Regents Questions

Geologic Time, Fossils, Radioactive Dating

August 2015

22 The photograph below shows rock layers separated by unconformity XY.

![Unconformity](image)

Which sequence of events most likely produced this unconformity?
(1) uplift and erosion of bedrock, followed by subsidence and more deposition
(2) intrusion of magma into preexisting rock, causing contact metamorphism
(3) eruption of a volcano, spreading lava over horizontal sedimentary rock layers
(4) separation of one rock layer, by movement along a plate boundary

24 Which statement best supports the inference that most of Earth’s present-day land surfaces have, at one time, been covered by water?
(1) Volcanic eruptions contain large amounts of water vapor.
(2) Coral reefs formed, in the past, along the edges of many continents.
(3) Seafloor spreading has pulled landmasses apart and pushed them together.
(4) Sedimentary bedrock of marine origin covers large areas of Earth’s continents.

33 The geologic cross section below shows rock layers that have not been overturned.

![Cross Section](image)

The fault is older than the
(1) slate (2) marble (3) unconformity (4) shale

Base your answers to questions 62 through 65 on the passage below and on your knowledge of Earth science.
Dinosaur Fossils

Bones of juvenile long-necked sauropod dinosaurs, *Abydosaurus mcintoshi*, have recently been found in 105-million-year-old sandstone at the Dinosaur National Monument in Utah. The remains of four individual dinosaurs were found, including two intact skulls. This find is unusual because the softer tissue holding the thin sauropod dinosaur skull bones together usually disintegrates, allowing the skull bones to separate. Only 8 of 120 types of sauropods discovered have complete skull specimens. These dinosaurs were herbivores, with large numbers of sharp teeth that were probably replaced five to six times each year. These teeth allowed only for the harvesting of plant material, but not for chewing it afterward. The plant-harvesting teeth and long neck identify *Abydosaurus mcintoshi* as a descendant of the brachiosaurs.

62 On the timeline below, place an X on line AB to indicate the time when *Abydosaurus mcintoshi* lived. [1]

[Timeline diagram]

63 Indicate the range of grain sizes in the type of bedrock in which *Abydosaurus mcintoshi* bones were found. [1]

64 Identify one group of organisms that was a likely food source for *Abydosaurus mcintoshi*. [1]

65 State a natural event that is inferred by most scientists to be the cause of extinction of the last of the dinosaurs. [1]

Base your answers to questions 66 through 69 on the block diagram below and on your knowledge of Earth science. The diagram represents an igneous intrusion that solidified between some layers of sedimentary rock. Letter X represents an index fossil in a sedimentary rock layer. The rock layers have not been overturned.

[Block diagram]

66 Describe the evidence represented in the diagram that indicates that the shale layer and the limestone layer are older than the igneous intrusion. [1]
67. The limestone layer is composed mostly of what mineral? [1]

68. Describe one characteristic of fossil X that makes it a good index fossil. [1]

69. The igneous intrusion contains the radioactive isotope potassium-40, which is used in radioactive dating to determine the age of rocks. State one property of potassium-40 that allows it to be useful in the radioactive dating of rocks. [1]

**June 2015**

5. Radioactive decay of $^{40}$K atoms in an igneous rock has resulted in a ratio of 25 percent $^{40}$K atoms to 75 percent $^{40}$Ar and $^{40}$Ca atoms. How many years old is this rock?
   (1) $0.3 \times 10^9$ y   (2) $1.3 \times 10^9$ y   (3) $2.6 \times 10^9$ y   (4) $3.9 \times 10^9$ y

23. The cross section below represents surface bedrock where faulting has occurred along line AB. When could this faulting have occurred?
   (1) before the Ordovician rocks were deposited   (3) before the Cambrian rocks were deposited
   (2) during the Ordovician period   (4) during the Cambrian period

25. The cross section below represents several rock units within Earth’s crust. Letter A represents Earth’s surface. Letters B, C, and D indicate boundaries between rock units. One of the unconformities is labeled.
   Which lettered boundary is most likely another unconformity?
   (1) A   (2) B   (3) C   (4) D

Base your answers to questions 79 through 82 on the passage and chart below, and on your knowledge of Earth science. The chart identifies some human species and the times when they are believed to have existed.
Human Species
Modern humans, *Homo sapiens*, appear to have evolved through several species of earlier members of the genus *Homo*. Each of these human species possessed specific features that made that species distinct. Many lived in (or at least have been discovered in) specific geographic areas, and existed for specific time ranges shown in the chart. In many cases, fossil remains are partial, often consisting of only teeth and skulls. Interpretation of human evolution continues to change with new discoveries.

<table>
<thead>
<tr>
<th>Human Species</th>
<th>Time of Existence from Fossil Evidence (million years ago)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Homo sapiens</em></td>
<td>0.25 to the present</td>
</tr>
<tr>
<td><em>Homo neanderthalensis</em></td>
<td>0.35 to 0.03</td>
</tr>
<tr>
<td><em>Homo rhodesiensis</em></td>
<td>0.6 to 0.1</td>
</tr>
<tr>
<td><em>Homo heidelbergensis</em></td>
<td>0.6 to 0.3</td>
</tr>
<tr>
<td><em>Homo mauritanicus</em></td>
<td>1.2 to 0.6</td>
</tr>
<tr>
<td><em>Homo erectus</em></td>
<td>1.5 to 0.2</td>
</tr>
<tr>
<td><em>Homo ergaster</em></td>
<td>1.8 to 1.25</td>
</tr>
<tr>
<td><em>Homo habilis</em></td>
<td>2.25 to 1.4</td>
</tr>
</tbody>
</table>

79 Complete the graph *in below* by drawing a bar to represent the time span that *each* human species existed. The bars for the first four species listed have already been drawn. [1]
80 Which human species shown in the chart was the first to exist? [1]

81 One species of the genus Homo could have evolved directly from another species of the genus Homo only if the other species:
  • existed before the new species appeared
  • did not become extinct before the new species appeared

Identify two species of the genus Homo from which Homo neanderthalensis may have directly evolved. [1]

82 During which geologic epoch did the Homo mauritanicus species exist? [1]

January 2015
9 The diagram below represents the placoderm fish *Bothriolepis*, an index fossil found in New York State.

![Diagram of Bothriolepis]

The surface bedrock at which location is most likely to contain this fossil?
(1) Ithaca  (2) Old Forge  (3) Albany  (4) New York City

10 The geologic cross section below includes an unconformity and an igneous intrusion.

![Geologic Cross Section with Unconformity and Igneous Intrusion]

Which two events produced the geologic unconformity in the rock record?
(1) intrusion of magma, followed by contact metamorphism  
(2) intrusion of magma, followed by erosion of rock layers  
(3) erosion of rock layers, followed by deposition of more sediments  
(4) erosion of rock layers, followed by intrusion of magma

27 The timeline below represents time on Earth from the beginning of the Paleozoic Era (A) to the present (B).

![Timeline of Earth's History]

Which numbered position best represents the time when humans first appeared in the fossil record?
(1) 1  (2) 2  (3) 3  (4) 4

28 The cross sections below represent three outcrops, labeled I, II, and III, containing some New York State index fossils. The rock layers have *not* been overturned.

![Cross Sections of Outcrops I, II, and III]
29 A bar graph of the radioactive decay of carbon-14 is shown below.

When the rock layers in the three outcrops are correlated, the oldest layer is the

(1) shale layer in outcrop I
(2) siltstone layer in outcrop II
(3) limestone layer in outcrop III
(4) conglomerate layer in outcrop III

The solid black sections of the bars on the graph represent the percentages of
(1) carbon-14 from the original sample that has not decayed.
(2) uranium-238 from the original sample that has not decayed.
(3) nitrogen-14 decay product resulting from the radioactive decay.
(4) lead-206 decay product resulting from the radioactive decay.

Base your answers to questions 48 through 50 on the drawing below and on your knowledge of Earth science. The drawing represents a swamp-forest environment that existed in North America at the base of the Acadian Mountains during the Carboniferous Period. Organism A lived in this swamp-forest.
54 Geologic events V through Z are listed below.
V. Metamorphism of some sedimentary rock
W. Formation of sedimentary rock layers
X. Tilting and erosion of sedimentary rock layers
Y. Intrusion/extrusion of igneous rock
Z. Erosion of some igneous rock

List the letters V through Z to indicate the correct order of the geologic events, from oldest to youngest, that formed this portion of Earth’s crust. [1]

55 Identify the name of the contact metamorphic rock formed at the boundary of the igneous rock and rock layer B. [1]

56 Describe one piece of evidence that suggests that rock layer C formed in a deeper sea environment than did rock layer A. [1]

57 Describe one piece of evidence represented in the cross section that indicates Earth’s crust has moved at this location. [1]

58 Identify the mineral composition of rock layer D. [1]

August 2014

16 Rifting of tectonic plates in eastern North America during the Jurassic Period was responsible for the
(1) formation of the Catskill delta (3) Alleghenian orogeny
(2) first uplift of the Adirondack Mountains (4) opening of the Atlantic Ocean

18 Much of the evidence for the evolution of lifeforms on Earth has been obtained by
(1) studying the life spans of present-day animals (3) correlating widespread igneous ash deposits
(2) radioactive dating of metamorphic rock (4) examining fossils preserved in the rock Record

19 The table below shows the radioactive decay of carbon-14. Part of the table has been left blank.

<table>
<thead>
<tr>
<th>Half-Life</th>
<th>Original Carbon-14 Remaining (%)</th>
<th>Number of Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>5,700</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>11,400</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>17,100</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After 22,800 years, approximately what percentage of the original carbon-14 remains?
(1) 15%     (2) 12.5%    (3) 6.25%    (4) 3.125
Base your answers to questions 36 and 37 on the data table below and on your knowledge of Earth science. The data table shows information on six major mass extinction events that occurred many million years ago (mya) in Earth’s history.

<table>
<thead>
<tr>
<th>Approximate Time (mya)</th>
<th>Certain Life-Forms That Became Extinct</th>
</tr>
</thead>
<tbody>
<tr>
<td>65.5</td>
<td>all dinosaurs and all ammonoids</td>
</tr>
<tr>
<td>200</td>
<td>many species of nautiloids, ammonoids, mammal-like reptiles, and early dinosaurs</td>
</tr>
<tr>
<td>251</td>
<td>all trilobites and 90% of other marine species and 70% of land species</td>
</tr>
<tr>
<td>376</td>
<td>many species of corals, brachiopods, and trilobites</td>
</tr>
<tr>
<td>444</td>
<td>more than half of brachiopod species, many trilobite species, and some coral species</td>
</tr>
<tr>
<td>520</td>
<td>small shelly fossil species and some early trilobite species</td>
</tr>
</tbody>
</table>

36 More than half of brachiopod species became extinct at the end of the
(1) Devonian Period  (2) Silurian Period  (3) Ordovician Period  (4) Cambrian Period

37 Which event is generally accepted as the cause of the mass extinction that occurred 65.5 million years ago?
(1) volcanic eruption  (2) continental collision  (3) asteroid impact  (4) sea-level change

Base your answers to questions 44 through 47 on the geologic cross section below and on your knowledge of Earth science. The cross section represents rock and sediment layers, labeled A through F. Each layer contains fossil remains, which formed in different depositional environments. Some layers contain index fossils. The layers have not been overturned.

Fossils Found in Layer

- Mammoth tusks in unconsolidated sediment
- Fossil jaw of mammal-like reptile
- Scale trees and seed ferns
- Eurypterids
- Nautiloids and ammonoids

(Not drawn to scale)
44 Which pair of organisms existed when the unconsolidated sediment in layer A was deposited?
(1) birds and trilobites (3) ammonoids and grasses
(2) dinosaurs and mastodons (4) humans and vascular plants

45 Which rock layer formed mainly from the compaction of plant remains?
(1) E (2) B (3) C (4) F

46 During which geologic epoch was layer F deposited?
(1) Late Devonian (2) Middle Devonian (3) Early Devonian (4) Late Silurian

47 The depositional environment during the time these layers and fossils were deposited
(1) was consistently marine (3) changed from marine to terrestrial (land)
(2) was consistently terrestrial (land) (4) changed from terrestrial (land) to marine

Base your answers to questions 51 through 54 on the cross section of part of Earth’s crust in your answer booklet and on your knowledge of Earth science. On the cross section, some rock units are labeled with letters A through I. The rock units have not been overturned. Line XY represents a fault. Line UV represents an unconformity.

51 On the cross section below, draw two arrows, one on each side of line XY, to show the direction of relative movement that has occurred along the fault. [1]

52 Write the letter of the oldest rock unit in the cross section. [1]

53 Identify the contact metamorphic rock that formed between rock units B and C. [1]

54 The table below shows the ages of the igneous rock units, determined by radioactive dating. How many million years ago did rock unit I most likely form? [1]

<table>
<thead>
<tr>
<th>Rock Unit</th>
<th>D</th>
<th>G</th>
<th>H</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (million years)</td>
<td>420</td>
<td>454</td>
<td>420</td>
<td>140</td>
</tr>
</tbody>
</table>