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EARTH AND SPACE SCIENCES

STUDENTS

One of the best ways for you to become familiar with and improve on the performance expectations of Earth and Space Sciences is to test your knowledge and understanding by answering practice questions. That is the purpose of this booklet. Within it are four exams, each containing 50 questions. Some questions will challenge you and force you to "think outside the box" by analyzing and interpreting reading passages, graphs and charts. These are critical thinking skills that are expected of you in today's world. Other questions are more content-oriented, dealing with learned facts. Still other questions will test whether you have a working knowledge of the 2024 Edition Reference Tables for Earth and Space Sciences, which are provided in the back of this book.

After you have completed an exam, check how well you have done. The answers and explanations for all questions are provided. Your teacher can assist you if you need additional instruction.

As its author, I hope that this book will improve your grade. But I truly hope that your knowledge of our Earth and Space continues to grow, for there is much for all of us to discover about these topics. When you have time, check the NASA website, especially the images sent back from the Hubble and the James Webb Space telescopes, for every image is a new discovery. Our understanding of our planet and our universe is constantly evolving. It's an exciting journey.

The best to you.

William Docekal

Science Teacher – Retired

EARTH AND SPACE SCIENCES

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Test 1

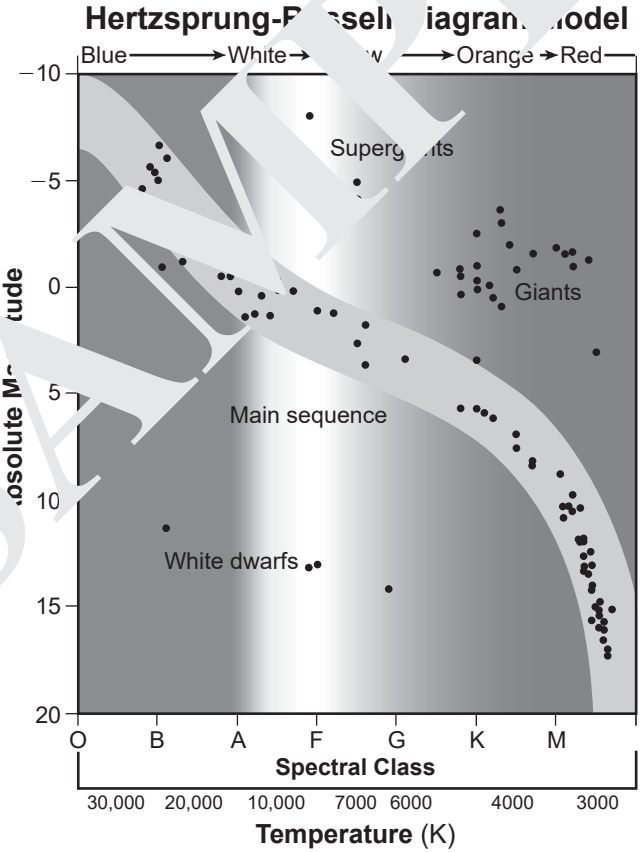
Answer all questions in this part.

Directions **Use your knowledge of Earth and Space Sciences to answer all questions in this examination. Throughout this exam, some questions may require the use of the *2024 Edition Reference Tables for Earth and Space Sciences.* This is provided in the back of this test book.**

Base your answers to questions 1 through 8 on the information below.

Our Sun – A Star

The Hertzsprung-Russell (H-R) diagram was developed from star charts by two scientists in different countries independently of each other in 1911. It classified stars based on their surface temperatures, observable color, and magnitude. Absolute magnitude is a measurement of how bright a star would appear if all stars are the same distance from Earth. The brighter the star, the lower the absolute magnitude value.



1. Our Sun is classified as a spectral class G star with a surface temperature between 5000 to 6000 K and an absolute magnitude of about five. Based on this information, complete the H-R diagram model by placing **one X** to indicate where the Sun is located. Also, identify the relative temperature and relative absolute magnitude of the Sun as it transitions to a red giant.

Change in relative temperature: _____

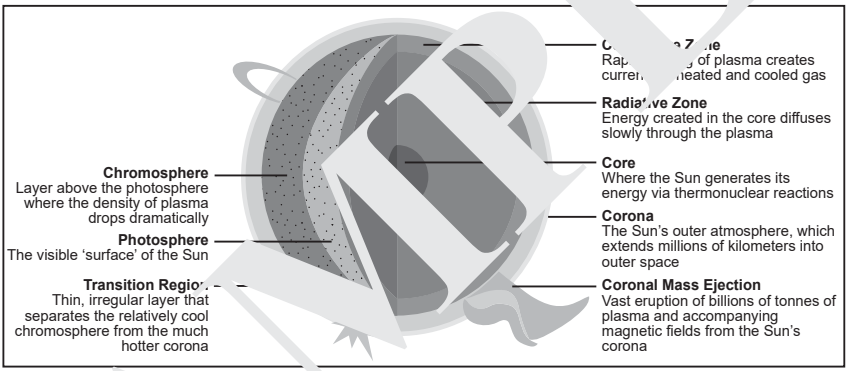
Change in relative absolute magnitude: _____

2. Astronomers are certain that our Sun will never transition to a supergiant. What is the criteria about our Sun for making this statement?

_____

The model below shows the layers of the Sun and information about some features of each layer.

Model of Sun's Layers



3. Based on the information in the model, which list of five of the Sun's layers are in the correct sequence to allow energy generated by fusion to eventually reach the Sun's surface as radiation?
(1) core → chromosphere → photosphere → transition region → corona
(2) core → radiative zone → transition region → photosphere → corona
(3) core → photosphere → corona → transition region → chromosphere
(4) core→radiative zone→convective zone→photosphere→chromosphere

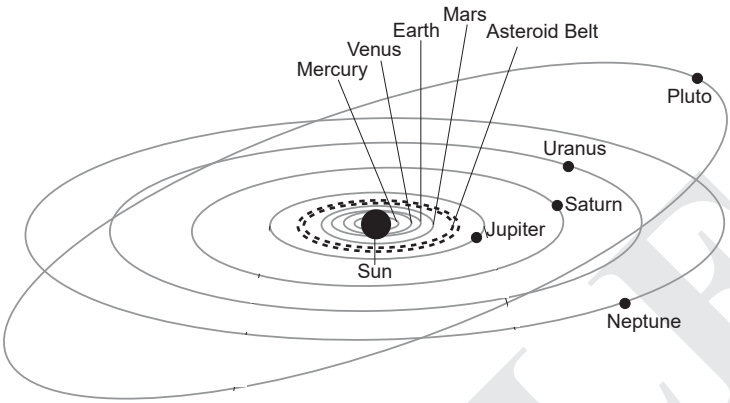
3____

4. Our Sun's average distance from Earth is 150 million km. The electromagnetic energy that is radiated from the photosphere travels at a speed of 300,000 km/sec. How long, in minutes, would it take for this radiated energy to travel from the photosphere to Earth? _____minutes

5. Which layer of the Sun would have rising and sinking plasma due to density differences? _____

The model below represents the orbits of celestial bodies around our Sun.

Our Solar System Model



6. The table shows the eccentricity of the orbits of Mercury and Venus around the Sun.

Planet	Eccentricity
Mercury	0.206
Venus	0.007

Place a check mark (√) in the boxes to indicate the **two** statements that are correctly predicted by Kepler's Laws.

- ☐ Venus orbits the Sun at a constant speed.
- ☐ Mercury travels faster in its orbit when it is closer to the Sun.
- ☐ Venus's orbit is less elliptical than Mercury's orbit.
- ☐ The orbital speeds of both planets are affected by their masses.
- ☐ Unlike Venus, the eccentricity of Mercury's orbit prevents Mercury from having a moon.

7. Based on the *Our Solar System Model*, if a new planet was identified that orbited the Sun at an average orbital distance greater than that of Mercury but less than that of Venus, the average speed of this planet would be
(1) greater than the average speed of Mercury, but less than the average speed of Venus
(2) less than the average speed of Mercury, but greater than the average speed of Venus
(3) greater than the average speed of Venus, but less than the average speed of Earth
(4) less than the average speed of Venus, but greater than the average speed of Earth

7____

An observer on Earth sees phases of the Moon, but the Moon isn't the only solar system body to exhibit phases. Venus also has observable phases as viewed from Earth. Venus's orbit around the Sun is approximately 225 Earth days.

The photograph shows a Moon phase and Venus viewed with unaided eyes in the night sky. The inset box shows Venus observed using a telescope. Both the Moon and Venus are in crescent phase.

Observed Phases of the Moon and Venus

8. Using *Our Solar System Model,* construct an explanation for why an observer on Earth can see a cycle of phases for the planet Venus. In the spaces below, write the terms for choices *A*, *B*, and *C* that correctly complete the passage.

Choices A:	**Choices B:**	**Choices C:**
• inside	• closer to	• Moon
• outside	• farther from	• Sun

Venus orbits the Sun, circling _A_ Earth's orbit in about 225 Earth days. This means that Venus is sometimes _B_ Earth, while at other times it is positioned on the other side of the _C_ . It is this change in relative positions of Venus that causes an observer on Earth to see phases of Venus.

Choice *A*:_____

Choice *B*: _____

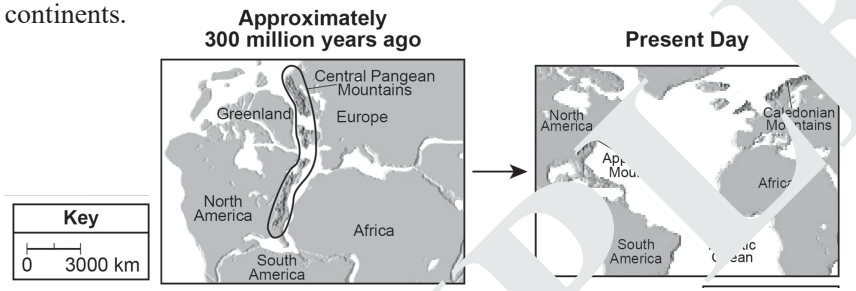
Choice *C*: _____

Base your answers to questions 39 through 45 on information below.

Plate Tectonics

Alfred Wegener was a German geophysicist and meteorologist who proposed the theory of continental drift in 1912. This theory attempted to explain how similar rock formations and plant and animal fossils could be found on separate continents. Widely dismissed by other scientists from Wegener's time, continental drift would eventually be accepted and become known as the theory of plate tectonics by the 1960s.

The model below shows some information about the position of the continents.



39. Use the model to explain how the Central Pangean Mountains were separated into the Appalachian Mountains and the Caledonian Mountains. In your explanation include a spatial or a temporal numerical value in which this process occurred.

One of the methods used to determine the absolute age of a rock is through the collection and analysis of zircon crystals. Zircon crystals have been found in some Appalachian Mountain regions. They grow in magma or semi-molten rock and are made of silicon, oxygen, and zirconium. Zircon crystals are ideal for age dating because they have the following characteristic

- have a very high melting temperature and hardness
- high density but non-magnetic
- contain small but measurable amounts of uranium (which substitutes for the zirconium in the crystal lattice when the crystal grows)

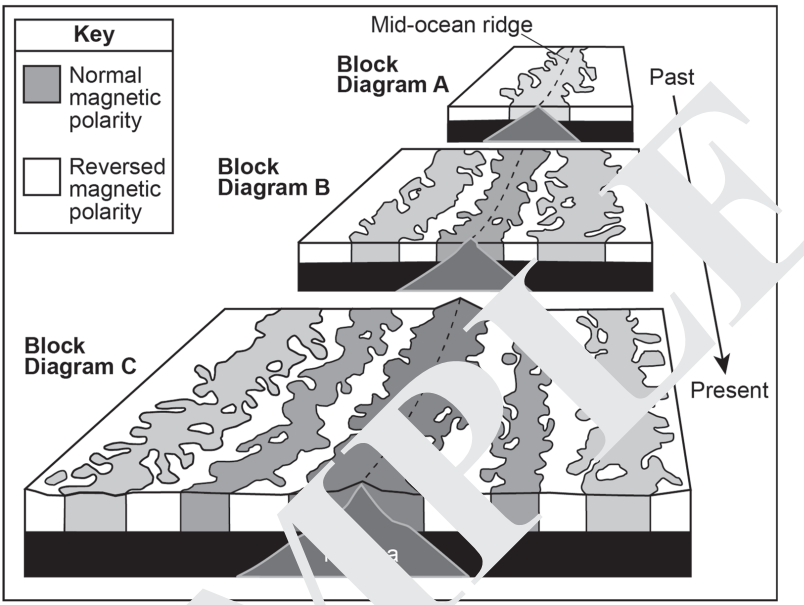
40. Identify one characteristic of zircon crystals that makes them ideal for determining the absolute age of rocks found in the Appalachian Mountains. Explain how this characteristic can be used to determine absolute age.

Characteristic: _____

Explanation 1: _____

The model below represents the polarity patterns found on the Atlantic Ocean floor over geologic time.

Model of Polarity Patterns of Ocean Floor Over Geologic Time



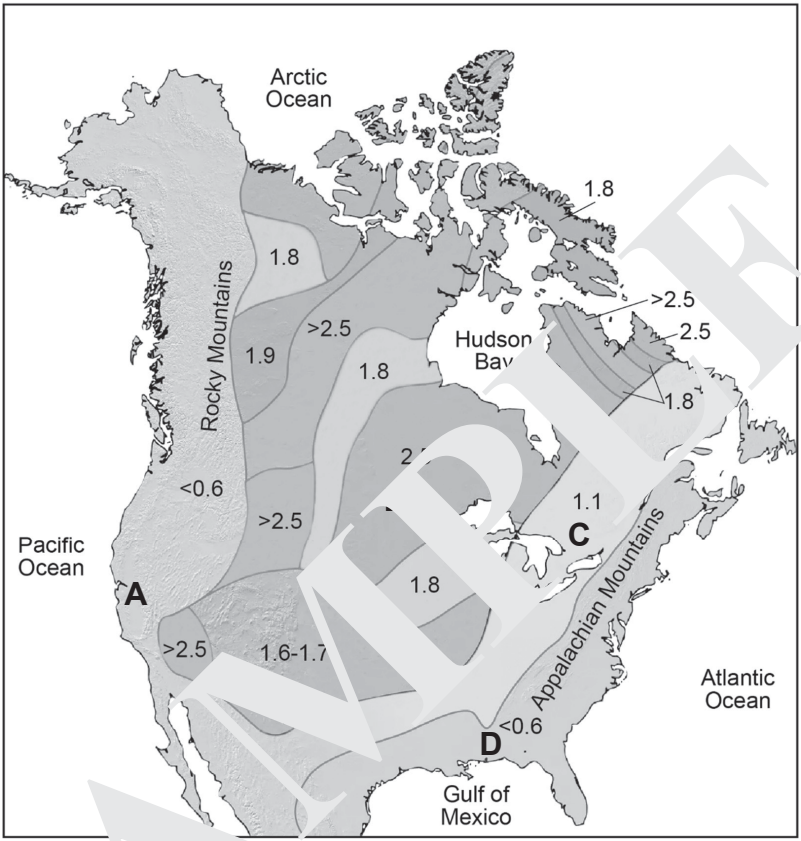
41. Which statement identifies the evidence for how the past and current movements of oceanic crust explain the ages of this ocean floor rock?
(1) Oceanic crust at the mid-ocean ridge in block diagram *A* is now the youngest normal magnetic polarity rock found in block diagram *C*.
(2) Ocean crust at the mid-ocean ridge in block diagram *A* is now the oldest normal magnetic polarity rock found in block diagram *C*.
(3) The reverse magnetic polarity rock closest to the mid-ocean ridge in block diagram *A* is younger than the reverse magnetic polarity rock closest to the mid-ocean ridge in block diagram *B*.
(4) The reverse magnetic polarity rock in block diagram *B* is the same age as the normal magnetic polarity rock in block diagram *B*. 41 ____

42. Describe how the pattern of Model of the Polarity Patterns of Ocean Floor Over Geologic Time is evidence for convection currents in the upper mantle.

_____

_____

Average Age of North American Continental Crust in Billions of Years



43. Based on evidence from the map above, which statement identifies the pattern of the ages of crustal rocks in North America?
(1) The oldest rocks in North America are found along the Gulf of Mexico, and the youngest rocks are found along the Hudson Bay.
(2) The central region of the continent contains the oldest rocks, while the youngest rocks are found along the Atlantic and Pacific Coasts.
(3) The oldest rocks are found in the Appalachian and Rocky Mountains.
(4) Rocks get younger toward the central regions. 43 ____

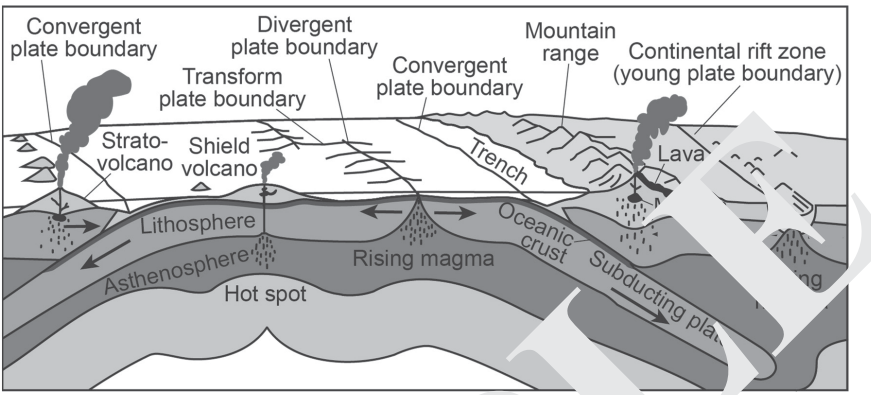
44. *a*) From the map above, give the letter of the region that has recorded the most seismic activity in the past 50 years. _____

b) Explain why you choose this region. _____

_____

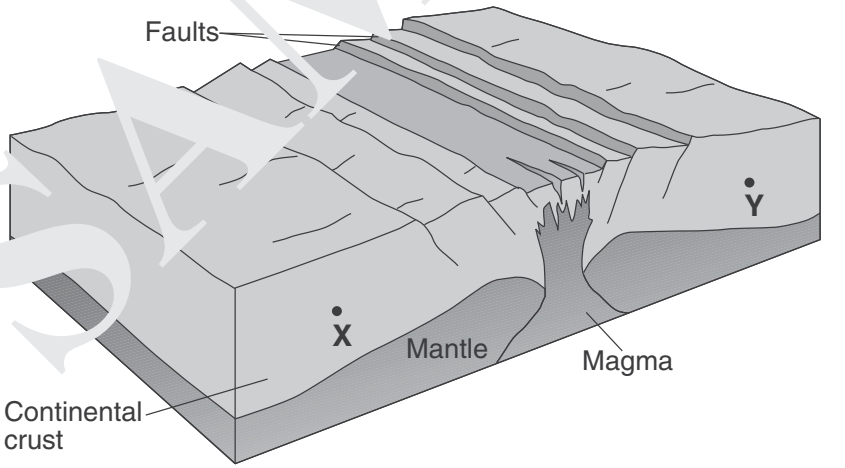
The model below shows some information about different tectonic plate interactions found on and below Earth's surface.

Earth's Surface and Interior Model



45. Shown in the model above is the beginning stage of the development of a continental rift zone.

The block diagram below represents the cross-section of this continental rift zone. Draw two arrows, one through point *X* and one through point *Y*, to indicate the relative direction of each of these sections of the continental crust.



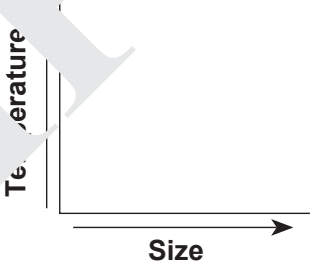
Base your answers to questions 46 through 50 on the passage below and on your knowledge of Earth science.

Cosmic Microwave Background Radiation

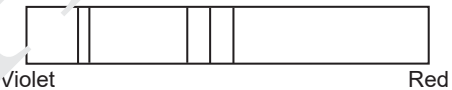
In the 1920s, Edwin Hubble's discovery of a pattern in the red shift of light from galaxies moving away from Earth led to the theory of an expanding universe. This expansion implies that the universe was smaller, denser, and hotter in the past. In the 1940s, scientists predicted that heat (identified as cosmic microwave background radiation) left over from the Big Bang would fill the universe. In the 1960s, satellite probes found that cosmic microwave background radiation fills the universe uniformly in every direction, and indicated a temperature of about 3 kelvins (K). This radiation has been cooling as the universe has been expanding.

46. Scientists infer that the universe began approximately
(1) 1.0 billion years ago (3) 8.2 billion years ago
(2) 3.3 billion years ago (4) 13.8 billion years ago 46 ____

47. On the graph draw a line that shows the relationship of the size of the universe to the temperature indicated by the cosmic microwave background radiation.



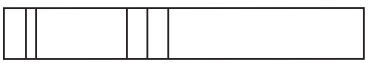
48. The diagram below represents the spectral lines from the light of an element in a laboratory on Earth.



Which diagram below best represents the pattern of spectral lines from the same element when it was observed by Edwin Hubble in the light of one of the distant galaxies?

(1)

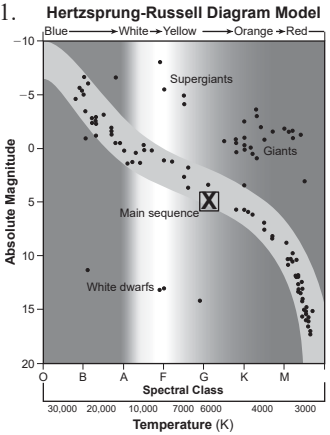
(3)



(2)

(4)

48 ____

1. 

Explanation: On the temperature scale locate the area of 5,000 to 6,000 K. From this position move directly up stopping at the absolute magnitude value of 5. At this intersection position, place a **X**. The **X** should be positioned in the Main sequence section; this is where the Sun is presently located on the H-R diagram.

Change in relative temperature: cooler *or* lower temperature
Change in relative absolute magnitude: decreased *or* lower magnitude value

Explanation: Our Sun radiates in the 5,000 to 6,000 K range. When its fuel runs low, it will undergo expansion. This would cause the Sun's temperature to decrease and the Sun to be repositioned in the Giants' star area. The *H-R Diagram Model* shows that Giant stars are at a cooler temperature, around 3,500 K. When our Sun, with an absolute magnitude of 5, transitions (changes) to a red giant star, its size will greatly increase, and it will become brighter. This would decrease its absolute magnitude value to the Giants' value, in the range of 0 to –3.

2. Answer: mass

Explanation: Our Sun is an average star; this classification is based on its mass. In its late stage of its life, the Sun will move off the Main Sequence and become a red giant star. Only massive stars become supergiant stars, for they contain the necessary mass to do so.

3. 4 Nuclear fusion produces the energy of a star that occurs in the very dense *core*. This energy is then slowly emitted outward, entering the large *radiative zone*. The next level that the energy enters is the *convection zone*. At the *photosphere*, the Sun's energy is radiated out in space, which we see. The layer above the photosphere is the *chromosphere*.

4. Answer: 8.3 minutes

Explanation: To arrive at this answer, one needs to divide the distance by the speed of light then convert the seconds to minutes.

Solution: $\frac{150{,}000{,}000 \text{ km}}{300{,}000 \text{ km/sec}} = \frac{1500}{3} = 500 \text{ sec} \; \frac{500 \text{ sec}}{60 \text{ sec/min}} = 8.3 \text{ minutes}$

5. Answer: convection zone

Explanation: In the *Model of Sun's Layers* it states, "rapid heating of plasma creates currents of heated and cooled gas." The different temperatures of the plasma, produce different density values. This causes the hotter plasma to rise, while the cooler plasma sinks, setting off a convection current.

6. Answer: Box 2 and 3 are checked.

   Explanation: In astronomy, the eccentricity value tells the shape of an orbiting celestial body. An eccentricity value of 0 is a perfect circle, for any number greater than 0, the orbiting path is elliptical (oval). The greater the eccentricity value is, the more elliptical the orbit will be. Venus' orbit, having a lower eccentricity value than Mercury, is less elliptical than Mercury's orbit. Having an eccentricity value greater than 0, the orbiting object at one time will be closer and at one time will be farther from the central object it is orbiting. This change of orbital distance produces different orbital speeds, being faster when closer and slower when farther from the orbiting object.

   Note, the revolution speed of all planets is fastest when the planets are closest to the Sun.

7. 2 The closer an orbiting object is to the Sun, the faster is its orbital speed. This new planet would have a slower orbital speed than Mercury, but greater than that of Venus.

8. Choice A: inside Choice B: closer to Choice C: Sun

   Explanation: Venus' orbital path is closer to the Sun than Earth. When Venus' orbit takes it closer to the Earth, at a certain position, the reflected sunlight off the clouds of Venus will produce a crescent phase seen using a telescope.

9. 3 During winter, the Earth's tilt of 23.5° causes the northern hemisphere to experience indirect sunlight, causing less heating ability of the radiant energy. If the tilt (obliquity) becomes less, to 22.1°, the Sun's rays striking the northern hemisphere would be slightly stronger, producing more energy year-round. This would result in less formation of polar ice.

10. 2 Diagram 2, *Influence of Fresh Water*, shows that the melting cold water of Greenland's glaciers makes the North Atlantic waters less salty, which lowers the density value of this water. This action restricts the southern warm water from moving north, resulting in a weakening of the ocean current circulation.

11. 1 The *Ocean Currents Mode*l shows that a warm current flows by location *Y*. This produces warmer air temperatures in this location. Warmer air holds more water vapor than cold air, resulting in more precipitation to location *Y*.

12. 4 Darker surfaces absorb more energy than lighter surfaces. When darker surfaces are exposed in glacial areas, more energy is absorbed causing more melting, decreasing the size of the glaciers.

13. *Projected CO_2 equivalent in 2100*: any value from 795 to 805 ppm.
    Projected global surface temperature change: any value that can be rounded to 2.4°C

    Explanation: The *Projected Atmospheric Greenhouse Gas Concentrations* graph shows that, for Scenario *B*, there would be 800 ppm of CO_2 in the atmosphere in 2100. The *Global Surface Air Temperature Change* graph show that, for Scenario *B*, there would be an increase in air temperature close to 2.4°C in 2100.

14. 1 Water vapor is a powerful greenhouse gas. It is responsible for keeping our planet at a temperature that supports life as we know it. Methane is another greenhouse gas.

37. 3 A spatial scale is defined as a measure of change across a given space. Big Maui was once one large island, but the spatial change has produced 4 separate islands. A temporal scale is a "timescale" measurement. It took 1.2 million years to break up "Big Maui" into 4 separate islands. The breakup of "Big Maui" occurred by continuous wave action eroding the island into smaller separate islands, along with the subsidence (sinking) of the landmass.

38. *Geoscience problem*: erosion *or* sea level rise

Explanation: Photograph 1 show the erosion of the shoreline by wave action and/or the rise of sea level.

How solution reduce the impact: Sandbags are beneficial because the waves will hit the sandbags and keep the coastline in place.
or Sandbags are beneficial because as water rises, the sandbags will prevent flooding from higher waves.
or The wall/rocks are a barrier to waves washing away the sediment under the highway.
or The wall/rocks will prevent water from flooding the road as water levels rise.

Explanation: As sea level rises and storms become stronger, more coastal erosion is occurring. Scientists and engineers are constantly designing ways to reduce the destructive impact of waves while preventing flooding. Sandbags and rock seawalls are traditional methods that are use today. Some other erosional control methods are erosion control matting, dune restoration projects and installing bulkheads.

39. Acceptable responses include, but are not limited to: Over 300 million years, the continents separated by the action of diverging tectonic plates.
or Diverging plates separated the continents, creating two separate mountain chains located 5000 to 7000 km apart.

Explanation: The separation of the continents occurred by the development of a divergent plate boundary at the now mid-Atlantic Ridge. The temporal numerical value is 300 million years ago when this even occurred. To obtain the spatial (space) value use the given distance scale to measure the distance of separation.

40. Answer: *Characteristic*: containing/presence of uranium

Explanation 1: Half of the uranium found in some of the zircon crystals will decay into a stable material after 4.5 billion years.
or Uranium is a radioactive substance that has a constant rate of decay, which allows it to be used for dating rock samples.

Explanation: Radioactive elements decay at a constant rate. By analyzing the ratio of the radioactive element to its decay product and knowing its half-life, the zircon crystal's absolute age can be determined.

41. 2 Block *A* represents a divergent plate boundary. This ocean floor (plate) formed during a normal magnetic polarity time period. This section of ocean floor slowly but continually drifted away from the mid-ocean ridge–one section drifting east and the other section drifting to the west. Block *C* represents the present ocean floor, showing the different magnetic reversals that developed over the years of separation. Here the original normal magnetic polarity (as shown in Block *A*) is the oldest, being the farthest from the Mid-ocean ridge.

42. Acceptable responses include, but are not limited to: The magnetic patterns have moved to the east and west, showing that convection currents moved the ocean plates in these directions.
or The pattern of the magnetic field on each side of the ridge is a mirror image of the other.

Explanation: The movement of the ocean floor in two different directions needs an "energy source" to move these plates. The Earth's interior heat creates convection currents within the upper mantle that provides the energy for the movement of plates.

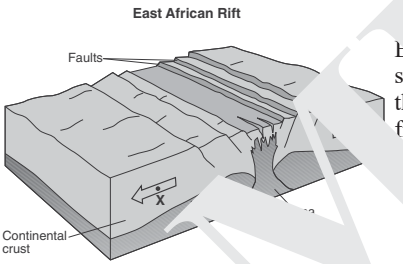
43. 2 The center of the North America continent has the oldest age continental crust at 2.5 billion years. Usually, the interior of continents will have the oldest rocks, as this area is not near a subduction zone where destruction of the plates occurs.

44. Answer: Location *A* *Explain*: Location *A* is closest to the Pacific Plate boundary.

Note: Both answers need to be correct to receive credit.

Explanation: Open to the *Global Tectonic Activity* reference table. The eastern side of the Pacific plate boundary is located in California. Here the famous San Andreas fault is located, being very seismically active.

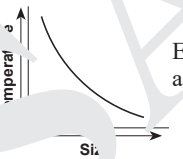
45.



Explanation: A continental rift zone is the start of a divergent plate boundary, where the crust is separating in opposite directions from the ridge. The East African Rift is a famous one that is occurring presently.

46. 4 It has been estimated that the Big Bang, that created our universe, occurred 13.8 billion years ago. Remember, our solar system age of origin is 4.6 billion years ago.

47.



Explanation: The passage states: "This radiation has been cooling as the universe has been expanding."

48. 3 Distance galaxies are moving away from us at as the universe expands. The wavelengths of radiating objects that are increasing in distance from us will undergo a redshift of their spectral lines. Choice 3 shows that all spectral lines have been shifted towards the red end of the spectrum.

49. 1 Electromagnetic energy travels at the speed of light in a wave-like motion.

50. *Wavelength*: shorter
Frequency: higher *or* more Hz

Explanation: Open to the *Portion of Electromagnetic Spectrum* reference table. Ultraviolet is positioned on left side of infrared. From the below wavelength arrow, this makes ultraviolet wavelength shorter than infrared wavelength. The frequency scale (Hz) shows that ultraviolet wavelengths are at a higher Hz than infrared.