



PART 1: Multiple choice: (60 points) Please circle the letter that best answers or completes the question.

1. Which boundary is the surface upon which lithospheric plates move?
 - A. The Mohorovicic Discontinuity (the Moho)
 - B. The asthenosphere – lithosphere boundary
 - C. Gutenberg’s Discontinuity
 - D. The crust

2. The average geothermal gradient in Earth’s crust is which of the following?
 - A. 25°C/km
 - B. 35°C/km
 - C. 45°C/km
 - D. 15°C/km

6. The basic structural unit in all silicate minerals is the...
 - A. Polymorph
 - B. Metallic bond
 - C. Silicate tetrahedron
 - D. Chloride ion

7. The core of Earth consists of _____.
 - A. A solid inner and a solid outer component
 - B. A solid outer and a liquid inner component
 - C. A liquid inner and a liquid outer component
 - D. A solid inner and a liquid outer component

8. As compared to aphanitic igneous rocks, phaneritic rocks _____.
 - A. Cooled more rapidly
 - B. Cooled less rapidly
 - C. Are still molten
 - D. Aren’t cool

9. Which of the following controls the viscosity of erupting lavas?
 - A. SiO₂ content
 - B. K₂O content
 - C. Al₂O₃ content
 - D. MgO content.

10. What best explains seamount – guyot tracks across an expanse of ocean
 - A. Motion of a hot spot beneath continental lithosphere
 - B. Motion of oceanic lithosphere over a stationary hot spot
 - C. Ancient astronauts
 - D. An ancient mid-ocean ridge



11. Submarine mafic eruptions commonly exhibit _____.
 - A. Porphyritic textures
 - B. Lava fountains
 - C. Pillow structures
 - D. Columnar joints.

12. Igneous intrusions which cut across layered strata are termed _____.
 - A. Sills
 - B. Batholiths
 - C. Laccoliths
 - D. Dikes.

13. The Heliocentric theory of the solar system was championed by whom?
 - A. Copernicus
 - B. Ptolemy
 - C. Eratosthenes
 - D. Newton

14. Where would geothermal heat flow be expected to be low?
 - A. Along mid-ocean ridges
 - B. At a hot spot
 - C. At the base of the lithosphere
 - D. In the center of a continent

15. What discovery was made upon visiting the Mid-Atlantic Ridge in the research submersible "Alvin"?
 - A. Pillow basalts
 - B. Rift valleys
 - C. An ecosystem based on energy from hot mineralized water
 - D. The singing group "the Chipmunks"

16. At a triple junction is a place on Earth's surface where _____.
 - A. Three tectonic plate boundaries coincide
 - B. Igneous, metamorphic and sedimentary rocks coexist
 - C. Glacial ice, continental rocks, and oceanic rocks can be found together
 - D. Three phases of matter (solid, liquid and gas) occur together in equilibrium

17. A cross-section through the oceanic crust that is preserved on continental crust is term a(n) _____.
 - A. Gabbro
 - B. Pillow basalt
 - C. Sheeted dike complex
 - D. Ophiolite



18. Which tectonic feature corresponds with the deepest part of the ocean?
 - A. A mid-ocean ridge
 - B. A transform fault – fracture zone
 - C. A continent – continent collision
 - D. A subduction trench

19. What can a geologist interpret from a xenolith?
 - A. The type of country rock a magma passed through
 - B. The temperature of the magma
 - C. The pressure of the magma
 - D. Ancient warrior princesses had kidney stones

20. Which of the following characterizes the transform fault that offsets mid-ocean ridge segments?
 - A. An abundance of shallow earthquakes
 - B. Effusive volcanism
 - C. All of the above
 - D. All of the below

21. Continental crust and oceanic crust _____.
 - A. Never occur on the same tectonic plate
 - B. Can transition one into the other
 - C. Are really the same
 - D. Always transition one into the other

22. X-Ray diffraction is useful in the study of minerals because it allows scientists to _____.
 - A. Determine that a mineral is solid
 - B. Determine that a mineral is naturally occurring
 - C. Determine that a mineral has an ordered atomic structure
 - D. Determine that a mineral is inorganic

23. A laccolith is _____.
 - A. A horizontal tabular intrusion that lies parallel to surrounding layers of sedimentary rock
 - B. A mushroom-shaped igneous intrusion
 - C. An intrusion formed within the magma chamber of a volcano
 - D. A vertical tabular intrusion that cuts across preexisting layers

24. Natural glass is not considered a mineral because it _____.
 - A. Is not homogenous
 - B. Is organic
 - C. Does not have a fixed crystalline structure
 - D. Can be made synthetically as well as being a naturally occurring substance



25. How does magma composition relate to volcanic eruptive style?
- A. Thick viscous magmas erupt in mild runny lava flows
 - B. was replaced by the theory of plate tectonics
 - C. was incorporated within the theory of plate tectonics
 - D. Thick viscous magmas erupt in massive explosions of rock and ash.
26. Which is the most common rock-forming mineral group in Earth's crust?
- A. Calcite
 - B. Quartz
 - C. Feldspars
 - D. Clay minerals
27. The oldest oceanic crust on the sea floor occurs _____.
- A. At the edges of ocean basins
 - B. In volcanic island arcs
 - C. Near mid-ocean ridges
 - D. Randomly distributed over the entire ocean basin
28. Silica tetrahedra may be coordinated to form all of the following structures EXCEPT _____.
- A. Long single chains
 - B. Extensive two-dimensional sheets
 - C. Three-dimensional frameworks
 - D. Double helixes
29. A(n) _____ is formed of material scraped off a descending, lithospheric plate.
- A. Mass movement complex
 - B. Continental shelf, terrain complex
 - C. Accretionary-wedge complex
 - D. Subterranean-accumulation complex
30. A good example of a present-day, passive continental margin is the _____.
- A. North flank of the East Pacific Rise
 - B. West coast of South America
 - C. East coast of the Japanese Islands
 - D. West coast of Africa



31. Earth's surface is protected from solar wind and cosmic radiation by _____.
- A. Earth's gravitational field
 - B. The ozone layer
 - C. Omniscient beings
 - D. The Van Allen radiation belts
32. Wegener's idea of continental drift was supported the following lines of evidence EXCEPT _____.
- A. Fossils of non-swimming organisms were found on opposite sides of the Atlantic
 - B. Mountain belts and unique rock types were observed to link across the Atlantic
 - C. The distribution of glacial striations and tropical sediments were consistent with Pangea
 - D. Paleomagnetic positive and negative anomalies (stripes) preserved in the oceanic crust
33. What is a guyot?
- A. A circular feature formed by impact of an asteroid on continental crust
 - B. A flat-topped submarine volcano
 - C. A blob-like igneous rock body that has cooled beneath the surface of the Earth
 - D. A mushroom-shaped igneous intrusion
34. Continental crust _____.
- A. Is thinner than oceanic crust
 - B. Contains more mafic rocks than oceanic crust
 - C. Is less dense than oceanic crust
 - D. Is mostly basaltic in composition
35. What does Bowen's Reaction Series describe?
- A. Temperature changes in a cooling magma
 - B. Pressure changes in a cooling magma
 - C. Compositional changes in a cooling magma
 - D. Textural changes in a cooling magma
36. Which of the following descriptors characterizes tectonic plates?
- A. They are rigid
 - B. They are thin and hot
 - C. They are made of continental rocks which plow through weaker oceanic rocks
 - D. They behave like plastic solids



37. How does magma composition relate to volcanic eruptive style?
- A. Increasing silica content makes magmas less viscous leading to less violent eruptions
 - B. Decreasing silica content makes magmas less viscous leading to less violent eruptions
 - C. Increasing silica content makes magmas more viscous leading to less violent eruptions
 - D. Decreasing silica content makes magmas less viscous leading to more violent eruptions
38. What is the most abundant element in the crust?
- A. Silicate
 - B. Iron
 - C. Oxygen
 - D. Aluminum
39. One difference between lava and magma is that _____.
- A. Magma is cooler
 - B. Magma is more dense
 - C. Lava has lost volatiles
 - D. Lava is under greater pressure
40. Minerals that lack cleavage are said to have _____.
- A. A poor attention span
 - B. Ductility
 - C. High specific gravity
 - D. Fracture
41. What is a major difference between a ridge transform and a fracture zone?
- A. Unlike a fracture zone, oceanic crust at a transform travels in 2 directions.
 - B. Fracture zones have multiple shallow earthquakes; transforms don't
 - C. Fracture zones are thermally expanded; transforms aren't
 - D. Transforms have extensive volcanic activity unlike fracture zones
42. At a subduction zone, which of the following is NOT present?
- A. A volcanic arc
 - B. A bathymetric trench
 - C. An axial rift
 - D. An accretionary wedge
43. Which of the following discoveries was the result of submarine detection efforts during the Cold War?
- A. Sonic booms create clouds.
 - B. Earthquakes concentrate along Mid-Ocean Ridges and ridge transform offsets.
 - C. Magnetic stripes were found oriented perpendicular to the Mid-Ocean Ridges.
 - D. Sea-water is a poor transmitter of sound waves.



44. Coarse-grained granite is most similar in composition to fine-grained _____.
- A. Andesite
 - B. Basalt
 - C. Komatiite
 - D. Rhyolite
45. Which of the following is an inference you can make about any euhedral quartz crystal?
- A. The crystal has magical healing powers
 - B. The crystal is a polymorph
 - C. The crystal must have grown in an open space
 - D. The crystal must be from Herkimer, New York

Part 2, Short Answer: (20 points) Please write a short sentence to answer the question

46. What is the Wadati – Benioff Zone?
47. Who first proposed continental drift?
48. What is a black smoker?
49. What does magnetic inclination reveal?
50. What kinds of rocks can preserve a paleomagnetic signal?
51. What is a geode?
52. What type of magma has a greater amount of volatiles?
53. What is a batholith?
54. How does a xenolith form?
55. Why does magma rise?



Part 3: True-False (10 Points) Please circle the T or the F to indicate whether the statement is True or False

56. The San Andreas fault is an example of a convergent tectonic margin.	T	F
57. Paris and New York City are now 2 meters further apart than 100 years ago.	T	F
58. Minerals are classified based upon their dominant cations.	T	F
59. Only a very small percentage of the solar wind intersects Earth's magnetic field.	T	F
60. Rocks of the continental crust are less buoyant than rocks of the oceanic crust.	T	F
61. Calcite is the hardness index mineral of 5 on the Moh's Scale of Hardness	T	F
62. Mineral color is not always useful as a diagnostic identification property	T	F
63. Dry rocks generally melt at lower temperatures than wet rocks.	T	F
64. Convergent margins are sometimes marked by the location of massive mountain ranges	T	F
65. The Earth is 4.6 billion years old.	T	F
66. In general, the age of the sea floor decreases away from a mid-ocean ridge.	T	F
67. Basalt is an extrusive igneous rock that is enriched in Na, K and Si.	T	F
68. The moon reveals evidence of on-going active plate tectonics.	T	F
69. A planitesimal is an accumulation of cosmic dust and debris.	T	F
70. The island of Hawaii is one of the best places on Earth to witness volcanic activity.	T	F
71. The Sierra Nevada batholith is the result of subduction of the Farallon Plate	T	F
72. Mantle convection is the only driving mechanism moving lithospheric plates.	T	F
73. When continental lithosphere rifts apart, it always develops into a subduction zone.	T	F
74. Sediment layers on top of oceanic crust are always thickest near the mid-ocean ridge.	T	F
75. The Aleutian Islands in Alaska are a classical example of an island arc.	T	F



Part 4: Essay (10 points) Please write a clear and legible essay on **ONE** of the following topic questions.

- A.) Briefly describe 3 lines of evidence that support and reinforce H.H. Hess's Theory of Sea-Floor Spreading.

- B.) Name and briefly describe at least three processes that cause a magma to change composition with time.