GEOLOGICAL TIME / DATING TECHNIQUES

Instructions: Read each question carefully before selecting the BEST answer. Provide specific and detailed answers to essay questions. Use GEOLOGIC VOCABULARY where APPLICABLE! USE AN 882 SCANTRON TO RECORD YOUR ANSWERS FOR THE FOLLOWING MULTIPLE CHOICE AND T/F QUESTIONS. TURN IN YOUR SCANTRON AND ANSWER SHEET ONLY!

Multiple Choice:
1. The era of "middle life" or the "age of dinosaurs" is the _______ era.
   a. Cenozoic   b. Precambrian   c. Neolithic   d. Mesozoic   e. none of these
2. The era known as the "age of mammals" or "recent life" is the _______.
3. What era is sometimes called the "age of fish" or "ancient life"?
   a. Precambrian   b. Paleozoic   c. Cenozoic   d. Mesozoic   e. none of these
4. Which one of the following lists places the division of geologic time in order from shortest to longest?
   a. era, period, epoch  c. epoch, period, era  e. period, epoch, era
   b. epoch, era, period  d. none of these
5. The age of Earth is about:
   a. 2 billion years.  b. 4.5 million years.  c. 16 million years.  d. 4.5 billion years.
6. Abundant fossil evidence did not appear in the geologic record until about (approximately):
   a. 5 billion years ago.  c. 6 million years ago.  e. 540 million years ago.
   b. 340 million years ago.  d. 3 billion years ago.
7. About 88 percent of geologic time is represented by the time span often called the:
8. The statement "The present is the key to the past" relates to
   a. Principle of Catastrophism  c. Principle of Uniformitarianism
   b. Aristotle's hypothesis  d. Tarbuck's theory  e. none of these
9. Most ancient rocks on the surface of the Earth have been recycled by plate tectonics, but there are ancient rocks on Earth that have been discovered to be approximately _______ years old.
   a. 4 thousand  b. 4 million  c. 4 billion  d. 4 trillion
10. Which one of the following represents the shortest expanse of time?
11. The forces and processes that can be observed shaping our present day landscapes have also operated in the geologic past. The preceding statement refers to:
    a. Principle of Uniformitarianism  d. Principle of Catastrophism
    b. Aristotle's hypothesis  e. Principle of Uniformity
    c. Answers a. and e.  f. Answers b. and d.
12. The principle of fossil succession states that:
    a. the same sequence of life forms repeats over and over
    b. there has been a change in life forms through time
    c. that different assemblages of fossils indicate different geologic ages
    d. answers b. and c
    e. answers a. and b.
13. Who is usually credited with formulating the doctrine of uniformitarianism?
14. Fossils that were wide-spread globally, but which denote particular short periods of time in the geologic past are termed:
    a. Environmental indicators  d. fossil discriminators
    b. Huttonian fossils  e. Index or guide fossils
    c. none of these
15. The subdivision of the geologic time scale that represents the longest geologic time span is called:
16. Radioactive dates are more accurate and therefore most often determined for:
    a. igneous rocks  b. sedimentary rocks  c. metamorphic rocks  d. glassy rocks
17. Radioactive carbon dates are effective and useful (accurate) for approximately the past:
   a. 5000 years   b. 50,000 years   c. 70,000 years   d. none of the above

18. Radioactive decay:
   a. produces heat  
   b. produces a transformation from one element to another  
   c. answers a. and b.  
   d. cannot be used to date rocks because the decay rate is not constant  
   e. none of these

19. Radioactive dates are based on:
   a. the ratio of unstable parent material and stable daughter product present in a sample  
   b. measuring the amount of unstable isotopes present  
   c. measuring the number of atoms that decay per unit time  
   d. none of these

20. Half life:
   a. is the time necessary for one half of the parent material to decay  
   b. times can be very short or very long  
   c. times are constant for a given isotope  
   d. all of the above  
   e. none of these

21. One type of radioactive decay involves the emission of a beta particle. When this occurs
   a. the atomic number decreases by 1  
   b. the atomic number increases by 1  
   c. the mass number increases by 1  
   d. the atomic number and the mass number both increase by 1  
   e. the atomic number decreases by 1 and the mass number increases by 1

22. When $^{127}/^{128}$ of a radioactive isotope has decayed ($1/128$ of the parent isotope is left) to become the stable daughter product, _______ half-lives have elapsed.
   a. four  
   b. five  
   c. six  
   d. seven  
   e. eight  
   f. nine

23. Which of the following materials might be dated using carbon-14?
   a. sandstone  
   b. wood  
   c. iron ore  
   d. granite

24. An alpha particle consists of
   a. one electron.  
   c. two electrons and two neutrons.  
   b. two protons and two neutrons.  
   d. either b. or c.  
   e. none of these

25. A beta particle consists of
   a. one electron.  
   c. two electrons and two neutrons.  
   b. two protons and two neutrons.  
   d. either b. or c.  
   e. none of these

26. When an alpha particle is emitted, how does the mass number and atomic number change?
   a. mass number 4 less, atomic number 2 less  
   b. mass number 2 less, atomic number 2 less  
   c. mass number 4 less, atomic number unchanged  
   d. mass number 4 less, atomic number 2 higher  
   e. none of these

27. When potassium-40 decays to argon-40, it does so by means of
   a. beta particle emission.  
   d. electron capture.  
   b. alpha particle emission.  
   e. both beta particle emission and electron capture.  
   c. both electron capture and alpha particle emission.

28. Assume that the half-life of a particular radioactive isotope is 150,000 years. Laboratory analysis shows that the ratio of radioactive parent to stable daughter product in a sample is 1:7. In other words, there is one parent isotope for every 7 daughter isotopes. What is the age of the sample?
   a. 75,000 years  
   c. 300,000 years  
   e. 600,000 years  
   b. 150,000 years  
   d. 450,000 years  
   f. none of these

29. If a rock is heated during metamorphism and the parent atoms migrate out of a mineral that is subsequently radiometrically dated, an inaccurate date will be obtained. This date will be _______ the actual date.
   a. younger than  
   b. older than  
   c. the same as  
   d. it cannot be determined  
   e. none of these

30. If a radioactive element has a half-life of 2 million years, the amount of parent material remaining after 12 million years of decay will be what fraction of the original amount?
   a. 1/64  
   b. 1/32  
   c. 1/16  
   d. 1/8  
   e. ¼  
   f. ½

31. Absolute dates are based on:
   a. fossils  
   b. educated estimates  
   c. radioactive decay  
   d. cross-cutting relationships
32. What is being measured in radiometric dating?
   a. the time when the radioactive isotope formed, prior to being incorporated into a mineral.
   b. the time of crystallization of a mineral containing an isotope
   c. the amount of the parent isotope only
   d. when the dated mineral became part of a sedimentary rock
   e. when the stable daughter isotope was formed

33. Absolute time:
   a. gives a non-specific date to an object
   b. gives a specific date to an object
   c. is only useful if fossils are present
   d. only gives the sequence in which events have taken place

34. How many half-lives are required to yield a mineral with 15.625 grams of U238 and 984.375 grams of Pb206?
   a. 5  b. 6  c. 7  d. 8  e. 9

35. Placing geologic events in sequential order as determined by their position in the rock record is called:
   a. absolute dating  b. uniformitarianism  c. relative dating  d. correlation  e. historical dating

36. In order to match rocks of similar age in different regions or to demonstrate age equivalency of rock units, geologists use
   a. Lateral tracing  d. Radiometric dating  f. Fossils
   b. sequence of beds  e. None of these  g. Similarity of rock type
   c. All of these

37. An undeformed sedimentary layer is _______ than the layer above and _______ than the layer below.
   a. younger, older  b. older, younger  c. younger, younger  d. older, older

38. Of five undeformed horizontal beds of sedimentary rock, we can say that
   a. the lowest layer is oldest
   b. the top layer is oldest
   c. the third layer from the bottom is older than the second layer from the bottom.
   d. there is no way of knowing which layer is youngest or oldest

39. An unconformity is
   a. a layer of sedimentary rock  d. a gap in the rock record
   b. A layer of rock with very unusual fossils  e. a period of erosion or non-deposition
   c. Either d or e  f. All of these

40. An angular unconformity occurs where:
   a. the beds are parallel above and below the unconformable contact
   b. the beds above and below the unconformable contact are at angles to one another
   c. sedimentary rocks overlie massive crystalline rocks
   d. all of the above

41. A nonconformity closely resembles:
   a. fault contact  b. an intrusive contact  c. a soil on its parent rock  d. all of these

42. Which of the following is used by geologists to determine the relative ages in a rock sequence?
   a. inclusions  b. fossils  c. cross-cutting relations  d. all of these

43. Assume that you have just examined several flat-lying sedimentary layers. After much study you determine that there is a considerable span of time for which no sedimentary rock layer exists at this site. You have just discovered a(n)
   a. angular unconformity
   b. series of conformable strata
   c. disconformity
   d. example of cross-cutting relationships

44. The principle of cross-cutting relationships states that
   a. sediments are deposited as essentially horizontal layers
   b. the present is the key to the past
   c. undisturbed sedimentary layers get progressively younger from bottom to top
   d. a fault that affects a sedimentary rock is younger than the rock

45. In undisturbed sedimentary deposits, the oldest beds:
   a. are water beds  b. are on the top  c. are on the bottom  d. could be answers b. or c.

46. Which of the following is related to relative dating?
   a. cross-cutting  b. inclusions  c. superposition  d. all of these
   e. both inclusions and superposition
47. A layer of sandstone is in contact with a mass of granite. The granite contains small pieces of the sandstone. Which rock is younger?
   a. Sandstone c. granite d. both are the same age
   b. it is not possible to determine which is older from the information provided.

48. The principle of original horizontality states that:
   a. in most cases sedimentary beds are deposited as horizontal units
   b. in rare cases, horizontality of rock layers occurs.
   c. in most cases, if the beds are inclined, this tilting occurred after the beds were deposited
   d. answers a. and c.

49. Which relative dating principle is illustrated in the previous question?
   a. cross-cutting c. original horizontality d. inclusions e. superposition
   b. none of the above

50. By applying the law of superposition _______ dates can be determined.
   a. Conventional b. radiometric c. relative d. isotopic e. both relative and radiometric

51. To depict the differences between geologic time and human time, answer the following. About what percent of geologic time is represented by written, recorded human history?
   a. Less than 0.01% c. Approximately 1% e. Approximately 10%
   b. Approximately 100% d. none of these

52. A geologic formation or rock formation is a series of rock layers that __________.
   a. can be recognized and mapped as a distinctive unit
   b. has approximately the same physical properties
   c. contains the same assemblage of fossils
   d. has all of these properties

53. Which of the following processes removes carbon dioxide from the atmosphere and produces oxygen as a by-product?
   a. Photosynthesis b. volcanic eruptions c. weathering of organic carbon d. all of these

54. Which of the following processes can add carbon dioxide to the atmosphere and cause global warming?
   a. Photosynthesis c. human activity e. answers b. and c.
   b. volcanic eruptions d. all of these f. answers a. and c.

55. When tilted or folded sedimentary rocks are overlain by more flat-lying strata a(n) __________ is said to exist.
   a. Disconformity b. angular unconformity c. nonconformity d. conformity e. none of these

56. A worm would stand a poor chance of being fossilized because
   a. worms have been rare during the geologic past c. worms have no hard parts
   b. worms contain no carbon-14 d. all of these e. none of these

57. Which of the following would be most likely to be fossilized:
   a. Squid b. worm c. tree branch d. horseshoe crab e. octopus

58. Fossils may include:
   a. Foot imprints c. molds of the original organism e. imprints of skin, feathers, etc.
   b. Skeletal remains d. all these

59. The oldest rock in the Grand Canyon is the __________.

Refer to the following geologic cross section for the following 4 questions. Units 1, 2, 3, 5, and 6 are sedimentary rocks. The Granite is an igneous rock.
60. When did the intrusion of the granite occur?
   a. after deposition of unit 1
   b. after deposition of unit 3 and before deposition of unit 5
   c. after deposition of unit 5 and before deposition of unit 6
   d. cannot be determined from the information given

61. Of the following events, which happened last (most recent feature of these options)?
   a. erosion of part of unit 3  
   b. intrusion of granite  
   c. deposition of unit 5  
   d. cannot be determined from the information given

62. What type of unconformity occurs between the granite and unit 5?
   a. Disconformity  
   b. angular unconformity  
   c. nonconformity  
   d. conformity  
   e. none of these

63. Of the following events, which is the oldest sedimentary unit in the cross-section shown above?
   a. unit 1  
   b. unit 2  
   c. unit 3  
   d. unit 5  
   e. unit 6

**True = A / False = B**
64. The geologic time scale was originally constructed by scientists without the aid of numerical dates.
65. Guide/Index fossils have wide geographic ranges and a specific time period of existence.
66. In reference to the geologic time scale, periods are divided into smaller time units called epochs.
67. There were NO mammal species on Earth during the “age of Dinosaurs.”
68. After a hundred half-lives there is still some of the original radioactive material remaining.
69. The number of radioactive atoms that decay during one half-life will change with each half-life that has elapsed.
70. Relative time tells us how long ago an event took place.
71. An isotope’s half life is the amount of time it takes for fifty percent of the atoms to decay and produce a corresponding amount of daughter isotopes.
72. The radioactive isotope, potassium-40, has Argon-40 as a daughter product.
73. Radiometric dating means using radioactive isotopes to determine absolute ages for rock and/or mineral samples.
74. Any interval of geologic time not represented by strata in a particular area is a gap or hiatus.
75. Key/index/marker beds are particularly distinctive rock units that allow identification of the same unit in different areas.
76. An unconformity involving older crystalline metamorphic rocks and younger sedimentary strata is called a nonconformity.
77. Inclusions are pieces of one rock contained within another.
78. James Hutton’s principle of uniformity states that “the past is the key to the present.”
79. The law of superposition is used in absolute dating.
80. In regards to cross-cutting relationships, if rock A cross-cuts rock B, then B is younger than A.
81. We are now living in the Cenozoic era.
82. It is usually not possible to obtain an accurate radiometric date from a sample of clastic sedimentary rock.
83. Coal swamps are associated with the Pennsylvanian period.
84. Probably the single most characteristic feature of the Precambrian is the relative absence of fossil evidence.

Use the answer sheet provided in class for the following questions and relative dating problem(s).
85. What is the name of a Phanerozoic era that represents the age of fish and other marine life?
86. At the end of what Period did the extinction of the Dinosaurs take place?
87. At the end of what Period did the extinction of the Trilobites and many other marine animals take place?

88. Fossils used for matching rocks of the same age are called:

89. The remains or traces of prehistoric life are called ____________.

90. What is the name of a Phanerozoic era that represents the age of mammals?

91. Dinosaurs lived during the ____________ era.

92. “This igneous dike is 10 million years old.” The preceding statement is an example of a (n) ____________ age or date. Use the terms that you have been learning in class!

93. The phrase, “The present is the key to the past,” refers to the doctrine of:

94. What is the atomic mass or weight of Uranium-238 (U-238)?

95. What is the atomic mass or weight for the radioactive isotope Neptunium-235?

96. What is the atomic number or atomic weight of Argon-40?

97. In an un-deformed sequence of sedimentary rocks, each bed is older than the one above and younger than the one below. The preceding is a statement of the law of ____________.

98. ____________ dating occurs when events are placed in their proper sequence or order without knowing their numerical ages.

99. The principle of ____________ ____________ states that fossil organisms succeed one another in a definite and determinable order and that a time period can be recognized by its fossil content.

100. An unconformity in which tilted or folded strata are overlain by more flat-laying layers is known as a (n) ____________ ____________.

101. A series of intersecting dikes or faults may be placed in proper sequence or order by using the principle of:

102. When one rock mass contains fragments of an adjacent rock mass, we know the adjacent rock mass must be older. The fragments used for relative dating in this situation are generally known as ____________.

103. An unconformity in which the sedimentary strata on either side are essentially parallel is a:

104. What term denotes a buried erosional surface between a mass of granite and the overlying sedimentary rocks?

105. Fossil A Ranges in age from the Permian to the Devonian, Fossil B Ranges in Age from the Pennsylvanian to the Ordovician, and Fossil C ranges in age from the Devonian to the Silurian. In what period did all three fossils exist at the same time?

Continue onto the next page....
106. See Answer Sheet and the figure below:

a. Use relative dating techniques to place the lettered events in the following diagram into a proper sequence starting with the oldest event first. Unit M is metamorphic rock. Units D and H are igneous rock, N is a fault, O, L, and J are unconformities, K represents an eroded stream channel, and the remaining units are sedimentary rock. The shaded area around parts of D and/or H represents contact metamorphism from the igneous intrusions. You should start with the oldest rocks at the bottom.

b. What type of unconformity occurs along L?

c. What type of unconformity occurs along O?

d. What type of unconformity occurs along J?

e. Have units E, F, and I been disturbed following deposition? (Yes or No?)

f. If units E, F, and I have been disturbed, describe how they have been disturbed.

The End!!!