Earth Systems 3209
Answer Key - August 2007

Selected Response Key

1.	**D**
2.	**C**
3	**A**
4.	**B**
5.	**A**
6.	**A**
7.	**C**
8.	**B**
9.	**D**
10.	**D**
11.	**B**
12.	**B**
13.	**B**
14.	**B**
15.	**D**
16.	**B**
17.	**A**
18.	**C**
19.	**A**
20.	**B**
21.	**A**
22.	**B**
23.	**C**
24.	**C**
25.	**B**
26.	**C**
27.	**D**
28.	**D**
29.	**A**
30.	**D**

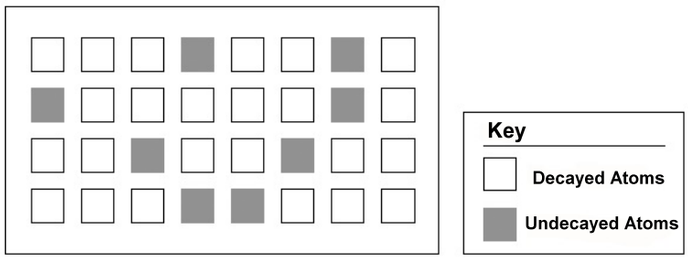
31.	**B**
32.	**A**
33.	**A**
34.	**B**
35.	**A**
36.	**C**
37.	**C**
38.	**D**
39.	**B**
40.	**A**
41.	**A**
42.	**B**
43.	**D**
44.	**C**
45.	**B**
46.	**B**
47.	**A**
48.	**B**
49.	**A**
50.	**D**
51.	**A**
52.	**C**
53.	**C**
54.	**A**
55.	**B**
56.	**D**
57.	**D**
58.	**D**
59.	**B**
60.	**D**

PART II
Total Value: 40%

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

Value

2% 61.(a) The diagram below represents the decay pattern of a radioactive isotope in an igneous rock sample. The half life of the radioactive isotope is 2.3 million years. Use the pattern to determine the age of the rock and show your working in the box below.



Answer:

The undecayed atoms represent the parent material remaining. 8 atoms remain out of a total of 32 atoms. This gives a fraction of 8/32 = 1/4 when reduced, thus, one quarter of the parent material remains which corresponds to two half-lives.
Thus, number of half-lives = 2.

The age of the rock is found by multiplying the number of half-lives by the time for one half-life (2.3 million). Thus, age = 2 x 2.3 million = 4.6 million years.

2% (b) According to the solar nebular hypothesis, describe how the solar system formed.

Answer:

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.

Value

2% 62.(a) As a driller, you are considering a location for a new fresh water well. Explain the two characteristics the geological materials must have to produce a flowing artesian well that provides a clean water supply.

Answer:

Two conditions that a flowing artesian well must have include:

1) The aquifer containing the ground water must be inclined to produce a pressure surface (water table) caused by gravity pulling the water down through the aquifer.
2) The aquifer must be confined between two aquicludes which are impermeable and holds the water under pressure. Also, the well must be drilled at a point where the surface of the ground is located below the pressure surface (projected water table).

2% (b) Geologists represent the interior of Earth as having different physical layers. Explain the importance of radioactive decay and gravitational forces in the segregation of Earth's interior.

Answer:

Billions of years ago, the decay of radioactive elements and heat generated by the colliding of particles, caused Earth's interior to melt. This allowed Earth's interior to segregate, where gravitational forces separated material based on density. The denser elements, nickel and iron, would sink to the interior (center) while the lighter rocky components (silicates) floated toward the surface. This segregation by density is thought to still occur today on a smaller scale and was responsible for the apparent layering of Earth's interior into layers with different physical properties.

2% 63.(a) Based on the definition of a mineral, ice would be considered a mineral and coal would not. Explain why this is true.

Answer:

In order for a substance to be a mineral it must satisfy the following conditions;
1) occur in nature
2) be inorganic (no carbon source from a living material)
3) be solid
4) have a definite chemical composition
5) have a definite molecular structure

Ice satisfies all of the above conditions, whereas coal is composed of carbon which originated from an organic, living source.

Value

2% 63.(b) A mineral sample was studied and the following data obtained. Using the data, determine the mineral's specific gravity.

Mass of Mineral Sample	129.6g
Volume of Water Displaced	18.0 cm^3

As outlined in the core lab on determining specific gravity, a minerals specific gravity is equal to the density of that mineral. To find the density, the mass is divided by the volume.

$$\text{Specific Gravity} = \text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{129.6\ g}{18.0\ cm^3} = 7.2\ \frac{g}{cm^3}$$

2% (c) Explain how sedimentary rocks may eventually form metamorphic rocks.

Answer:

Sedimentary rocks may change to form metamorphic rocks when exposed to either of the following conditions: high heat, high pressure, and being altered by chemical fluids.

- Heat generally bakes a rock and causes the texture and/or mineral composition to change form resulting in the formation of metamorphic rock.
- Pressure causes sedimentary particles (minerals) to compress which may result in the reorganization of the particles (elements) to form metamorphic textures and/or metamorphic minerals.
- Chemical fluids often cause the rock texture and chemical composition of the minerals to alter, forming a metamorphic rock.

2% (d) Both granite and rhyolite are classified as felsic rocks; however, their textures are very different. Describe the texture of each and explain why these textural differences occur.

Answer:

Texture of Granite: coarse grained (phaneritic)
Reason: Molten rock called magma is insulated within Earth and loses its heat slowly to the surrounding rock. This slow cooling allows the crystals within the magma to become relatively large which forms the coarse texture.

Texture of Rhyolite: fine grained (aphanitic)
Reason: molten rock, called lava, flows on or near the surface where it loses it heat quickly to the surrounding cooler rock or air above. This rapid cooling does not allow large crystals within the lava to form and results in the formation of a fine texture.

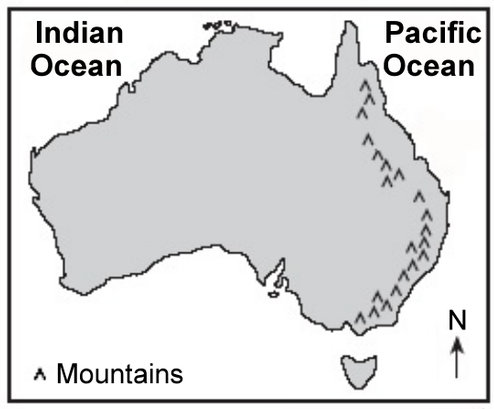
Value

2% 63.(e) Alfred Wegener's Theory of Continental Drift failed to explain how the continents actually moved. How does the current Theory of Plate Tectonics explain the movement of continents today?

Answer:

Arthur Holmes is credited with providing a mechanism to explain the movement of tectonic plates (continents). This mechanism focuses on convection of the upper mantle, the asthenosphere. The lithospheric plates sit directly on this layer and move apart in areas of high heat flow where the convection of the asthenosphere rises, causing tectonic plates to separate at what is called divergent plate boundaries. These convection currents move along the base of tectonic plates and cause them to move in the same direction. The convection of the asthenosphere sinks in cooler areas as tectonic plates tend to collide at convergent plate boundaries. As a result, the tectonic plates are pulled downward within subduction zones and are recycled within the mantle.

2% (f) A range of mountains is found on Australia's east coast. With reference to plate boundaries, explain how this mountain range may have been formed.



Answer:

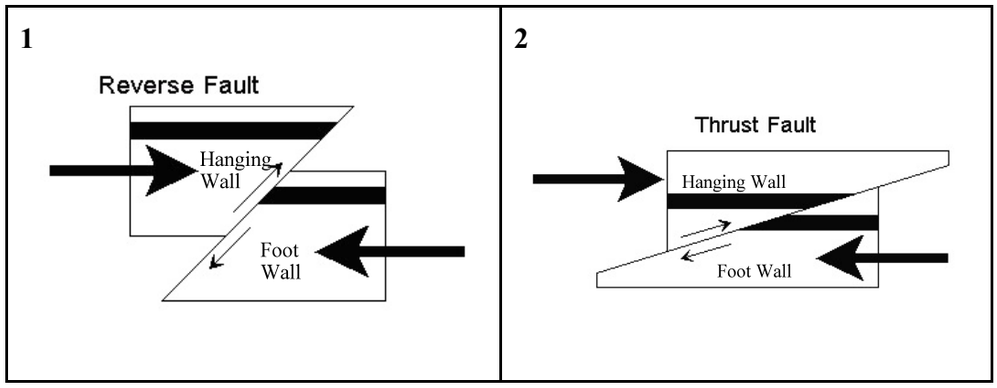
Mountain ranges are found along convergent plate boundaries. At these boundaries one tectonic plate moves toward and collides with another plate boundary. In the above diagram, an oceanic plate (Pacific) collides with a continental plate (Australian). This collision causes the oceanic plate to subduct beneath the continental plate. These compressional forces generally deform the tectonic plates which result in the continental plate uplifting to form a mountain chain along the length of the convergent boundary.

Value

4% 63.(g) Sketch and describe two types of faults that occur at a convergent plate boundary.

Answer:

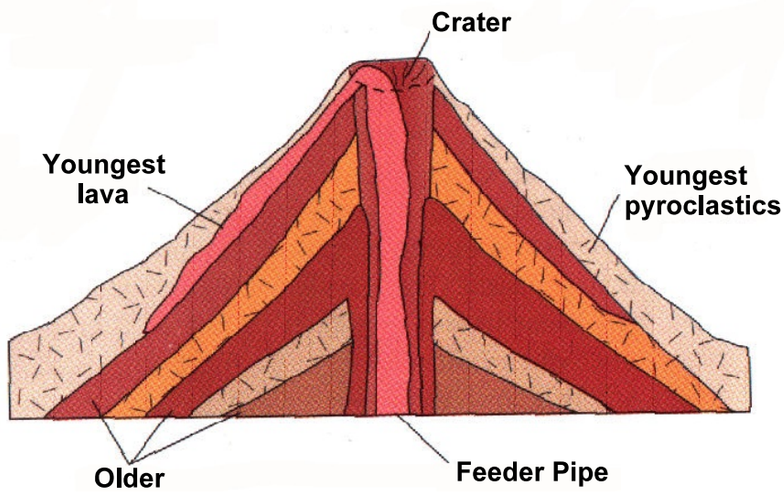
At convergent boundaries, compressional forces cause tectonic plates to fracture which result in both reverse faults and thrust faults. In both faults, the hanging wall moves up over the foot wall. In a reverse fault, the angle along the fault plane is steep, and in a thrust fault, the angle along the fault plane is not as steep (as seen in the diagrams below).



2% (h) Given the information in the table, draw, name and fully label the volcano described.

Volcano
• Alternating slow moving lava flows and explosive ash falls or pyroclastic flow.
• Rare catastrophic blast eruptions

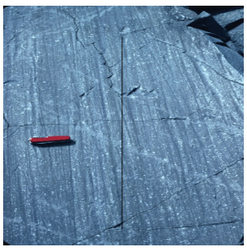
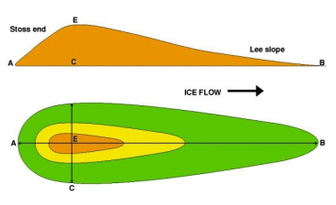
Answer: Strata volcano or Composite volcano



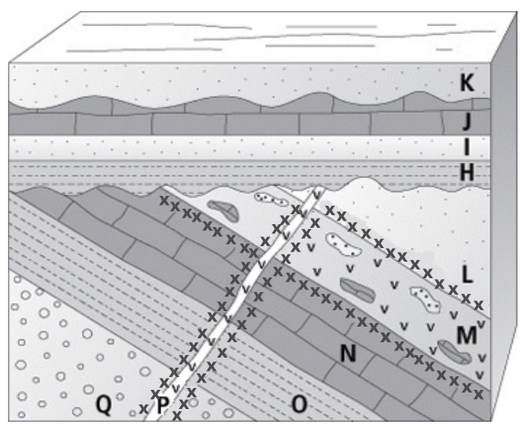
Value

2% 63(i) Draw and explain a glacial feature that will show the direction in which a glacier moved.

Answer:

	Diagram to the left displays scratches left behind as a glacier moved over a rock. These scratches on the surface of the rock are called **"striations"**. The arrow indicates the possible directions of ice movement to produce the striations displayed.
	In areas of ground moraine, glaciers may streamline and shape and sculpt the till and create elongate hills called **drumlins**. The orientation of drumlins can be used to determine the direction of ice movement. The steep side of the drumlin faces in the direction from which the ice came.

4% (j) Use the diagram below to answer the following questions.



(i) Determine the sequence of events in the formation of the geological cross-section from oldest to youngest.

Answer:

oldest → *youngest*

Q O N L M P H I J K

(ii) What geologic feature is seen within rock unit M?

Answer: Included fragments (Inclusions)

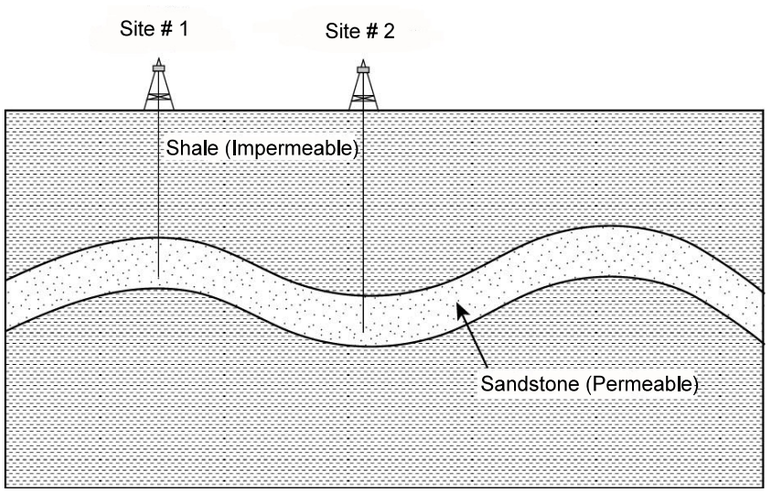
(iii) Explain how this geologic feature in rock unit M would have formed.

Answer:

Intrusion of rock unit "M" would have forced rock fragments of rock units "N" and "L" to be contained within rock unit "M".

Value

2% 63.(k) A company exploring for oil drills at two separate sites. At which site would you most likely find oil? Explain your choice.



Answer:

Oil would most likely be found at site #1. Fluids such as oil, gas and water can move through permeable rocks such as sandstone (aquifer). If the aquifer is folded as seen in the diagram, oil, because of its low density, can be trapped within the up-folds (anticlines) of the folded aquifer layer. This is why site #1 could hold oil, whereas, site #2 would not likely hold oil.

2% 64.(a) Explain two reasons why a modern day earthworm is unlikely to become part of the fossil record.

Answer:

Earthworms lack hard body parts necessary for fossilization. As well, they are found within the soil layer of Earth's surface, making them prone to predation. Soft bodied organisms tend to decompose quickly making it difficult to bury and become fossilized.

2% 64.(b) Explain two ways a beetle could become fossilized.

Answer:

A beetle has a hard shell made of a material called chitin (contains carbon). Because it has a hard outer shell containing carbon, beetles can become fossilized by processes such as mold and cast, along with carbonization. Beetles may also be preserved in a tree sap called amber.

During carbonization, the organism is buried rapidly and over time is compressed by layers of overlying fine sediment. The resulting pressure causes liquid and gas components to be released from the organism, leaving a residue of carbon behind preserving external details of the organism.

During the fossilization process of mold and cast, the organism is buried rapidly in fine sediment and with time the organism disappears leaving an opening called a mold. Often mineral matter or sediment may fill this opening which forms an external replica of the original organism, called a cast.

2% (c) With reference to Rodinia and Pangea, use the Plate Tectonics theory to describe what our planet could look like in the future.

Answer:

In the past billion years scientist suggest that the major landmasses of Earth joined together on numerous occasions to form super continents, Rodinia and Pangaea are two such examples. With undisputable evidence supporting a mobile Earth which forms the basis of the plate tectonic theory, it is believed that the major landmasses will once again join to form another massive super-continent in the future.