluids escape from magma, forming crystals.
(B) Molten rock on Earth's surface is buried before it crystallizes.
(C) Rock is reheated and recrystallizes during metamorphosis.
✔ (D) Slow cooling below surface followed by rapid cooling on surface.

20. Which intrusive/extrusive pair of rocks have the same chemical composition?

		Granitic (felsic)	**Andesitic (intermediate)**	**Basalic (mafic)**	**Ultramafic**
Dominant Minerals		Quartz Potassium feldspar	Amphilobole Intermediate plagioclase feldspar	Pyroxene calcium-rich plagioclase feldspar	Olivine Pyroxene
Color		Light-colored Less than 15% dark minerals	Medium-colored 15-40% dark minerals	Dark grey to black More than 40% dark minerals	Dark-green to black Nearly 100% dark minerals
Texture	**Coarse-grained**	Granite	Diorite	Gabbro	Peridotite
	Fine-grained	Rhyolite	Andesite	Basalt	Komatite
	Porphyritic	"Porphry" follows any of the above names whenever there are appreciable phenocrysts			
	Glassy	Obsidian (compact glass) Pumace (frothy glass)			

	Intrusive	**Extrusive**
(A)	basalt	andesite
(B)	basalt	gabbro
(C)	granite	diorite
✔ (D)	granite	rhyolite

21. Which rock forms from slow cooling magma?

(A) basalt
✔ (B) granite
(C) obsidian
(D) rhyolite

22. Which rock most likely has small (< 2.0 mm) grains of quartz held together by iron rich cement?

(A) black quartzite
(B) fossil limestone
(C) garnet schist
✔ (D) red sandstone

23. What information may be obtained from ripple marks?

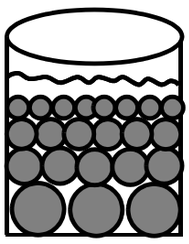
✔ (A) current direction
(B) rate of condensation
(C) rate of evaporation
(D) temperature of crystallization

24. Which feature is best for determining the direction of glaciers?

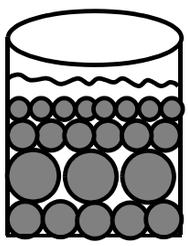
(A) cirque
✔ (B) drumlin
(C) erratic
(D) kame

25. A number of four different-sized spherical particles, made of the same uniform material, are dropped into a column of water at the same time. Which represents the most likely sedimentation pattern that would occur in the container?

✔ (A)



(B)



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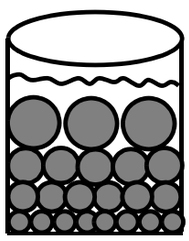
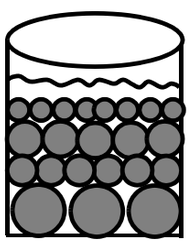


(D)



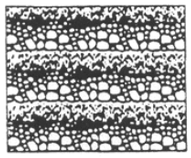
26. What is the primary agent of contact metamorphism?

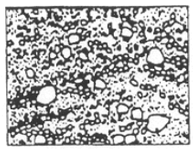
(A) folding
✔ (B) heat
(C) pressure
(D) water

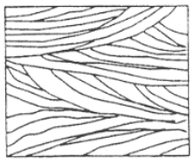
27. Which sedimentary rock is the parent rock for marble?

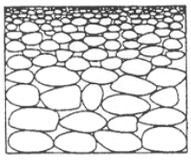
(A) gypsum
✔ (B) limestone
(C) sandstone
(D) shale

28. Which cross section best represents the sediment that was transported and deposited by wind?

(A) 

(B) 

✔ (C) 

(D) 

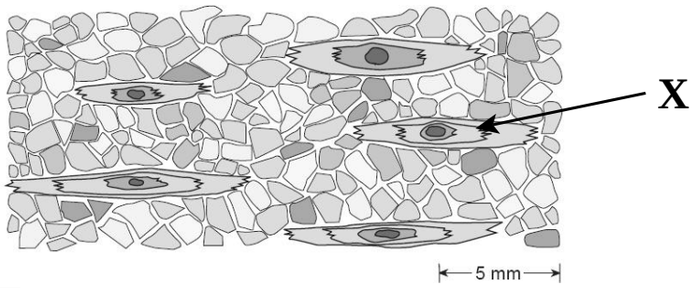
29. Which conditions are necessary for a material to be classified as a mineral?

✔ (A) naturally occurring, inorganic, and definite chemical structure
(B) naturally occurring, synthetically derived, and definite chemical structure
(C) solid, naturally occurring, and organic
(D) solid, synthetically derived, and inorganic

30. At which plate boundary do island arcs form?

✔ (A) convergent
(B) divergent
(C) transform
(D) rift valley

31. Which directions of maximum compressive stress most likely caused the alignment of the elongate crystals labeled “X” in the metamorphic rock?



(A) ⇒⇐

(B) ⇐⇒

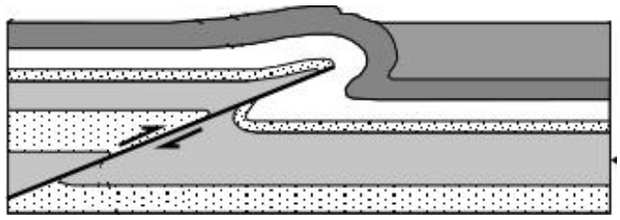
(C) ⇑
⇓

✔ (D) ⇓
⇑

32. What happens to the rocks on either side of a fault after an earthquake?

(A) metamorphosed by the extreme heat and pressure
(B) melted to form new igneous rocks at the fault boundary
(C) remain stretched to their breaking point
✔ (D) returned to unstrained positions and retain original shape

33. What type of fault is represented in the cross section below?



(A) normal
(B) strike-slip
✔ (C) thrust
(D) transform

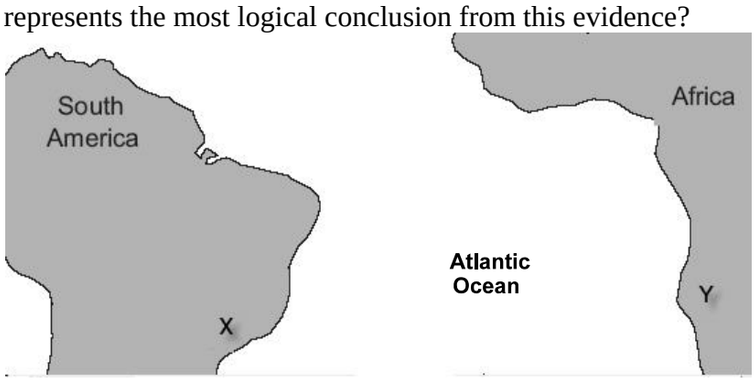
34. What does the Mercalli scale use to rate earthquake intensity?

✔ (A) amount of damage to structures
(B) height of tsunamis created
(C) maximum amplitude on a seismograph
(D) number of aftershocks produced

35. Which describes lava that usually forms shield volcanoes?

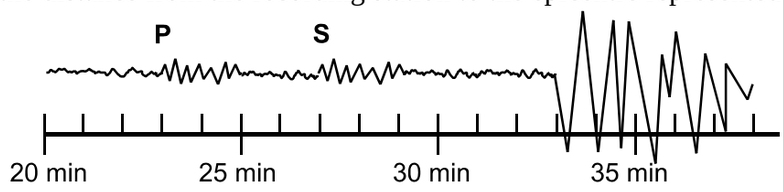
		Silica Content	Viscosity
	(A)	high	high
	(B)	high	low
	(C)	low	high
✔	(D)	low	low

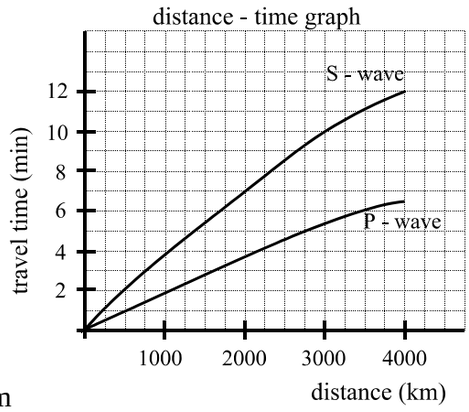
36. Remains of *Mesosaurus*, an extinct freshwater reptile, have been found in similarly aged bedrock formed from lake sediments at locations X and Y in the diagram below. Which statement represents the most logical conclusion from this evidence?



(A) *Mesosaurus* existed on separated continents at different times.
(B) *Mesosaurus* migrated from location X to Y.
(C) South America and Africa climates are similar.
✔ (D) South America and Africa were joined when *Mesosaurus* lived.

37. What is the distance from the recording station to the epicentre represented below?





(A) 1000 km
(B) 1500 km
✔ (C) 2500 km
(D) 3500 km

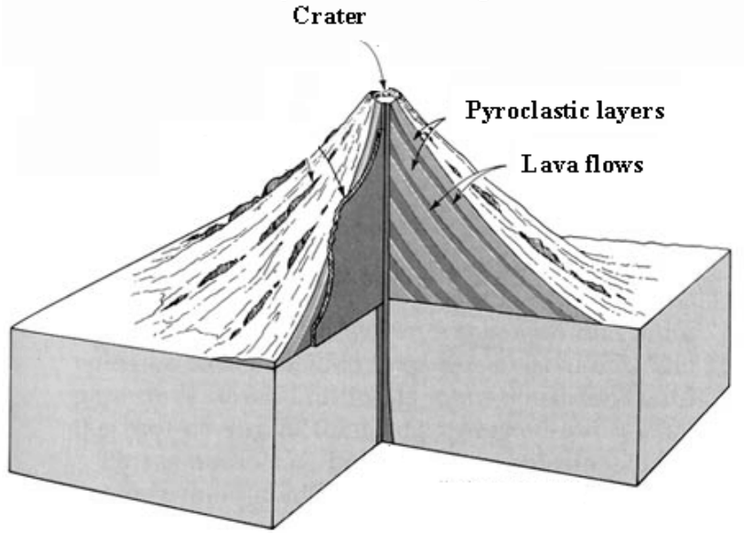
38. What are stalactites?

(A) $CaCO_3$ deposits grown from a cavern floor.
✔ (B) $CaCO_3$ deposits which hang from a cavern ceiling.
(C) FeO_3 deposits grown from a cavern floor.
(D) FeO_3 deposits which hang from a cavern ceiling.

39. What is the most abundant element in Earth's crust?

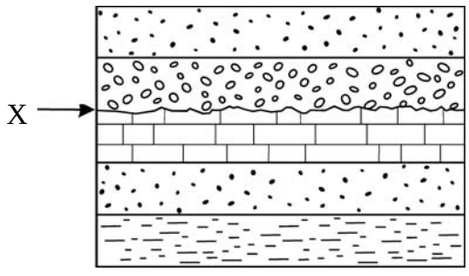
(A) calcium
✔ (B) oxygen
(C) silicon
(D) sodium

40. What type of cone will most likely form in the diagram below?



(A) cinder
✔ (B) composite
(C) fissure
(D) shield

41. What is indicated by "X" in the diagram below?



(A) angular unconformity
✔ (B) disconformity
(C) fault line
(D) nonconformity

42. Which type of deposit concentrates heavy metals within streams?

(A) hydrothermal
(B) magmatic segregation
✔ (C) placer
(D) secondary enrichment

43. Which is the most common mineral in Earth's crust?

✔ (A) feldspar
(B) hematite
(C) mica
(D) quartz

44. What is the volume of a mineral sample if its mass is 48 g and its specific gravity is 3?

(A) 4 cm^3
(B) 12 cm^3
✔ (C) 16 cm^3
(D) 60 cm^3

45. What type of plate boundary is present where two plates slide past each other?

(A) convergent
(B) divergent
✔ (C) transform
(D) transverse

46. Which combination will most likely lead to fossilization?

	burial	body parts
✔ (A)	rapid	hard
(B)	rapid	soft
(C)	slow	hard
(D)	slow	soft

47. In which era were trilobites abundant?

(A) Cenozoic
(B) Mesozoic
✔ (C) Paleozoic
(D) Precambrian

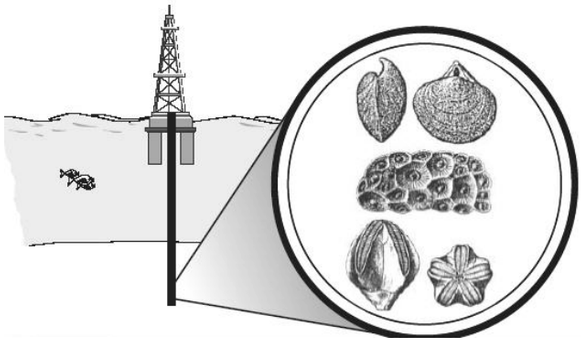
48. Which is an example of a non-renewable resource?

(A) forests
(B) hydroelectricity
✔ (C) minerals
(D) water

49. Which is the correct order of events of Earth's history up to today?

(A) breakup of Pangaea → creation of Appalachian Mountains → formation of Atlantic ocean → breakup of Rodinia
(B) breakup of Pangaea → formation of Atlantic ocean → breakup of Rodinia → creation of Appalachian Mountains
(C) breakup of Rodinia → creation of Appalachian Mountain → formation of Atlantic ocean → breakup of Pangaea
✔ (D) breakup of Rodinia → creation of Appalachian Mountains → breakup of Pangaea → formation of Atlantic ocean

50. The diagram below shows an offshore oil rig that drills through a rock layer containing a number of fossils. Which method of fossilization most likely occurred?



(A) carbonization
(B) impressions
(C) preservation in amber
✔ (D) molds and casts

Part II
Total Value: 40%

Instructions: Complete ALL questions in the space provided. You may use diagrams in any question to aid in your answer.

Value

2% 51.(a) Explain how the Geocentric model and the Heliocentric model of our solar system illustrates a paradigm shift.

Answer:

A paradigm shift happens when an ideal or belief changes to a new ideal or belief which is brought about by new evidence. Ancient astronomy believed that Earth was the center of the solar system (Geocentric model) and at a later date with the introduction of new evidence this view changed and astronomy now follows a sun centered model (Heliocentric) of the solar system. This change is what scientist refer to as a paradigm shift.

2% (b) Uranium-235 decays to form lead-207 and has a half-life of 713 million years. Determine the age of a sample of uranium-235 if the original mass was 256 grams and after radioactive decay the final mass is 32 grams. Show your workings.

Answer:

First; 256g → 128g → 64g → 32g Thus, 3 half lives.

Second; 713 Million Years x 3 = 2,139 Million Years

The radioactive sample is 2,139 Million Years old.

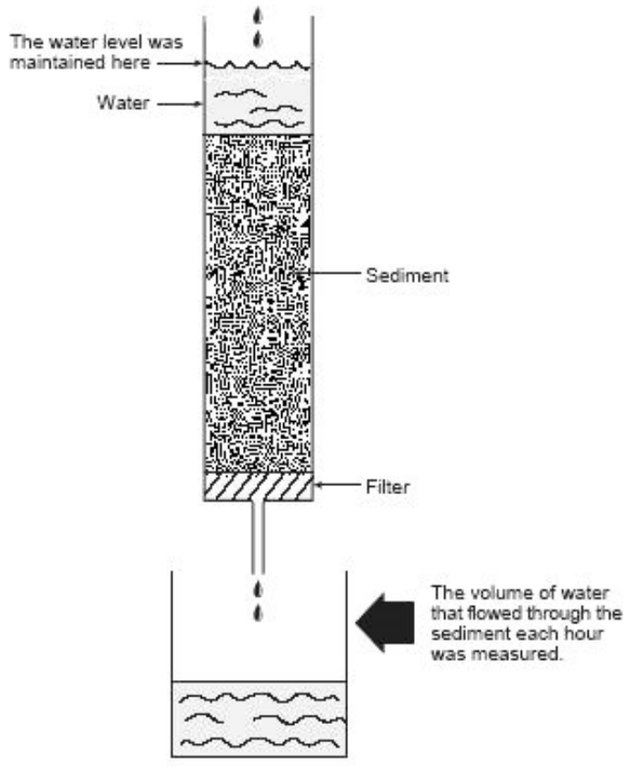
2% (c) Explain how Earth's original hydrosphere developed.

Answer:

When Earth segregated, gases (CO_2, H_2O, etc...) were released and formed Earth's original atmosphere. Water vapour condensed to form clouds and heavy rains fell to Earth increasing its cooling and dropping the surface temperature. After time Earth's temperature dropped below 100 degrees celsius and the rain accumulated on Earth to form the original hydrosphere.

Value

51.(d) The diagram below shows an instrument that was used to determine the rate of water flow through a variety of sediments for a 10 hour period. The porosity of each sediment was also measured by determining how much water was required to completely saturate the dry sediment.



Sediment	Flow rate of water (litres per hour))
well-sorted clay	0
well-sorted gravel	300
well-sorted sand	25

1% (i) What is the relationship between the particle size and porosity of the sediments?

Answer:

The larger the particle size, the greater the porosity.

The smaller the particle size, the less the porosity.

2% (ii) If contaminated liquid was added to the top of this instrument, which sediment from the table above would be best for purifying the water? Explain.

Answer:

Well-sorted sand would be the best for purifing the contaminated water.

Liquids would pass through slowly and this allows contaminants to be filtered from the water.

1% (iii) Why is the permeability and porosity of a mixture of silt and sand different from the permeability and porosity of well-sorted sand?

Answer:

Permeability and porosity would be different because well-sorted sand would have ample pore space allowing liquids to pass through easier, whereas, the mixture of sand and silt would have less pore space due to the fact that smaller silt grains would occupy the space between the sand grains which would resist the flow of liquids through the mixture.

Value

2% 52.(a) Which would be better, hardness or colour, for identifying a mineral? Explain.

Answer:

Hardness is more reliable than colour when identifying minerals according to physical properties. The hardness of a mineral, regardless of its colour, will always be the same. Whereas, the colour of one mineral may vary. For example, Quartz exist in a variety of colours, but it has a hardness of seven on Mohs hardness scale.

(b) A geologist obtained the data below to determine how cooling rate affects the size of mineral crystals forming from molten granite.

Cooling Time of Granite (minutes)	Average Crystal Size (mm)
1	0.25
2	0.75
3	1.5
4	2.5
5	3.75

1% (i) What conclusion can be made from the data?

Answer:

The longer the cooling time of Granite, the larger the average crystal size.

4% (ii) Give two examples of igneous rock textures and describe, in detail, the environment in which they form.

Answer:

Texture	Environment
Coarse (Phaneritic)	Plutonic (intrusive) environment, magma cools very slow.
Fine (Aphanitic)	Volcanic (extrusive) environment, lava cools quickly.
Porphyritic	Formed in both a plutonic and volcanic environments. Magma forms coarse crystals while cooling slowly beneath Earth's surface and the magma (with large crystals) moves to the surface of Earth and cools rapidly forming fine crystals enclosing the coarse crystals.
Glassy	Volcanic (extrusive) environment, lava cools extremely fast not allowing crystal to form which results in glass.
Vesicular	Volcanic (extrusive) environment, lava cools quickly trapping gas bubbles.

Value

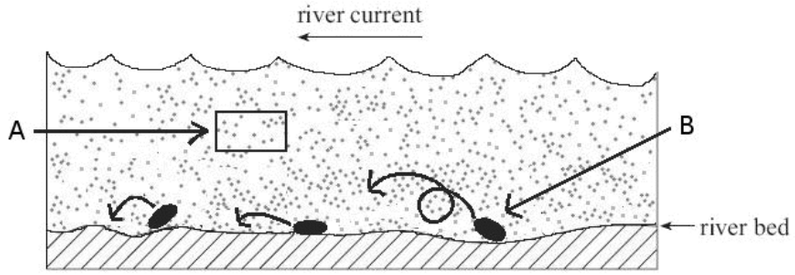
3% 52.(c) Explain using examples, why two silicate minerals could have similar compositions, yet display different cleavages.

Answer:

Silicate minerals have silicon and oxygen as the main elements comprising their composition. Silicate minerals are classified according to the arrangement of the atoms. Common arrangements include sheet silicates, single and double chains, and network (3-D) silicates. The arrangement of the atoms will determine the type of cleavage a particular silicate will display.

Example: Sheet silicates (Micas) have cleavage in one direction, chain silicates (feldspars) have cleavage in two directions, and Network silicates (Quartz) have no cleavage.

53.(a) The diagram below shows two processes, "A" and "B", by which water transports sediments.



2% (i) Identify how sediment is transported by process A and process B?

Answer:

Process A: Suspension, or Saltation, or Dissolved

Process B: Rolling, or Bouncing, or Sliding.

2% (ii) What is the difference between process A and B?

Answer:

Process "A" transports a greater amount of smaller sediment within the water by the currents, whereas, process "B" transports larger sediment along the stream bed by the force of the water and the currents.

2% (iii) Describe how the sediments change in shape and size as they travel downstream.

Answer:

Sediment travelling down stream tend to become more rounded and get smaller as a result of erosion within the stream.

Value

3% 53.(b) Give an example of an environment where regional metamorphism occurs and describe the conditions necessary for regional metamorphism to occur there.

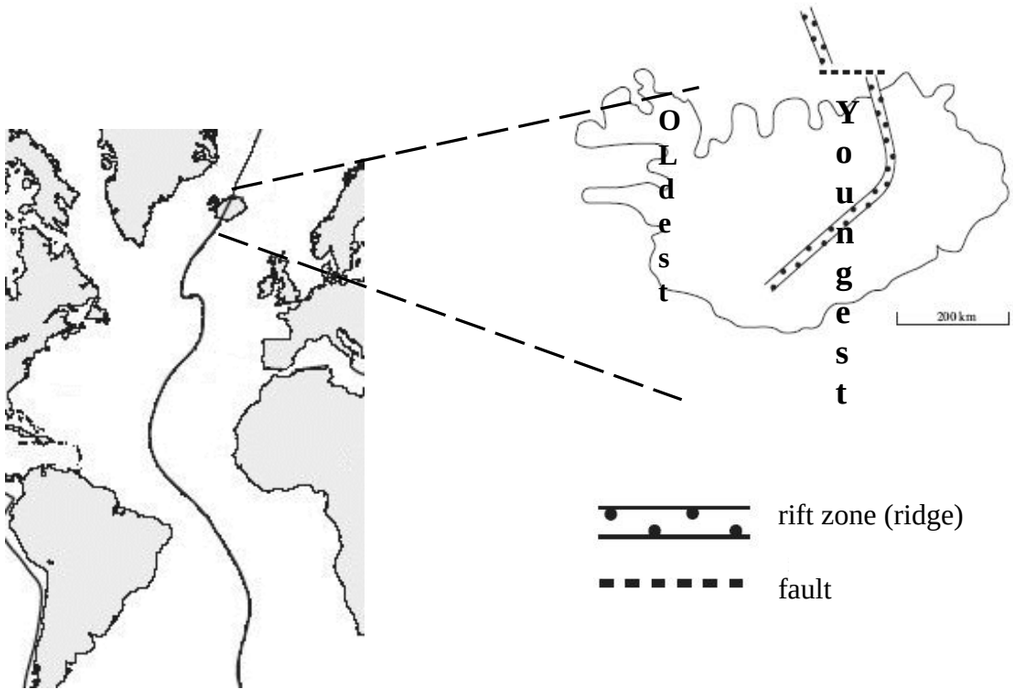
Answer:

Regional metamorphism occurs in environments that are exposed to conditions of extreme heat and pressure. Such environments include deep within mountain systems along convergent boundaries and also deep within geosynclines along the margins of continents.

54.(a) The diagram below shows two tectonic features of Iceland.

1% (i) Label on the map of Iceland to the right, where you would expect to find the oldest and youngest igneous rocks on the island.

Answer:



1% (ii) What type of plate margin is involved in the formation of Iceland?

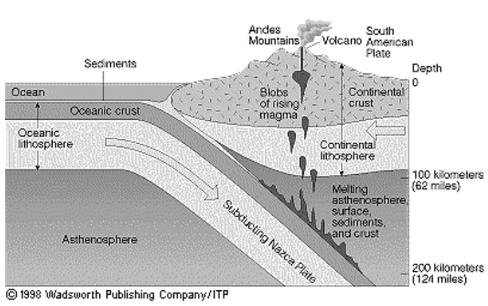
Answer:

Divergent Boundary

2% (iii) The diagram above illustrates sea floor being created. Draw a fully labelled cross section showing a plate boundary where sea floor is destroyed.

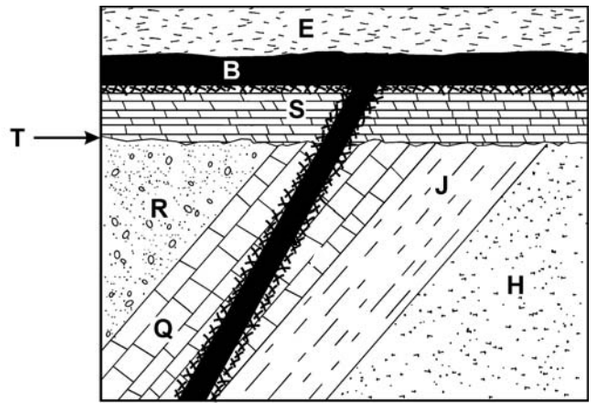
Answer:

Sea floor is destroyed at convergent boundaries; a diagram of either one of the three different convergent boundaries would answer this question.



Value

54.(b) Use the diagram below to answer the questions that follow.



2% (i) List the eight geologic events, represented by letters in the diagram above, in the order they occurred from oldest to youngest.

Answer:

oldest ⟶ youngest

H - J - Q - R - T - S - B - E

2% (ii) What does "T" indicate in the diagram above and explain the process by which this feature formed.

Answer:

"T" indicates an angular unconformity.

Unconformities form through the process of erosion and "T" in the above diagram is the result of Layers H, J, Q, and R being tilted (uplifted) and eroded at a later time.

2% (iii) Why is there no contact metamorphism between "B" and "E"?

Answer:

No contact metamorphism is seen at the boundary of rock units "B" and "E" because rock unit "E" was not present when Rock unit "B" formed. This implies that rock unit "B" is a lava flow that flow on to the surface of Earth and was later buried by Rock unit "E" (sediment).

Value

3% 54.(c) Explain how the properties of P- and S- waves reveal information about Earth's outer and inner core.

Answer:

The properties of both P- waves and S - waves reveal unique information about Earth's interior. Because P - waves are compressional waves it can pass through all states of mater and S - wave are transverse waves it can only pass through the solid state of matter. With this in mind, scientist concluded that Earth's outer core is a liquid.

Scientist also concluded that the density of the Inner core is different form the outer core because the velocities of Both P - waves and S - waves change at a certain depth beneath Earth's surface.

2% (d) Compare two ways gold can be concentrated in Earth's crust.

Answer:

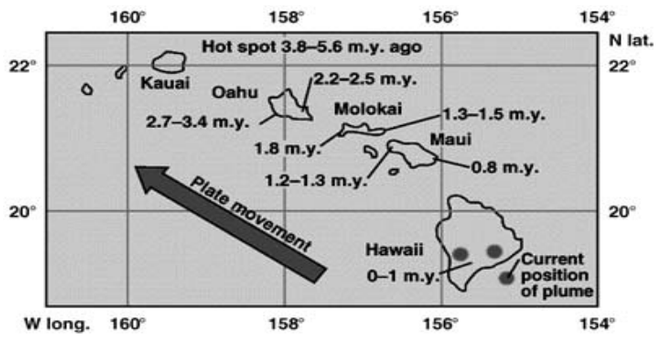
Gold can be concentrated by;

1) Hydrothermal deposits - Hot fluids dissolve and transport gold as it moves through Earth's crust near major heat sources (magma). Gold carried in solution is later precipitated as it moves through areas of fractured rock in cooler areas near Earth's surface to form vein deposits.

2) Placer deposits - Gold is eroded form rock and transported as part of the streams sediment load. The heavier and more dense gold tends to settle and accumulate in areas of lower stream energy to form placer deposits.

2% 55. (a) With the aid of a diagram, explain how the ages of the Hawaiian Islands can be used to indicate that the Pacific Plate is moving.

Answer:



Scientist have calculated the age of rocks on the numerous Hawaiian islands and found that the islands located farther North West are the oldest. The youngest rocks were dated on the island directly over the hot spot and this suggests that the Pacific plate is moving from South-East towards the North-West.

Value

2% 55.(b) Trace fossils provide information about the past even though they do not contain actual remains of the organism. Give one type of trace fossil and describe the information obtained from it.

Answer:

Trace fossils may include;

1) Tracks or trails - Information that may be gathered include, size of organism, mode of transportation, etc...

2) Burrows - indicate environment organism lived.

3) Gastroliths (stomach stones) - indicate type of organism and diet.

4) Caprolites - Indicate what organisms diet was.

2% (c) Use a specific example to compare the processes of petrification and carbonization.

Answer:

Petrification is when an organisms internal cavities and/or pores and cell structure are filled with or replaced by mineral matter and both external and internal details are preserved. Whereas, carbonization is when an organism buried in sediment is compressed and loses liquid and gaseous components leaving a residue of carbon outlining a replica of the organism.