

PART I
Total Value: 60%

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

1. In which branch of Earth Science is ancient life studied?

☐ (A) climatology
☐ (B) meteorology
☒ (C) paleontology
☐ (D) volcanology

2. Which statement best represents how relative time is correctly used in Earth Science?

☒ (A) Dinosaurs became extinct 65 million years ago.
☐ (B) Dykes and sills are younger than surrounding rock.
☐ (C) The rock is 500 million years old.
☐ (D) The rock unit above is older than the rock unit below.

3. Volcanic ash was deposited at the bottom of a lake as varves. If the sequence contains 240 alternating layers of light and dark sediment, how many years ago did the volcanic eruption occur?

☐ (A) 30
☐ (B) 60
☒ (C) 120
☐ (D) 240

4. Which represents the shortest span of geologic time?

☒ (A) eon
☐ (B) epoch
☐ (C) era
☐ (D) period

5. If carbon-14 has a half-life of 5730 years, how many years have passed if 1/8 of the original amount of carbon remains?

☐ (A) 716
☐ (B) 5730
☒ (C) 17 190
☐ (D) 34 380

6. Which is the correct order of the major divisions of geologic time from oldest to youngest?

oldest \longrightarrow youngest

☐ (A) Paleozoic \rightarrow Precambrian \rightarrow Cenozoic \rightarrow Mesozoic
☐ (B) Paleozoic \rightarrow Precambrian \rightarrow Mesozoic \rightarrow Cenozoic
☒ (C) Precambrian \rightarrow Paleozoic \rightarrow Cenozoic \rightarrow Mesozoic
☐ (D) Precambrian \rightarrow Paleozoic \rightarrow Mesozoic \rightarrow Cenozoic

7. Which sphere of Earth contains all life?

☒ (A) atmosphere
☐ (B) biosphere
☐ (C) geosphere
☐ (D) hydrosphere

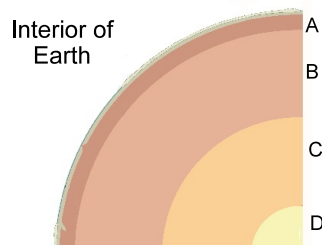
8. At which boundary is the Moho located?

- (A) core-lithosphere
- (B) core-mantle
- (C) crust-lithosphere
- ✓ (D) crust-mantle

9. Which layer of Earth is relatively weak and flows like plastic?

- ✓ (A) asthenosphere
- (B) crust
- (C) inner core
- (D) lower mantle

10. Which layer below consists of molten nickel and iron?



- (A) A
- (B) B
- ✓ (C) C
- (D) D

11. From which source did all water on Earth originate?

- (A) comet impact
- (B) glacial melt
- (C) photosynthesis
- ✓ (D) volcanic outgassing

12. Where is the least amount of Earth's water located?

- (A) glaciers
- (B) ground water
- (C) oceans
- ✓ (D) rivers

13. What is formed when chemical bonding joins two or more elements together in definite proportions?

- (A) atom
- ✓ (B) compound
- (C) isotope
- ✓ (D) molecule

14. Which elements are most abundant in Earth's crust?

- (A) aluminum and carbon
- (B) aluminum and oxygen
- (C) silicon and carbon
- ✓ (D) silicon and oxygen

15. Which is a native element in Earth's crust?

- ✓ (A) aluminum
(B) gold
(C) magnesium
(D) sodium

16. Which chemical formula is matched with its mineral group?

	Chemical Formula	Mineral Group
(A)	Al_2O_3	halides
(B)	CaSO_4	sulfides
✓ (C)	Fe_2O_3	oxides
(D)	ZnS	sulfates

17. Which describes the streak of a mineral?

- ✓ (A) appearance in reflected light
(B) colour in its powdered form
(C) resistance to scratching
(D) splitting along fractured surfaces

18. A sample of galena has a mass of 160 g and displaces 20 mL of water. What is its specific gravity?

- ✓ (A) 4
(B) 8
(C) 16
(D) 160

19. Given the information below, what is the order of minerals from softest to hardest?

- Corundum scratches quartz.
- Quartz scratches calcite.
- Calcite scratches talc.

softest —————→ *hardest*

- (A) corundum → quartz → calcite → talc
(B) corundum → quartz → talc → calcite
(C) talc → calcite → corundum → quartz
✓ (D) talc → calcite → quartz → corundum

20. Which most likely forms due to high temperature and pressure?

- ✓ (A) conglomerate
(B) gneiss
(C) sandstone
(D) shale

21. Which pair of rocks have the same mineral composition?

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

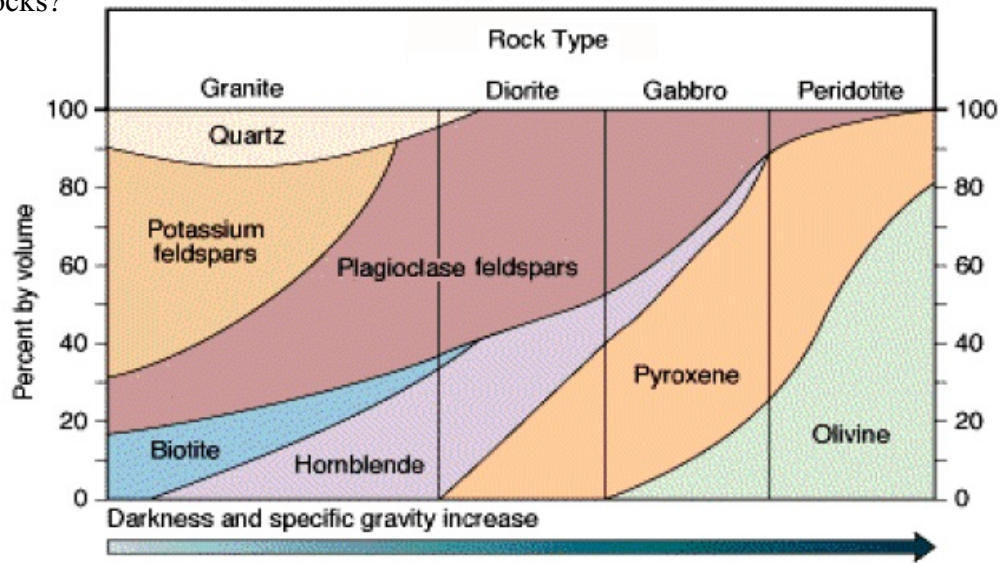
22. Which best describes the silica composition of rhyolite and basalt?

	rhyolite	basalt
(A)	high	high
✓ (B)	high	low
(C)	low	high
(D)	low	low

23. Which best describes a rock with a porphyritic texture?

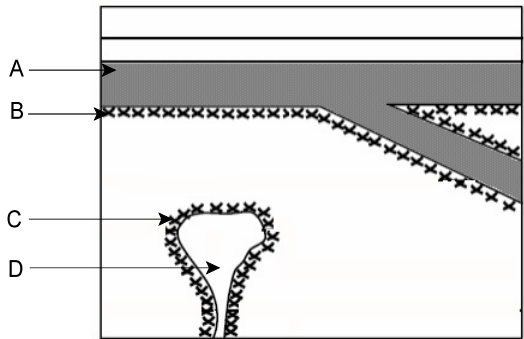
- (A) large crystals of equal size
- ✓ (B) large crystals surrounded by many small crystals
- (C) small crystals of equal size
- (D) small crystals surrounded by many large crystals

24. From the graph below, which best describes the concentration of pyroxene in felsic and mafic rocks?



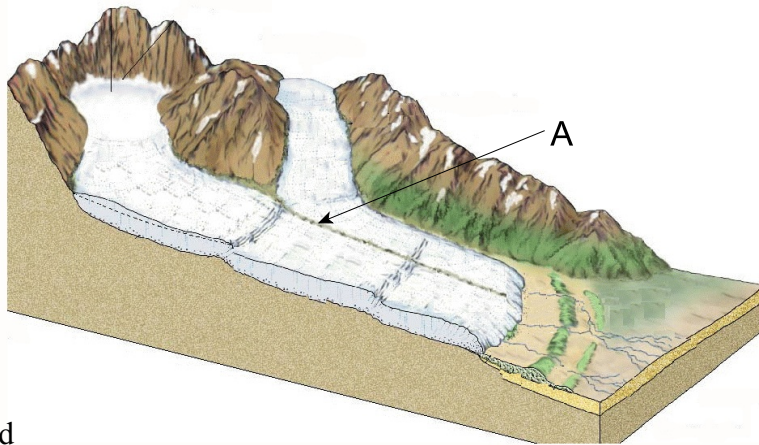
	Felsic	Mafic
(A)	high	high
(B)	high	low
✓ (C)	low	high
(D)	low	low

25. In the diagram below, where would you most likely find a rock with a vesicular texture?



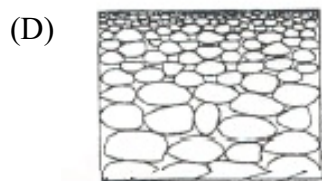
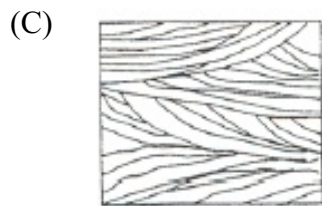
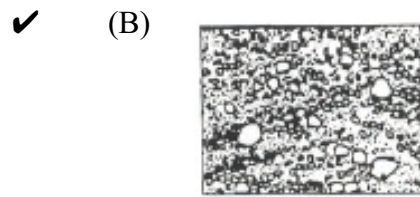
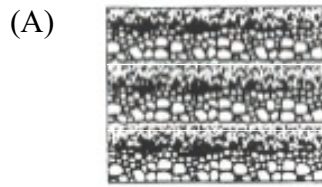
- ✓ (A) A
- (B) B
- (C) C
- (D) D

26. Which rock type would be formed furthest from the mouth of a river?
- (A) breccia
 - (B) conglomerate
 - (C) sandstone
 - ✓ (D) shale
27. Which best represents the phrase, “well sorted”, when describing sediment?
- (A) composed of distinct bedding planes
 - (B) composed of only one type of mineral
 - (C) contains grains of different sizes
 - ✓ (D) contains grains of similar size
28. Which type of moraine is indicated by A in the diagram below?

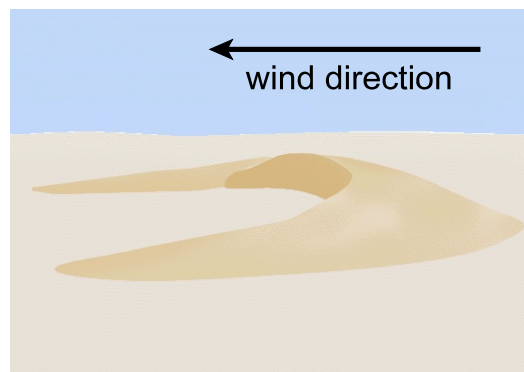


- (A) end
 - (B) lateral
 - ✓ (C) medial
 - (D) terminal
29. Which results from a continental glacier?
- (A) arête
 - (B) cirque
 - ✓ (C) esker
 - (D) horn
30. Which are erosional glacial features?
- (A) drumlins
 - (B) eskers
 - (C) moraines
 - ✓ (D) striations
31. Which occurs at the boundary of an igneous intrusion and existing rock?
- ✓ (A) contact metamorphism
 - (B) cross bedding
 - (C) pillow basalts
 - (D) regional metamorphism
32. Which rock is formed when a lithified sand dune becomes metamorphosed?
- (A) gneiss
 - (B) marble
 - ✓ (C) quartzite
 - (D) slate

33. Which best represents sediment deposited by a glacier?



34. Which type of dune is represented in the diagram below?



- ✓ (A) barchan
(B) longitudinal
(C) star
(D) transverse

35. Which evidence was used by Alfred Wegener to support the Continental Drift theory?

- ✓ (A) jigsaw fit of continents
(B) movement along faults
(C) sea stacks located along shorelines
(D) shallow-focus earthquakes at ridges

36. What evidence was used to support the Plate Tectonic theory?

- (A) crustal uplifting
(B) hanging valleys
(C) isostatic adjustment
✓ (D) seafloor spreading

37. Which plate boundary is associated with island arc volcanoes?

- ✓ (A) convergent
- (B) divergent
- (C) rift valley
- (D) transform

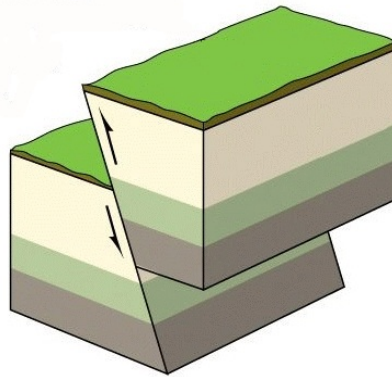
38. Which best explains why region 1 of the mid-Atlantic ridge has wider magnetic stripes than those found nearby in region 2?

- ✓ (A) In region 1, sea floor spreading was at a greater rate.
- (B) In region 1, sea floor spreading was at a slower rate.
- (C) There is less rhyolite in region 1.
- (D) There is more rhyolite in region 2.

39. A region is found to contain folding and areas with abundant outcrops of silica-rich rocks. Which best describes what happened to create the geology of this region?

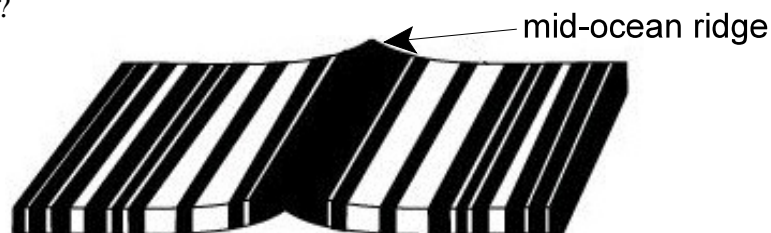
- ✓ (A) hot spot activity
- (B) ocean closed
- (C) ocean opened
- (D) transform movement

40. Which feature would be found in the same tectonic environment as shown in the diagram below?



- ✓ (A) drumlin
- (B) folded rocks
- (C) rift valley
- (D) shield volcano

41. The diagram below represents a sea floor at a mid-ocean ridge. What does the striped pattern indicate?



- ✓ (A) continental drift
- (B) magnetic reversals
- (C) polar wandering
- (D) subduction

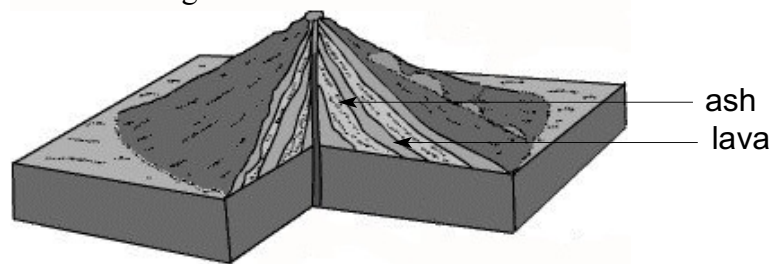
42. Which is an example of hotspot volcanism?

- ✓ (A) Aleutian Trench
- (B) Hawaiian Islands
- (C) Himalayan Mountains
- (D) San Andreas Fault

43. How much more energy is released from an earthquake of magnitude 7 on the Richter scale compared to an earthquake of magnitude 4?

- (A) 3
- (B) 90
- (C) 1000
- ✓ (D) 27 000

44. Which is represented in the diagram below?



- ✓ (A) cinder cone
- (B) composite volcano
- (C) pyroclastic cone
- (D) shield volcano

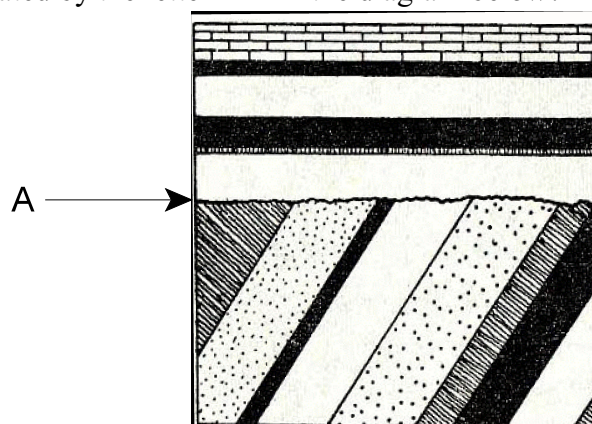
45. Which volcano will produce basaltic lava when it erupts?

- (A) cinder
- (B) composite
- ✓ (C) shield
- (D) stratovolcano

46. Which mineral is the main source of zinc?

- (A) galena
- (B) gypsum
- (C) hematite
- ✓ (D) sphalerite

47. What is indicated by the letter “A” in the diagram below?

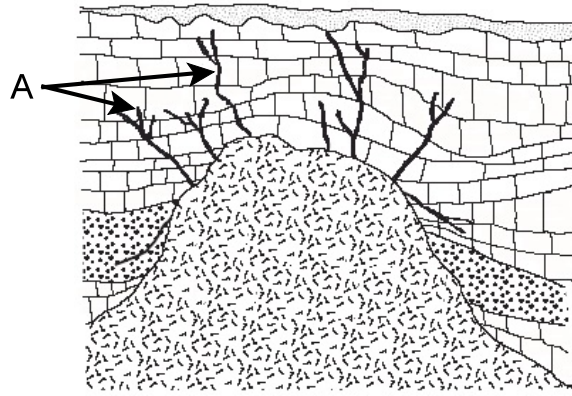


- (A) contact metamorphism
- (B) regional metamorphism
- (C) thrust fault
- ✓ (D) unconformity

48. Which type of deposit would concentrate gold within a river system?












- (A) enriched
- (B) hydrothermal
- (C) leached
- ✓ (D) placer

49. What type of mineral deposit will form at letter “A” in the diagram below?



- ✓ (A) hydrothermal
(B) magmatic
(C) pegmatitic
(D) placer
50. Which resource is present at the Voisey’s Bay site in Labrador?
- (A) asbestos
(B) crude oil
(C) iron
✓ (D) nickel
51. Which is a hard, black coal which generates high energy when burned?
- ✓ (A) anthracite
(B) bituminous
(C) lignite
(D) peat
52. Which type of fossil is represented by footprints and worm burrows?
- (A) body
(B) external mold
(C) internal mold
✓ (D) trace
53. In which rock will fossils most likely form?
- (A) basalt
(B) gneiss
(C) granite
✓ (D) limestone
54. Which factor is most important for the formation of a fossil?
- (A) burial in coarse sediment
(B) high rates of mechanical weathering
✓ (C) presence of hard body parts
(D) slow burial in a deep water environment
55. In which era did fossils first become abundant in the rock record?
- (A) Cenozoic
(B) Mesozoic
✓ (C) Paleozoic
(D) Precambrian

56. The table below shows four layers of sedimentary rock found in a cliff section.

Layer 1				
Layer 2				
Layer 3				
Layer 4				

A geologist working at another cliff section has discovered a layer of similar sedimentary rock that contains brachiopods and snails. The newly discovered layer is most similar to which layer?

- (A) 1
(B) 2
✓ (C) 3
(D) 4
57. Which is the correct evolutionary sequence of organisms from oldest to youngest?
- oldest —————> youngest
- (A) amphibian → fish → mammals → reptiles
(B) amphibian → fish → reptiles → mammals
✓ (C) fish → amphibian → mammals → reptiles
(D) fish → amphibian → reptiles → mammals
58. In which environment did the trilobite fossils most likely form?
- (A) deep water and high energy
(B) deep water and low energy
✓ (C) shallow marine and high energy
(D) shallow marine and low energy
59. Which became extinct at the end of the Mesozoic era?
- (A) birds
✓ (B) dinosaurs
(C) invertebrates
(D) mammals
60. How have geologists been able to determine the angle of a descending plate at a subduction zone?
- (A) measuring the amount of radioactive decay
(B) measuring the height of local mountains
(C) plotting the depth of every earthquake epicentre
✓ (D) plotting the depth of every earthquake focus

PART II
Total Value: 40%

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

Value

- 2% 61.(a) The Orion nebula is a cloud of dust and gas in space. Explain how this nebula could form a solar system similar to the one in which we live.

Answer:

To explain how the Orion nebula could form a solar system we refer to the nebula hypothesis which explains the formation of the solar system in which Earth exists. According to the nebula hypothesis, a huge rotating cloud of dust and gases begins to contract towards its center. As the nebular material contracted it rotated faster and faster which caused the material to flatten into a disk shape. The material concentrated in the center formed the protosun which eventually formed the sun we see today. The remaining material within the flattened disk began to accrete to form the planets we see today. In time most of the remaining debris was added to the nine planets or was swept out into space by solar winds.

- 2% 61.(b) With reference to uniformitarianism, describe how mass extinctions may occur on Earth again.

Answer:

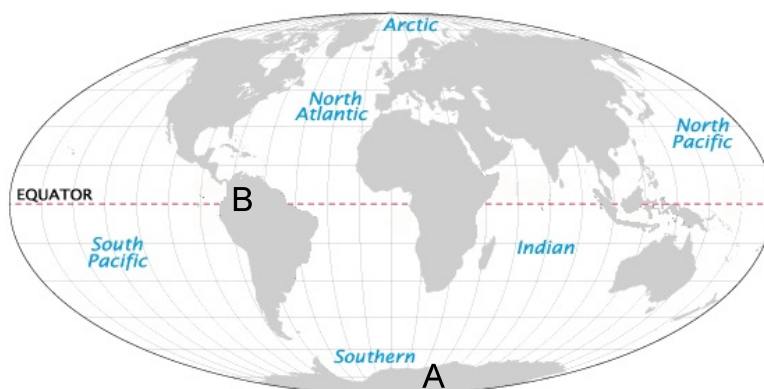
Uniformitarianism suggests that the processes that shaped Earth in the past are essentially the same as those operating today. Thus in the future the same processes will continue to affect Earth. Plate tectonics and meteorite impacts are two possible explanations that scientist believe caused mass extinctions in the past. These phenomena continue to occur today and will continue into the future which may once again be the cause of mass extinctions.

- 2% 62.(a) Describe two characteristics of an aquifer that would make it a reliable water source.

Answer:

Two characteristics of an aquifer that would make it a reliable water source centers around the porosity, permeability, and the ability of the aquifer to recharge at a sufficient rate. An aquifer must have sufficient pore space between the grains (high porosity) to allow the water to flow freely (high permeability) which allows a continuous and reliable water supply. Also an adequate amount of water must be able to reach the aquifer if it is to be a reliable water source.

- 2% 62.(b) Why can glaciers occur in locations A and B on the map below?

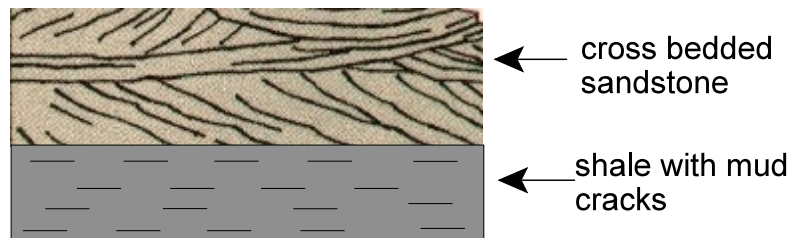


Answer:

In order for glaciers to form temperatures must be cold enough that the rate of snow/ice accumulation exceeds the rate of melting. Location “A” is located at a high degree of latitude and is located near the South pole where the sun’s rays hit Earth at a low angle which spreads heat over a wider area. For this reason ice accumulation exceeds melting and glaciers exist. At location “B” which is at the equator and experiences high amounts of heat glaciers can form in mountains at high altitudes. Within the troposphere, approximately 16 km in height above the equator, temperatures decrease with altitude. At higher altitudes the temperature drops below freezing and snow can accumulate to form glaciers.

Value

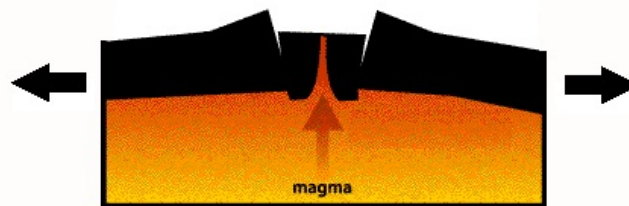
2% 63.(a) Describe the environment of formation for the rock layers below.



Answer:

Both rock units, cross bedded sandstone and shale with mud cracks, formed in an environment predominated by sedimentary rocks. The sedimentary feature of cross bedding in the sandstone indicates a high energy depositional environment. Such environments could include; shallow marine where water moves at varying speeds, in the mouth of a river within a delta, and in deserts within sand dunes. Mud cracks seen in a fine grained rock called shale would indicate a shallow water environment in a warm setting so that evaporation of the water would leave dried mud behind.

4% 63.(b) Use the cross-section below to answer questions (i) and (ii).



(i) Describe the type of faulting and the eruptive style present in the cross-section.

Answer:

Faulting: normal faults, also horst and graben.

Eruptive style: fluid eruptions with little gases, generally classified as gentle eruptions.

(ii) Name and describe the intrusive and extrusive igneous rocks associated with the feature represented in the cross-section.

Answer:

Intrusive igneous rock would be Gabbro. This rock is mafic in composition (dark colored) and has a coarse (phaneritic) texture. Extrusive igneous rock would be Basalt. This rock is mafic in composition (dark colored) and has a fine (aphanitic) texture.

4% 63.(c) Use the photograph below to answer questions (i), (ii), and (iii).

(i) What type of volcano is shown?

Answer:

Composite or Stratovolcano.



(ii) Describe a plate tectonic environment in which this type of volcano occurs.

Answer:

Composite volcanoes form along convergent boundaries where tectonic plates move toward one another forming subduction zones. Within this subduction environment, the mafic ocean floor subducts beneath the felsic continental crust. At depths of approximately 100 km or so the mafic ocean crust melts and buoyantly moves up through, melting the felsic continental crust where it mixes and produces a magma which is intermediate in composition. This high viscosity, intermediate magma later erupts to the surface and builds composite cones within the mountainous environments which lie adjacent to the convergent boundary.

Value

63.(c) (iii) Give an example where this type of volcanic activity is occurring on Earth.

Answer:

Examples include; Mt. Fuji in Japan, Mt. Pinatubo in the Philippines and Mt. St. Helens in the USA.

4%

63.(d) Use the diagram below to answer questions (i) and (ii).



(i) Describe the process that formed the mountain range.

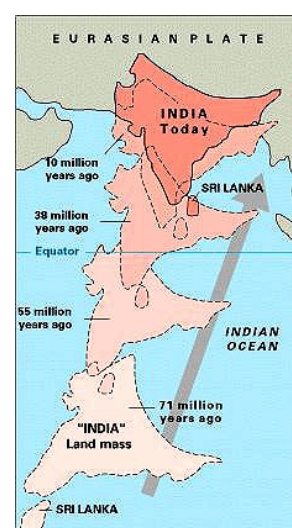
Answer:

The Himalayan mountain range formed when India collided with Asia (seen in diagram to right). This mountain range was the result of a continent - continent collision. Tectonic forces within the mantle moved India Northward where it collided with Asia. When two continents collide, neither will subduct which results in both land masses being pushed up to form some of the tallest mountains in the world.

(ii) Explain why fossils of marine organisms are found in this mountainous region.

Answer:

Marine fossils are often found in sedimentary rocks high in mountains despite the absence of a marine environment. These sedimentary rocks originated long before the mountains formed and were squeezed between the colliding land masses and seen in the diagram to the right. As a result of the collision between the continental land masses, the sedimentary rocks were uplifted to high elevations as the mountainous region formed.



3%

63.(e) In the diagram below, choose the location (A, or B) where earthquakes are most likely to occur and the location where they are least likely to occur. Justify each choice.



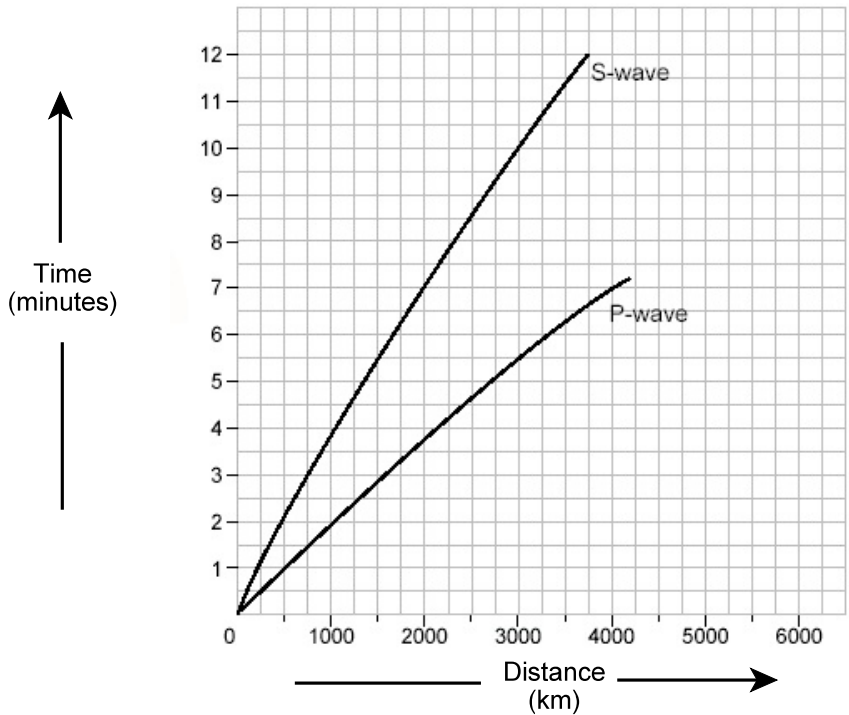
Answer:

Earthquakes are most likely to occur at “location B” because this area is a part of an active plate margin that surrounds much of the Pacific Ocean. The Pacific plate is subducting beneath Alaska and these compressional forces often lead to earthquakes.

Earthquakes are least likely to occur at “location A” because this area of Eastern North America is part of a passive plate margin where little or no tectonic forces are presently active. This environment is relatively stable and seldom experiences earthquake activity.

Value

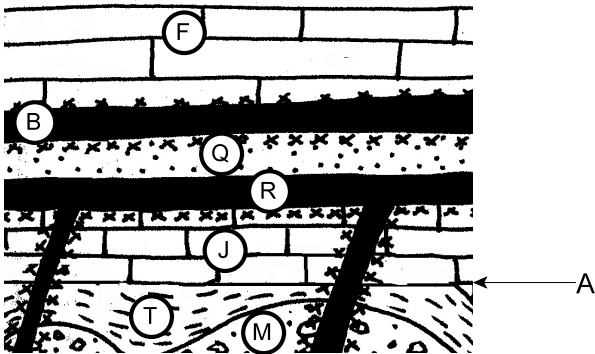
2% 63.(f) Use the graph below to complete the table.



Answer:
Omit station A. Information given is inconclusive to find arrival time of S-wave and the distance from the epicenter.

	P-Wave Arrival Time (minutes)	S-Wave Arrival Time (minutes)	Time Difference (minutes)	Distance from Epicenter (km)
Seismic Station A	6.5	N/A	2.5	N/A
Seismic Station B	6.25 minutes (6minutes and 15 seconds)	11.5	5.25 minutes (5 minutes and 15 seconds)	3500

4% 63.(g) Use the diagram below to answer questions (i) and (ii).



(i) What feature is indicated by A and what process formed it?

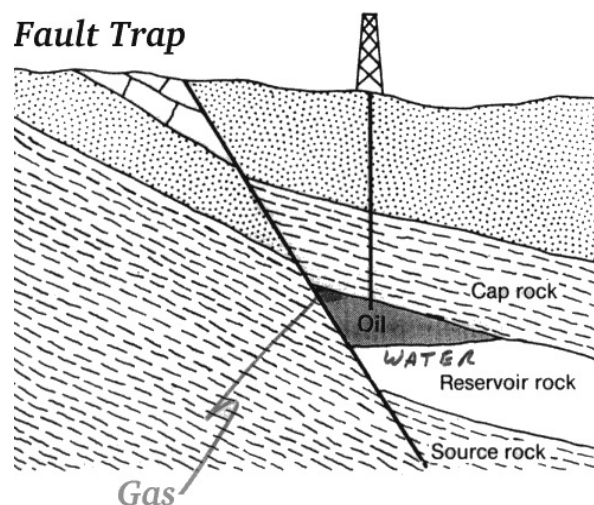
Answer:
Feature “A” is an angular unconformity which forms when layers of sedimentary rock are uplifted, tilted at an angle (by folding in this case) and then eroded. This erosion surface is later buried by sediment as a result of the area subsiding (sinking). The buried erosional surface is referred to as an angular unconformity.

- 63.(g) (ii) Units R and B are basaltic in composition. Describe the difference between the formation of each unit.

Answer:

Despite the fact that both rock units “R” and “B” are basaltic in composition, the two rocks formed under very different conditions. The contact metamorphism (xxx’s) which is located only on the bottom of unit “R” suggests that this molten rock made it to the surface and erupted as a lava flow which was later buried by the sedimentary layer above. Thus, unit “R” cooled quickly and would contain smaller crystals that indicates a volcanic environment. Unit “B” has contact metamorphism on top and below which suggests that the molten rock intruded between two sedimentary layers beneath the surface and cooled at a slower rate producing larger crystals that indicates a plutonic environment.

- 3% 63.(h) Draw a cross-section of a fault-type oil trap. Label the cap rock, reservoir rock, and the location of oil, natural gas, and water. Indicate on the cross-section the best drill hole location.



- 3% 64.(a) Recently, linear chains of volcanoes, metamorphic rocks, and numerous outcrops of rhyolite and granite were found on a planet. Reverse faulting was also observed. Describe three features of the plate tectonic environment on this planet.

Answer:

A plate tectonic environment which has linear chains of volcanoes, metamorphic rocks, reverse faulting, and the igneous rocks granite and rhyolite most likely would be a convergent boundary (subduction zone) where compressional forces are present. Some of these features listed below are necessary to form mountain chains, reverse faulting, metamorphic rocks and the igneous rocks granite and rhyolite.

Three features of this tectonic environment may include:

- | | |
|--|----------------------------------|
| 1) compressional forces | 2) collision of tectonic plates |
| 3) subduction of a tectonic plate | 4) formation of oceanic trenches |
| 5) volcanic eruptions | 6) formation of new rock types |
| 7) melting of tectonic plates and sediment | |

- 3% 64.(b) Name one renewable and one non-renewable resource found in Newfoundland and Labrador and explain why each resource is classified this way.

Answer:

A **renewable resource** found in Newfoundland and Labrador can include; 1) trees, 2) fish, 3) water, 4) any other suitable resource. These resources are renewable because they have the ability to regenerate and replenish naturally. Therefore they are referred to as sustainable resources.

A **non-renewable resource** found in Newfoundland and Labrador can include; 1) minerals and 2) fossil fuels such as oil. These resources are non-renewable because they do not have the ability to regenerate and replenish naturally and once the resource is exhausted it is gone forever. Therefore non-renewable resources are referred to as unsustainable resources.