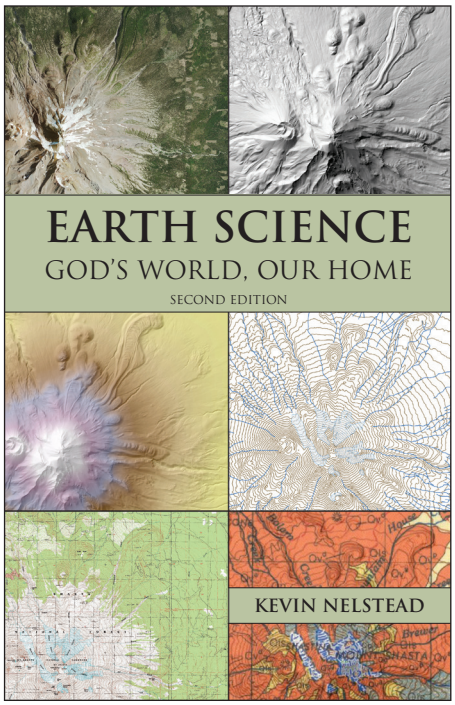

Earth Science:
God's World, Our Home

All Keys and Sample Answers

Thank you for using *Earth Science: God's World, Our Home*. This supplementary document is being provided to aid in situations in which the adult teacher responsible for conducting the course does not possess a background in this subject, or in which a student is studying independently. The answers here are only samples and should not be considered the only correct response to the question.

In environments where there are multiple students in a class or group, it is the recommended method that the student should form their own answers in complete sentences as a homework assignment. These should be graded for completion only, not accuracy. Then in the group setting, students bring their preliminary answers to class where they collaborate with each other and the teacher and improve their answers. The final product will be a useful study tool developed by the group. In such an arrangement, there would be no need for this document, but it is provided for the many home study situations in which there is no collaborative group.

More critical information about conducting the course is provided in the textbook introduction and in documents in the Digital Resources. A full presentation of strategies and techniques for mastery-learning can be found in our book *From Wonder to Mastery*, available from our website.

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Contents

Chapter 1

Learning Check 1.1

1.1.1 Distinguish between the lithosphere, hydrosphere, atmosphere, and biosphere.

The lithosphere is the rigid outer layer of Earth, composed mostly of solid rock. The hydrosphere is the part of Earth that is made out of water. The atmosphere is the outer layer of gases that surrounds Earth, and the biosphere is made up of all organisms that live on Earth along with the environments in which they live.

1.1.2 Suggest two or three ways that the biosphere interacts with the other Earth systems.

Plants in the biosphere change the atmosphere by consuming carbon dioxide and producing oxygen. Plants also help to break down minerals in the soil—the lithosphere—by removing nutrients. Plants use their root systems to take in water from the hydrosphere.

1.1.3 Give a definition for each of the three major subdivisions of Earth science that you will be learning about in this course.

Geology is the study of the materials that make up Earth and the processes that change Earth over time.

Oceanography is the study of the oceans.

Meteorology is the study of the atmosphere.

Learning Check 1.2

1.2.1 Contrast the geocentric model of the solar system with the heliocentric model.

In the geocentric model, the planets known before the sixteenth century orbited around Earth in perfectly circular orbits. In the heliocentric model, planets, asteroids, comets, and other solar system bodies orbit the Sun.

1.2.2 Describe Earth's location in space, relative to the Sun and solar system, the galaxy, and the universe.

Earth is one of eight planets that orbit the Sun and is the third closest planet to the Sun. The Sun is the center of the solar system, which is located in the Milky Way galaxy at the edge of a spiral arm. The Milky Way galaxy is just part of the much larger universe.

1.2.3 In what ways does Earth seem to be "just right" for complex life?

Earth is in the habitable zone, so its temperature remains in a region that supports life. Earth is also an ideal size, has a good amount of water, and seems to have just the right chemical composition. The large Moon stabilizes the tilt of Earth's axis, which stabilizes the climate. Finally, Earth's plate tectonics are also one of the systems that make Earth just right for life.

1.2.4 What is meant by a habitable zone, for both the solar system and galaxy as a whole?

Earth occupies a special location within the solar system—it is in the "habitable zone," which means that it is far enough from the Sun that the temperature doesn't boil the oceans, but close enough to the Sun that the oceans don't freeze, either. Earth is also in a galactic habitable zone—far from the galactic core with its strong gravitational fields and disruptive events, but also not so close to the edge of the galaxy where heavier elements are scarce.

1.2.5 In what ways does Earth seem to be a very small place in the universe? What does this tell us about ourselves? What does it tell us about God?

Our Sun is but one of perhaps 200 billion stars in the Milky Way galaxy, and there are at least 100 billion observable galaxies in the universe. This vastness of the universe speaks of the bigness of God even more than it speaks of the smallness of the human race.

Learning Check 1.3

1.3.1 Calculate the approximate speed at which Earth moves in its orbit around the Sun. You can simplify the problem by assuming that Earth's orbit around the Sun is circular.

For this problem, we want to calculate the velocity (speed), meaning distance (Earth's orbit) over time (365.24 days):

$$v = \frac{d}{t}$$

First, we calculate the length of the orbit, so we use the equation for the circumference of a circle:

$$2\pi r = 2 \cdot 3.14 \cdot 150{,}000{,}000 \text{ km} = 942{,}500{,}000 \text{ km}$$

Now let's convert the time into seconds:

$$365.24 \text{ dy} \cdot \frac{24 \text{ hr}}{1 \text{ dy}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} \cdot \frac{60 \text{ s}}{1 \text{ min}} = 31{,}556{,}736 \text{ s}$$

Finally, compute the speed:

$$v = \frac{d}{t} = \frac{942{,}500{,}000 \text{ km}}{31{,}556{,}736 \text{ s}} = 29.9 \ \frac{\text{km}}{\text{s}}$$

So Earth moves at about 30 km/s, or 30,000 m/s.

1.3.2 What effect does the elliptical orbit of the Sun have on Earth's seasons?

Earth's elliptical orbit has a minor effect on seasons but is not their primary cause. The Northern Hemisphere winter is slightly warmer than it would be if Earth's orbit were circular, and Northern Hemisphere summer is slightly cooler than it would otherwise be.

1.3.3 Explain how the tilt of Earth's axis causes seasons.

As Earth orbits the Sun, its axis always points in the same direction. On June 21, the Northern Hemisphere is tilted towards the Sun and receives more direct Sunlight than does the Southern Hemisphere. On about December 21 the Northern Hemisphere is pointed away from the Sun, and so it is the day when the Northern Hemisphere receives the least sunlight.

1.3.4 Speculate as to what seasons would be like if Earth's axis were not tilted, and what seasons would be like if Earth's axis were tilted at 45° instead of 23.5°.

With no tilt, there would be no seasons at all and no changes to the lengths of days and nights. Every day would be just the same. With a 45° tilt, the seasons would be much more extreme than they are now for those not on the equator. The longest day of the year would be even longer, and the additional hours of sunlight might not allow much cooling at night. In the same way, the shortest day of the year would be shorter than it is now, and there would be not many hours of sunlight to warm the Northern Hemisphere.

Learning Check 1.4

1.4.1 Explain why the Moon has phases.

The phase of the Moon is the shape of the sunlit portion of the Moon's face as seen from Earth. As the Moon orbits Earth, the same hemisphere of the Moon always faces us, but part of the near side of the Moon is in sunlight, and part of it in darkness.

1.4.2 Why does the full Moon rise at roughly the same time that the Sun sets?

The full Moon is on the opposite side of Earth from where the Sun is, so the full Moon rises roughly when the Sun sets and sets roughly when the Sun rises.

1.4.3 If you were on the Moon, how would the appearance of Earth change throughout the 29.5-day lunar cycle?

From an astronaut's perspective on the Moon, Earth has phases just like the Moon does, except in reverse. If during a new Moon, an astronaut on the Moon were to look at Earth, she would see a "full Earth" — a complete illuminated circle. If, however, the astronaut on the Moon looked at Earth during a full Moon, she would see nothing, because Earth would be blocking the sunlight.

Learning Check 1.5

1.5.1 Describe how the Sun, Earth, and Moon must be arranged for solar and lunar eclipses to occur.

A solar eclipse occurs when a new Moon passes in front of the Sun, causing the Moon's shadow to fall on Earth. Lunar eclipses occur when Earth's shadow covers the face of the Moon, and the Moon is full.

1.5.2 During a solar eclipse, why do people in some places see a partial eclipse, while others see a total eclipse?

This effect can be explained by the fact that there are two regions in shadows cast from light sources, the umbra and the penumbra. People located in the umbra of the Moon's shadow will see a total eclipse. People located in the penumbra, where the Sun is not completely dark, will see only a partial solar eclipse.

1.5.3 Explain why there aren't a solar eclipse and a lunar eclipse every month.

The Moon's orbit around Earth is inclined at 5° to the ecliptic, so the new Moon usually passes either above or below the Sun in the sky rather than right in front of it. For lunar eclipses, because of the same 5° tilt, the Moon usually misses Earth's shadow as it orbits, and no lunar eclipse occurs.

Learning Check 1.6

1.6.1 Contrast the Hebrew and Islamic calendars, distinguishing between the lunar calendar and the lunisolar calendar.

The Hebrew calendar is a lunisolar calendar, which is based on both the phases of the Moon and the orbit of Earth around the Sun. The Islamic calendar, on the other hand, is a lunar calendar in which months are based strictly on the phases of the Moon. In the Islamic calendar, a new month begins at the first sighting of the thin crescent Moon the day after the new Moon. In the Hebrew calendar, each month starts with the new Moon. Both calendars contain 354 days, but in the Hebrew calendar leap months are added to keep holidays at roughly the same time each year. In contrast, the Islamic calendar allows holidays to migrate through the seasons.

1.6.2 Describe the features of the Julian and Gregorian calendars. Explain why it was necessary to switch from one to the other.

The Julian Calendar is very similar to the calendar we use today, containing twelve months with either 30 or 31 days, except February with 28 days. Every fourth year was a leap year. The minor problem with the Julian calendar was that it observed 365.25 days in the year instead of 365.24, which is the actual time Earth takes to orbit around the Sun. Pope Gregory XIII introduce a revised calendar, called the "Gregorian calendar," so that church holidays would stay in particular seasons. This calendar requires that years divisible by 100 must also be divisible by 400 in order to be a leap year.

Chapter 1 Exercises

1. Give a definition for each of the four major Earth systems and describe how these systems interact with each other.

The lithosphere is the rigid outer layer of Earth, composed mostly of solid rock. The hydrosphere is the part of Earth that is made out of water. The atmosphere is the outer layer of gases that surrounds Earth, and the biosphere is made up of all organisms that live on Earth along with the environments in which they live.

These four systems all interact with each other, as, for example, organisms in the biosphere are dependent on the other three systems for resources. In turn, plants in the biosphere produce oxygen and change the atmosphere. These are just some of many other ways the four systems interact with each other.

2. Draw a sketch of our solar system, showing the Sun, planets, and habitable zone.

Consult Figures 1.9 and 1.12 in section 1.2.1 and 1.2.2 of book.

3. What are some ways in which Earth appears to be specially designed for living organisms to thrive?

Earth occupies a special location within the solar system—it is in the "habitable zone," which means that it is far enough from the Sun that the temperature doesn't boil the oceans, but close enough to the Sun that the oceans don't freeze, either. Earth is also an ideal size, has a good amount of water, and seems to have just the right chemical composition. There are a number of other factors that make Earth just right for living organisms to thrive.

4. Describe what is meant by the term "galactic habitable zone."

Just as there is a habitable zone in our solar system, where conditions are right for life to flourish, there seems to be a galactic habitable zone in spiral galaxies where conditions are right for life to exist.

5. Describe Earth's orbit around the Sun and explain why the shape of this orbit is not the primary cause of seasons

The Earth's orbit is in the shape of an ellipse, but it is so nearly circular that it has little effect on the seasons. The seasons are the result of the Earth's tilted axis.

6. Draw a sketch like Figure 1.18 and use it to explain what causes Earth's seasons.

Consult Figure 1.18 in section 1.3.2 of book.

As Earth orbits the Sun, its axis always points in the same direction. On June 21, the Northern Hemisphere is tilted toward the Sun and receives more direct sunlight than does the Southern Hemisphere. On about December 21 the Northern Hemisphere is pointed away from the Sun, and so it is the day when the Northern Hemisphere receives the least sunlight. These dates correspond to the summer and winter solstices in the Northern Hemisphere.

7. Explain why it is that, outside the tropics, summer days are warm or hot and winter days are cool or cold.

There are two factors at work here: first of all, the Sun is in the sky for a long time on a summer day, which means there is a long period of time for Earth's surface to absorb rays from the Sun. Second, the Sun is higher in the sky on a summer day, which means that sunlight is concentrated on a smaller area than in the winter.

8. Predict what Earth's days and seasons would be like if Earth's axis were tilted at close to 90° rather than 23.5°.

For those not on the equator, the seasons would be very extreme. The longest day of the year would be much longer, and the additional hours of sunlight would not allow much cooling at night. In the same way, the shortest day of the year would be much shorter than it is now, which would not allow many hours of sunlight to warm the Northern Hemisphere.

9. Draw a sketch of Earth, showing the location of the Tropics of Cancer and Capricorn, and Arctic and Antarctic Circles.

Consult Figure 1.21 in section 1.3.3 of book for diagram.

10. Describe the path the Sun would take across the sky viewed from the North Pole on the summer solstice, autumnal equinox, and winter solstice.

Viewed from the North Pole on the summer solstice, the Sun would never set but would "travel" in arcs up and down the sky. On the autumnal equinox, a person would see the Sun traveling just above the horizon. On the winter solstice, there would be no sunlight, since the North Pole would be tilted away from the Sun.

11. Draw sketches of the eight phases of the Moon, in order, from the new Moon through the waning crescent.

Consult Table 1.1 in Section 1.4 of book.

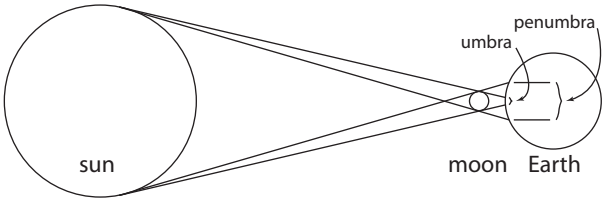
12. Draw a sketch like Figure 1.22 and use it to explain the cause of lunar phases.

Consult Figure 1.22 in Section 1.4 of book.

13. When people on Earth see a quarter Moon, what would Earth look like from the Moon?

Earth would also be a quarter Moon, but the opposite side would be illuminated. So, for instance, if the Moon was a first quarter Moon, Earth would look like a "last quarter Earth" from the Moon.

14. Draw a sketch of a total solar eclipse with labels for the Sun, Moon, Earth, umbra, and penumbra.



15. Explain why solar eclipses are only visible in limited geographic areas, but lunar eclipses are visible from the entire night side of Earth.

A solar eclipse occurs when a new Moon passes in front of the Sun, causing the Moon's shadow to fall on Earth. This means that the people in the umbra of the Moon's shadow will see a total solar eclipse, while people in the penumbra of the Moon's shadow will only see a partial solar eclipse.

A lunar eclipse occurs when the Moon passes through Earth's umbra, so everyone on the night side of Earth will be able to see the Moon.

16. Describe the similarities between the Hebrew and Islamic calendars, and then explain what the biggest difference is between how they work.

The Hebrew calendar is a lunisolar calendar, which is based on both the phases of the Moon and the orbit of Earth around the Sun. The Islamic calendar, on the other hand, is a lunar calendar in which months are based strictly on the phases of the Moon. In the Islamic calendar, a new month begins at the first sighting of the thin crescent Moon the day after the new Moon. In the Hebrew calendar, each month starts with the new Moon. Both calendars contain 354 days, but in the Hebrew calendar leap months are added to keep holidays at roughly the same time each year. In contrast, the Islamic calendar allows holidays to migrate through the seasons.

17. Compare the Julian and Gregorian calendars, and explain how the Gregorian calendar corrected a problem with the Julian calendar.

The Julian Calendar is very similar to the calendar we use today, containing twelve months with either 30 or 31 days, except February with 28 days. Every fourth year was a leap year. The minor problem with the Julian calendar was that it observed 365.25 days in the year instead of 365.24, which is the actual time Earth takes to orbit around the Sun. Pope Gregory XIII introduced a revised calendar, called the "Gregorian calendar," so that church holidays would stay in particular seasons. This calendar requires that years divisible by 100 also be divisible by 400 in order to be a leap year.

Chapter 2

Learning Check 2.1

2.1 Compare lines of latitude to lines of longitude, explaining how they are similar and how they are different.

Both lines of latitude and longitude give locations as angles. Lines of run parallel to the equator and to each other, so they are always the same distance apart. Unlike lines of latitude, lines of longitude are not parallel but come to a point at the poles.

2.1.2 Explain how Harrison's invention of the first marine chronometers enabled navigators to determine their longitude while at sea.

A navigator at sea would use a sextant to measure the angle between the horizon and an astronomical body with printed tables of the positions of these bodies at various times. With the further help of marine chronometers, highly accurate clocks, the navigator was able to use astronomical bodies at specific times accurately to determine both the latitude and longitude of the ship.

2.1.3 Describe how the GPS system is used.

A minimum number of 24 satellites are always orbiting Earth, continuously transmitting radio signals that can be used to determine locations on Earth. At any given moment, there are at least four satellites in the sky over any location. The radio signals sent by the satellites contain both the time and position of the satellite when the signal was sent.

Learning Check 2.2

2.2.1 Explain why it is impossible to make an accurate map of Earth on a flat sheet of paper without using a projection.

Because Earth is roughly spherical, the true sizes, angles, and shapes of features on Earth need to be distorted in order to make a flat map. A map projection is a method by which the curved surface of Earth is portrayed on a flat surface.

2.2.2 Describe the difference between cylindrical, conic, and azimuthal projections.

A cylindrical projection is created by extending features on Earth's surface onto a cylinder wrapped around Earth. A conic projection is created by extending features on Earth's curved surface onto a cone. Finally, an azimuthal projection is created by projecting Earth's surface onto a plane that touched the planet at only one point.

2.2.3 Describe the shape of Earth.

The shape of Earth is roughly spherical, or more accurately oblate spheroid. It is a flattened sphere where the equator has a greater radius than the measurement from the center to a pole.

Learning Check 2.3

2.3.1 List the six regions of the electromagnetic spectrum, from low energy to high energy.

Radio Waves

Infrared

Visible light

Ultraviolet

X-Rays

Gamma Rays

2.3.2 Describe a way that remote sensing is used to study each of the four Earth systems (lithosphere, hydrosphere, atmosphere, and biosphere).

Remote sensing in the form of echo sounding can determine the elevations for a map of a volcano, part of the lithosphere. Echo sounding is also applicable in the hydrosphere, as it can use sound waves transmitted through water to determine water depth. Remote sensing images from weather satellites give detailed and timely information about Earth's atmosphere. The biosphere can benefit from satellite imagery as well, because these images can be used quickly to analyze damage forests due to wildfires.

Learning Check 2.4

2.4.1 Explain what a Geographic Information System is.

A Geographic Information System is computer software that analyzes data about Earth, and then presents it in the form of maps. The data contained in the GIS may include imagery, elevation data, as well as points, lines, and polygons that represent both natural and man-made features.

2.4.2 Explain how contours are used to portray Earth's landscape on a topographic map.

A topographic map represents the surface of Earth, and contour lines are lines that connect points of equal elevation. The shapes of the contour lines on the map, then, reflect the shape of the land surface.

2.4.3 What are the four basic principles of contour lines?

1. Where contour lines are far apart, the slope is gentle; where they are close together, the slope is steep.

2. Contour lines never cross each other.

3. Where a contour line crosses a stream on a topographic map, the contour line will be V-shaped, with the V pointing to areas with higher elevation.

4. Contour lines form closed loops around elevated areas and depressed areas.

2.4.4 Explain what is meant by the term map scale.

Map scale is the ratio between a length on a map and the corresponding horizontal distance on the ground.

Chapter 2 Exercises

1. Use the map of the United States below to determine the name of the cities with the following coordinates:
a. 40°N, 105°W

Denver

b. 42°N, 88°W

Chicago

c. 26°N, 80°W

Miami

d. 46°N, 123°W

Portland

e. 41°N, 74°W

New York

f. 34°N, 118°W

Los Angeles

g. 42°N, 71°W

Boston

h. 30°N, 95°W

Houston

2. Use the map of the United States above to determine the latitude and longitude, to the nearest degree, of the following states:
a. Albuquerque, New Mexico

35°N, 107°W

b. Atlanta, Georgia

34°N, 85°W

c. Dallas, Texas

33°N, 97°W

d. Minneapolis, Minnesota

45°N, 94°W

e. San Francisco, California

38°N, 123°W

f. Seattle, Washington

48°N, 123°W

g. Toronto, Ontario, Canada

44°N, 80°W

h. Washington, DC

39°N, 77°W

3. Use the map of a portion of Yellowstone National Park below to determine the names of the features with the following coordinates.

a. 44°59'N, 110°42'W

Mammoth Hot Springs

b. 44°48'N, 110°27'W

Mount Washburn

c. 44°38'N, 110°27'W

Mud Volcano

d. 44°32'N, 110°50'W

Lower Geyser Basic

e. 44°25'N, 110°34'W

West Thumb

4. Use the map of a portion of Yellowstone National Park above to determine the latitude and longitude, to the nearest minute, of the following features:

a. Fishing Bridge

44.35°N 110.23°W

b. Lower Falls

44.43°N 110.30°W

c. Norris Geyser Basin

110.42°W 44.44°N

d. Old Faithful

110.50°W 44.27°N

e. Tower Falls

110.24°W 44.54°N

5. Illustrate how features on a globe can be projected onto a cylinder, cone, and plane.

Consult Figures 2.12, Figures 2.15, and Figure 2.17 in Section 2.2 of book.

6. Describe the shape of Earth, and explain why it is not spherical.

Earth is an oblate spheroid. It is slightly flattened at the poles and has a slight bulge at the equator. This is because Earth's daily rotation on its axis causes it to flatten at the poles relative to the equator.

7. Describe an example of remote sensing using one of the non-visible parts of the electromagnetic spectrum.

In addition to using visible light, many satellites record infrared radiation, which means the satellite detects wavelengths of light that the human eye cannot see. This enables the sensor to distinguish changes in vegetation and soil moisture that are too subtle to be seen with visible light. For example, infared wavelengths can be used to produce an image of a forest fire burn area in which healthy trees are easily distinguishable from the burn area. Infrared wavelengths are also useful for geological investigations, such as searching for mineral deposits.

8. What are some advantages of using satellites to observe Earth's weather?

Weather observations used to be limited to those made at manned weather stations, but now satellites can help meteorologists detect storms developing all over Earth. Satellites these days also give forecasters detailed information about the temperatures of cloud tops, wind speeds, precipitation, and much more. Satellites can even gather remote-sensing data in the dark due to infrared radiation.

9. Explain why contour lines are far apart in flat areas but close together in steep areas.

Contour lines connect points of equal elevation. In flat areas there will be few contour lines as there will be little change in elevation. Steep areas, where the elevation is constantly changing, will have many contour, and they will be drawn close together.

10. Use the topographic map of High Top Mountain below to answer the following questions (elevation values are in feet).
a. What is the contour interval of this map?

20 ft

b. What is the interval between index contours?

100 ft

c. Estimate an elevation value for the × at the top of High Top Mountain.

between 1580 and 1600 ft, eg. 1590 ft.

d. What are the gradients between A—B and C—D, measured in feet per mile?

1400 ft/mi, 480 ft/mi

e. What are the percent slopes between A—B and C—D?

26%, 9%

Chapter 3

Learning Check 3.1

3.1.1 Draw a sketch of the Cycle of Scientific Enterprise, with arrows and key words.

Consult figure 3.1 in textbook for diagram.

3.1.2 Give examples of theories in geology, meteorology, and oceanography. Try to use theories that were not mentioned in this section. (Hint: you can page through this book.)

Oceanography: Seafloor spreading theory. New oceanic crust forms at the mid-ocean ridges and then slowly moves away from the ridge crest.

Geology: Mantle convection theory. Floor spreading occurs because of convection currents in the asthenosphere, which is the deeper part of Earth's mantle.

Meteorology: Man-made global warming theory. Humans are causing climate change through carbon dioxide emissions.

3.1.3 Explain why reading and writing are important aspects of doing science.

Scientists spend a large amount of their time reading technical papers in scientific journals. Reading these articles and interacting with other scientists allow scientists to keep up with the latest research. Scientists also spend a lot of time writing reports and papers about the results of their research.

Learning Check 3.2

3.2.1 Explain why some scientific hypotheses cannot be tested by conducting an experiment.

In experimental science, scientists conduct experiments to determine whether a hypothesis is valid. Historical science requires other methods of investigation, because it is impossible to recreate historical events like it is possible to conduct an experiment in physics or chemistry.

3.2.2 In what ways is historical science like detective work?

When investigating historical science, geologists and archeologists often work like detectives solving a crime. A detective looks for evidence at a crime scene and then attempts to reconstruct the events that happened, and likewise, a historical scientist puts together all of the evidence to create a credible explanation of what happened.

Learning Check 3.3

3.3.1 Explain how scalability, accessibility, and complexity make Earth science work more challenging.

Scalability is the ability of processes in a scale model to work in the same way as processes do in nature. A tornado in the laboratory, for example, will behave like a real tornado in some ways, but not others. Accessibility, which is the ease or difficulty of getting to a place, can prevent scientists from making direct measurements in a given place. And complexity is a quality of nature that makes it difficult for scientists to control one variable at a time as in a controlled experiment.

3.3.2 Describe a place on or in Earth that seems inaccessible, and suggest a way scientists might be able to study that place.

Earth's core is an inaccessible place, however, a scientist could potentially capture images of the core in similar ways that a doctor takes an X-ray of a person. Scientists might also be able to create models of Earth's core, testing what happens to different metals at extremely high temperatures.

Learning Check 3.4

3.4.1 Find a psalm that declares God's glory in the creation and write a selection of verses from that psalm. Your psalm should be one that was not discussed in this section.

There are many examples students could cite, but one beautiful example not in this section is from Psalm 104:

He made the moon to mark the seasons;

the sun knows its time for setting.

You make darkness, and it is night,

when all the beasts of the forest creep about.

The young lions roar for their prey,

seeking their food from God.

When the sun rises, they steal away

and lie down in their dens.

Man goes out to his work

and to his labor until the evening.

O Lord, how manifold are your works!

In wisdom have you made them all;

the earth is full of your creatures.

Here is the sea, great and wide,

which teems with creatures innumerable,

living things both small and great.

3.4.2 How can an Earth scientist's work demonstrate love for God and love for people?

The vocations of meteorologist, oceanographer, and geologist are all ways to love God and people. Earth scientists can serve God by doing their work with integrity and diligence, and they can serve people by making weather forecasts, finding energy and mineral deposits, finding and protecting drinking water resources, and many other ways.

3.4.3 Name three ways in which God has revealed truth to us.

God has revealed truth to us through Jesus Christ, through his word, and through creation.

3.4.4 Explain what is meant by the statement, "all truth is God's truth."

Since one way that God reveals himself to his people is through creation, we can learn more about him by studying nature. Because all truth is God's truth, any revelation about God, no matter the source, will bring us to a better understanding of our creator and the world he made.

Learning Check 3.5

3.5.1 Explain ways in which stewardship of Earth is like stewardship of something in your life, such as money or time.

God expects us to be stewards of all the resources we possess, and for students, one of their most valuable resources is time. If students spend their time wisely, reviewing regularly, they will learn the material well and will likely succeed in their studies. In the same way, God expects us to be stewards of Earth, managing the natural resources available to us in a way that will supply both our needs and the needs of future generations.

3.5.2 Explain what is meant in Genesis 1:28, when Adam and Eve were given the command to have dominion over Earth.

In this passage, God makes Adam and Eve vice-regents, ruling Earth in God's place. This means that humans are to rule over the creation as God would: to be stewards of creation for God's glory, for the good of all the people of Earth, and for the flourishing of the creation itself.

3.5.3 Using examples, explain the difference between renewable and nonrenewable natural resources.

A renewable natural resource is one that that can be replaced as it is used, such as trees, cotton, or water. A nonrenewable natural resource is one that is not replaced when it is removed from nature for human use, such as iron ore or coal.

3.5.4 Why is it important that humans use natural resources in a sustainable way?

Neither renewable or nonrenewable resources are available to us in an unlimited way. At the rate we are mining coal, for example, it will all be consumed within a few hundred years. Using natural resources in a sustainable way means that our present actions will not adversely affect future generations.

Chapter 3 Exercises

1. Using the concept of the Cycle of Scientific Enterprise, describe how Earth scientists study Earth.

Like other kinds of science, Earth science begins with the collection of many facts, such as the composition of seawater or the temperature inside Earth. Over a long period of time, a theory is developed to account for all of these facts. From this theory scientists form hypotheses, testable predictions based on the theory. After the hypothesis is tested through an experiment, Earth scientists analyze the results to see whether the initial hypothesis was confirmed. Confirmation of the hypothesis adds support to the theory the

hypothesis was derived from, and a successful theory will be supported by the results of a large number of experiments. A theory that does not lead to successful predictions is considered weak, and will eventually need to be revised or discarded.

2. How do Earth scientists use experiments to study Earth?

When doing experimental science, scientists test hypotheses by conducting planned, well-controlled experiments. Experimental science is valuable for evaluating many processes that are occurring today, like the movement of glacier ice.

3. Why is it sometimes necessary for Earth scientists to use historical science rather than experimental science?

In experimental science, scientists conduct experiments to determine whether a hypothesis is valid. Historical science requires other methods of investigation, because it is impossible to recreate historical events such as the formation of the solar system.

4. Read Job 38–39 and list eight ways in which God is glorified in the creation.

1. The ocean has limits and does not overcome all of creation.

2. Dawn comes every morning.

3. The earth contains vast expanses and the deepest darkness.

4. Even a desolate wasteland can produce grass.

5. The stars are unmovable.

6. The clouds are innumerable.

7. All of the animals are provided with food.

8. The animals throughout creation, such as donkeys, horses, ostriches, and hawks, are beautiful and full of life.

5. Suggest ways in which an Earth scientist's work can serve people. Be as specific as possible, and don't use examples from this chapter.

An Earth scientist may serve people by warning people about natural disasters, removing pollutants or contaminants from soil, finding and developing new, sustainable forms of energy, and many other ways.

6. When learning about Earth sciences, why is it important to remember that "all truth is God's truth?"

Since one way that God reveals himself to his people is through creation, we can learn more about him by studying nature. Because all truth is God's truth, any revelation about God, no matter the source, will bring us to a better understanding of our creator and the world he made.

7. Explain why good stewardship of Earth is a biblical concept.

In Genesis, God makes Adam and Eve vice-regents, ruling Earth in God's place. This means that humans are to rule over the creation as God would: to be stewards of creation for God's glory, for the good of all the people of Earth, and for the flourishing of the creation itself. Stewardship of Earth is like stewardship of any other valuable resource we have, whether it is our money, time, or talents.

8. Explain why it is important to use renewable natural resources wisely, even though they can be replenished over time.

Renewable natural resources are not available to us in an unlimited way. Water in a stream, for example, will be replenished by future rainfall or snow, but often our demand for this resource is greater than the amount of water flowing into a river or stream. This leads to shortages of water and other resources, which can create inconvenient or even dangerous conditions.

9. Write a paragraph about a way in which some part of the creation has been degraded in or near your community. Is this problem becoming better, worse, or staying about the same?

In November 2014 in La Porte, Texas, a toxic gas leak from a chemical plant killed four workers. While the damage to the workers and their families cannot be undone, the company is facing a number of fines and is being required to go through rigorous inspections to ensure the company provides a safe and healthy workplace. My hope is that this tragic accident will cause chemical plants everywhere to keep their workers, and all of creation exposed to these chemicals, safe.

Sample Course Lesson Schedule Earth Science Fall Term

Lesson No.	Week	Topic	Text Ref	Assignment	Notes
1	1	Welcome			
2		Introduction to Earth Science	1.1	Learning Check 1.1	
3		Earth in the Solar System, Galaxy, Universe	1.2	Learning Check 1.2	
4		Earth's Orbit and the Seasons	1.3	Learning Check 1.3	
5	2	Phases of the Moon	1.4	Learning Check 1.4	
6		Eclipses	1.5	Learning Check 1.5	
7		Quiz 1			Begin 1.6 After quiz
8		Calendars	1.6	Learning Check 1.6	
9	3	Class work on Chapter 1 Exercises		Chapter 1 Exercises	
10		Locations on Earth	2.1	Learning Check 2.1	
11		Quiz 2			Spare time after quiz
12		Map Projections and the Shape of the Earth	2.2	Learning Check 2.2	Distribute Weekly Review Guide 1
13	4	Remote Sensing	2.3	Learning Check 2.3	
14		Mapping, GIS, Topo Maps	2.4		
15		Topo Maps: Margin Info and Gradient	2.4	Learning Check 2.4	
16		Quiz 3			Continue 2.4 after quiz
17		Class work on Chapter 2 Exercises		Chapter 2 Exercises	Distribute Weekly Review Guide 2
18	5	Experiment 1: Topo Maps		Experiment 1 Report	
19		Review Day			
20		The Cycle of Scientific Enterprise	3.1	Learning Check 3.1	
21		Quiz 4	3.2	Learning Check 3.2	Discuss 3.1 after quiz
22		Experimental vs. Historical Science	3.2		Distribute Weekly Review Guide 3
23	6	Challenges in Studying Earth	3.3	Learning Check 3.3	
24		Christianity and Earth Sciences	3.4	Learning Check 3.4	
25		Class Discussion			
26		Quiz 5			Begin 3.5 after quiz
27		Stewardship of Earth	3.5	Learning Check 3.5	Distribute Weekly Review Guide 4
28	7	Class work on Chapter 3 Exercises		Chapter 3 Exercises	
29		Atoms, Elements, Crystals	4.1		
30		Atoms, Elements, Crystals	4.1	Learning Check 4.1	
31		Quiz 6			Begin 4.2 after quiz; Dist. Weekly Review Guide 5
32	8	Minerals	4.2	Learning Check 4.2	
33		Mineral Properties	4.3	Learning Check 4.3	
34		Quiz 7			Spare time after quiz
35		Mineral Resources	4.4	Learning Check 4.4	Distribute Weekly Review Guide 6
36	9	Class work on Chapter 4 Exercises		Chapter 4 Exercises	
37		Experiment 2: Identifying Minerals		Experiment 2 Report	
38		Review Day			
39		Quiz 8			Begin 5.1 after quiz
40		Rock Cycle	5.1	Learning Check 5.1	Distribute Weekly Review Guide 7
41	10	Igneous Rocks	5.2	Learning Check 5.2	
42		Sedimentary Rocks	5.3	Learning Check 5.3	
43		Metamorphic Rocks	5.4	Learning Check 5.4	
44		Quiz 9			Begin 5.5 after quiz
45		Energy Resources	5.5	Learning Check 5.5	Distribute Weekly Review Guide 8
46	11	Class work on Chapter 5 Exercises		Chapter 5 Exercises	
47		Experiment 3: Identifying Rocks		Experiment 3 Report	
48		Quiz 10			Begin 6.1 after quiz
49		Continental Drift	6.1	Learning Check 6.1	Distribute Weekly Review Guide 9
50	12	Ocean Floor	6.2	Learning Check 6.2	
51		Seafloor Spreading	6.3	Learning Check 6.3	
52		Plate Tectonics	6.4	Learning Check 6.4	
53		Quiz 11			Begin 6.5 after quiz
54		Mountain Building	6.5		Distribute Weekly Review Guide 10
55	13	Class work on Chapter 6 Exercises		Chapter 6 Exercises	
56		Review Day	-		
57		Volcanoes and Plate Tectonics	7.1		
58		Quiz 12		Learning Check 7.1	Continue 7.1 after quiz
59		Volcanoes	7.2		Distribute Weekly Review Guide 11
	14	Thanksgiving week			
60	15	Volcanoes	7.2	Learning Check 7.2	
61		Igneous Intrusions	7.3	Learning Check 7.3	
62		Earthquakes	7.4		
63		Quiz 13		Learning Check 7.4	Continue 7.4 after quiz
64		Earthquake Damage	7.5	Learning Check 7.5	Distribute Weekly Review Guide 12
65	16	Interior of Earth	7.6	Learning Check 7.6	
66		Class work on Chapter 7 Exercises		Chapter 7 Exercises	
67		Experiment 4: Studying Volcanoes with Maps		Experiment 4 Report	
68		Quiz 14			
69		Review Day			Distribute Weekly Review Guide 13

Sample Course Lesson Schedule Earth Science Spring Term

Lesson Number	Week	Topic	Text Ref	Assignment	Notes
1	1	Mechanical and Chemical Weathering	8.1		
2		Mechanical and Chemical Weathering	8.1	Learning Check 8.1	
3		Erosion	8.2	Learning Check 8.2	(No quiz first week of Spring Term)
4		Soils	8.3		Distribute Weekly Review Guide 14
5	2	Soils	8.3	Learning Check 8.3	
6		Class work on Chapter 8 Exercises		Chapter 8 Exercises	
7		Experiment 5: Modeling Weathering		Experiment 5 Report	
8		Quiz 15			Begin 9.1 after quiz
9		The Hydrologic Cycle	9.1	Learning Check 9.1	Distribute Weekly Review Guide 15
10	3	Streams	9.2		
11		Streams	9.2	Learning Check 9.2	
12		Quiz 16			Begin 9.3 after quiz
13		Stream Landforms	9.3	Learning Check 9.3	Distribute Weekly Review Guide 16
14	4	Groundwater	9.4		
15		Groundwater	9.4	Learning Check 9.4	
16		Caverns and Groundwater Landforms	9.5	Learning Check 9.4	
17		Quiz 17			After quiz work on Chapter 9 Exercises
18		Class work on Chapter 9 Exercises		Chapter 9 Exercises	Distribute Weekly Review Guide 17
19	5	Experiment 6: The Stream Table			
20		Experiment 6: The Stream Table		Experiment 6 Report	
21		Quiz 18			Begin 10.1 after quiz
22		Landforms Caused by Mass Movement	10.1	Learning Check 10.1	Distribute Weekly Review Guide 18
23	6	Desert Landforms	10.2	Learning Check 10.2	
24		Glaciers	10.3		
25		Glaciers	10.3	Learning Check 10.3	
26		Quiz 19			Prep for Experiment 5 after quiz
27		Glaciation In Earth's Past	10.4	Learning Check 10.4	Distribute Weekly Review Guide 19
28	7	Class work on Chapter 10 Exercises		Chapter 10 Exercises	
29		Experiment 7: Glaciers with Topo Maps		Experiment 7 Report	
30		Review Day			
31		Quiz 20			Distr. Weekly Review Guide 20; begin 11.1 after quiz
32	8	Geologic Time	11.1	Learning Check 11.1	
33		Relative Age	11.2		
34		Quiz 21			Continue 11.2 after quiz
35		Relative Age	11.2		Distribute Weekly Review Guide 21
36	9	Relative Age	11.2	Learning Check 11.2	
37		Fossils	11.3		
38		Fossils	11.3	Learning Check 11.3	
39		Quiz 22			Prep for Experiment 6 after quiz
40		Absolute Dating	11.4		Distribute Weekly Review Guide 22
41	10	Absolute Dating	11.4	Learning Check 11.4	
42		Sedimentary Environments	11.5	Learning Check 11.5	
43		An Overview of Earth History	11.6		
44		Quiz 23			Begin 11.6 after quiz
45		An Overview of Earth History	11.6		Distribute Weekly Review Guide 23
	11	Spring Break			
46	12	An Overview of Earth History	11.6	Learning Check 11.6	
47		Class work on Chapter 11 Exercises		Chapter 11 Exercises	
48		Review Day			
49		The Oceans	12.1	Learning Check 12.1	(No quiz week after Spring Break)
50		Seawater	12.2	Learning Check 12.2	Distribute Weekly Review Guide 24
51	13	Currents and Waves	12.3	Learning Check 12.3	
52		Tides	12.4	Learning Check 12.4	
53		Marine Life	12.5	Learning Check 12.5	
54		Quiz 24			Continue 12.4 after quiz
55		Shorelines	12.6	Learning Check 12.6	Distribute Weekly Review Guide 25
56	14	Class work on Chapter 12 Exercises		Chapter 12 Exercises	
57		Composition and Structure of Atmosphere	13.1	Learning Check 13.1	
58		Properties of the Atmosphere	13.2		
59		Quiz 25			Work Experiment 9 report or begin 13.1 after quiz
60		Properties of the Atmosphere	13.2	Learning Check 13.2	Distribute Weekly Review Guide 26
	15	Spare week			
61	16	Energy and Water in the Atmosphere	13.3	Learning Check 13.3	
62		Circulation of the Atmosphere	13.4	Learning Check 13.4	
63		Class work on Chapter 13 Exercises		Chapter 13 Exercises	
64		Quiz 26			Begin 14.1 after quiz
65		Clouds and Precipitation	14.1		Distribute Weekly Review Guide 27
66	17	Clouds and Precipitation	14.1	Learning Check 14.1	
67		Air Masses and Fronts	14.2		

68		Air Masses and Fronts	14.2	Learning Check 14.2	
69		Quiz 27			Spare time after quiz
70		Weather Forecasts	14.3	Learning Check 14.3	Distribute Weekly Review Guide 28
71	18	Severe Weather	14.4	Learning Check 14.4	
72		Class work on Chapter 14 Exercises		Chapter 14 Exercises	
73		Experiment 8: Weather Maps		Experiment 8 Report	
74		Quiz 28			Distribute Weekly Review Guide 29
75	19	Review Day			
76		Climate	15.1	Learning Check 15.1	
77		Classification of Climates	15.2	Learning Check 15.2	
78		Quiz 29			
79		Climate Change	15.3		Distribute Weekly Review Guide 30
80	20	Climate Change	15.3	Learning Check 15.3	
81		Air Pollution	15.4	Learning Check 15.4	
82		Class work on Chapter 15 Exercises		Chapter 15 Exercises	
83		Quiz 30			Spare time after quiz
84					

Earth Science
Weekly Review Guide No. 12

Your assignments this week include the following review tasks:

1. Review all the quizzes you have taken so far and figure out what you lost points for. If you are not clear on how to improve your responses, visit with your instructor about it during the week. Do this before the next quiz.

2. Go through your flash cards once or twice, reciting aloud all definitions.

3. Sketch the phases of the moon, in order, labeling each one.

4. Diagram the rock cycle, labeling each circle and each arrow.

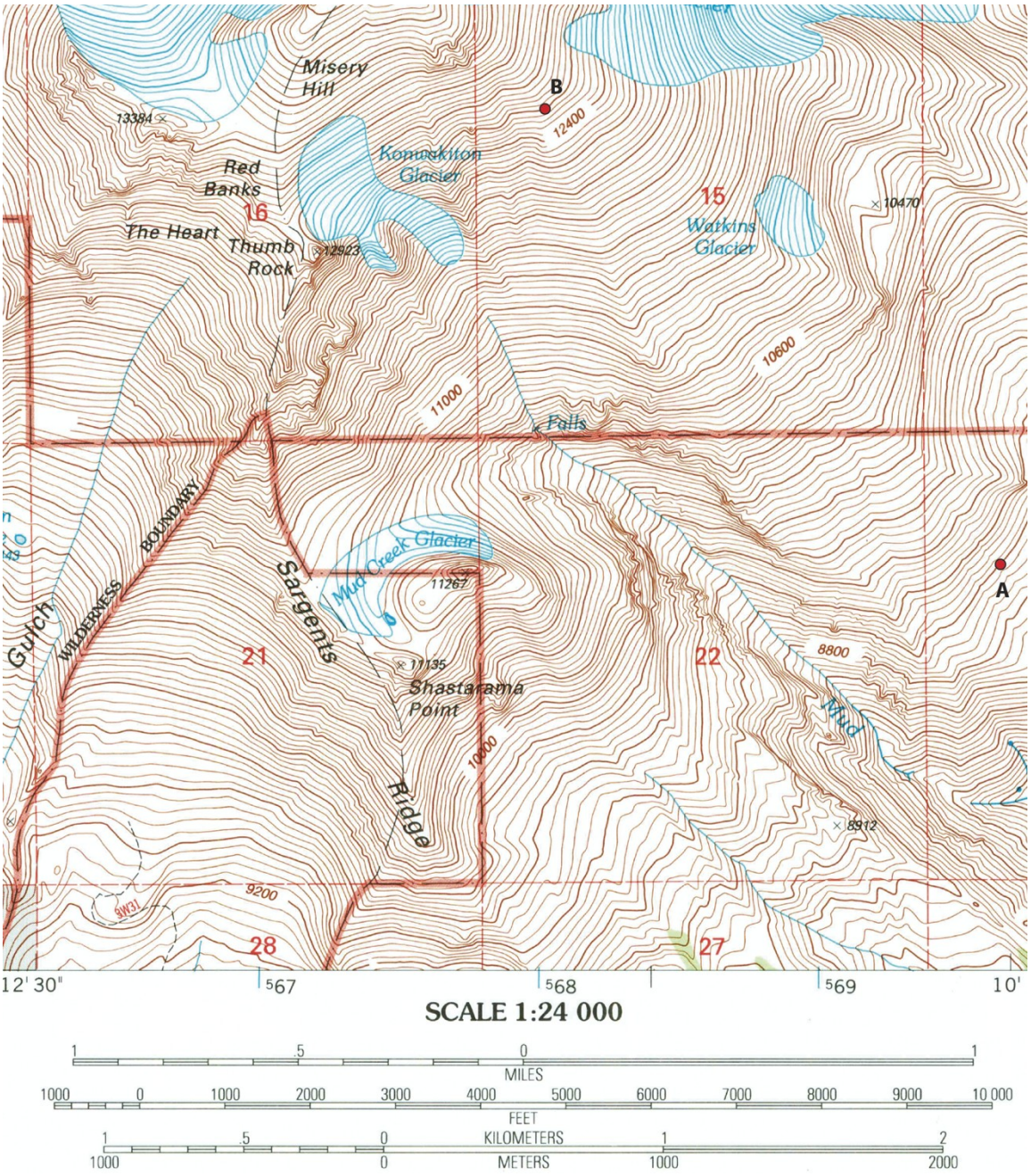
5. Describe the theory of plate tectonics in detail to your cat.

6. Recite how we know the seafloor is spreading.

7. List and describe four sources of energy that are alternatives to fossil fuels.

8. For the map on the next page, determine:

    a. the contour interval
    b. the number of horizontal miles represented by one inch on the map
    c. the gradient and percent slope between A and B
    d. the horizontal distance in miles from Shastarama Point to the 13,384-ft peak in the upper left corner of the map.



Answers to #8:
a. 40 ft
b. 0.38 mi
c. 2540 ft/mi; 49.7%
d. 1.32 mi

Earth Science
Weekly Review Guide No. 15

Your assignments this week include the following review tasks:

1. Read through the Objectives Lists in the text for Chapters 1–4. Identify the five items from those lists that you feel least comfortable with or remember least about. Then look up each of these topics in the text and reread that section.

2. Review the Cycle of Scientific Enterprise from Chapter 2.

3. Review the properties of minerals used for mineral identification in Chapter 4.

Earth Science
Weekly Review Guide No. 18

Your assignments this week include the following review tasks:

1. Review all the quizzes you have taken so far this semester and figure out what you lost points for. If you are not clear on how to improve your responses, visit with your instructor about it during the week. Do this before the next quiz.

2. Practice reciting (to your cat or your favorite stuffed animal) the phases of the moon and the explanation for them.

3. Pretend your grandmother wants you to give her a complete description of volcanoes, the different types and how they work. Practice reciting this description to your cat (or to your grandmother, if she asks).

Earth Science
Weekly Review Guide No. 21

Your assignments this week include the following review tasks:

1. Review all the quizzes you have taken so far this semester and figure out what you lost points for. If you are not clear on how to improve your responses, visit with your instructor about it during the week. Do this before the next quiz.

2. Read over the questions and answers for Quizzes 6–10.

3. Go through your flash cards for Chapters 1–6.
4. Get out Quiz 14. Cover your answers for question 5 and write them again.
5. Tell your cat all about the Cycle of Scientific Enterprise, including definitions for each major term and how they relate to each other.
6. Practice explaining the difference between scientific theories and facts on the one hand, and truth on the other. Explain the difference between the ways we know scientific information and the ways we know truth.

First and Last Name_____

Earth Science Quiz 14

Point values for each item are shown in parentheses. Questions on this quiz may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar.

1. What are calderas and how do they form? (10)

2. Describe the three types of plate boundaries. (10)

3. Describe the three main types of volcanoes. (20)

4. Describe four types of faults. (20)

5. Describe how coal deposits form. (20)

6. Match these terms with the images on the next page, and identify each as igneous, sedimentary, or metamorphic: conglomerate, gneiss, granite, pumice, sandstone, schist. (20)

Name:_____
Type:_____

Name:_____
Type:_____

Name:_____
Type:_____

Name:_____
Type:_____

Name:_____
Type:_____

Name:_____
Type:_____

First and Last Name_____

Earth Science Quiz 17

Point values for each item are shown in parentheses. Questions on this quiz may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar.

1. Describe techniques farmers use to conserve soil. (20)

2. Use the soil triangle shown on the back to complete the chart below: (20)

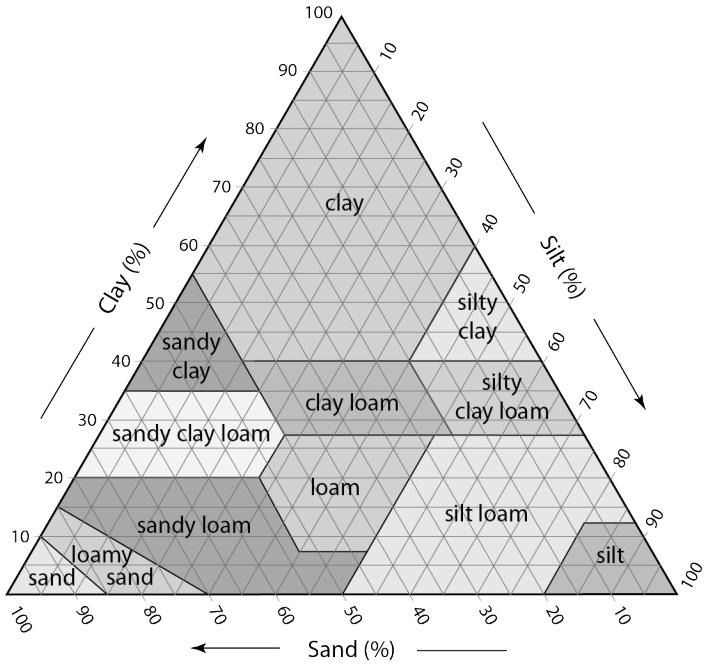
Soil Sample	% Sand	% Silt	% Clay	Texture
1		40	20	
2	40		60	

3. Describe the hydrologic cycle. (20)

4. Describe the shape of the Earth. (10)

5. Describe four types of faults. (20)

6. How do the Richter and Mercalli scales each classify earthquakes? (10)


Clay (%)
Silt (%)
Sand (%)
clay
silty clay
sandy clay
clay loam
silty clay loam
sandy clay loam
loam
silt loam
sandy loam
loamy sand
sand
silt

First and Last Name_____

Earth Science Quiz 20

Point values for each item are shown in parentheses. Questions on this quiz may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar.

1. Describe five types of mass movement. (20)

2. Describe a soil profile, with its A, B, C, and O horizons. (20)

3. On the back, draw the rock cycle, including arrows and labels. (20)

4. Compare the transport of sediment by wind to transport by water. (20)

5. Describe how sand dunes move. (10)

6. Explain how volcanic arcs form along convergent plate boundaries. (10)

First and Last Name_____

Earth Science Quiz 25

Point values for each item are shown in parentheses. Questions on this quiz may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar.

1. Describe why scientists such as Lyell and Hutton concluded that Earth must be millions of years old. (20)

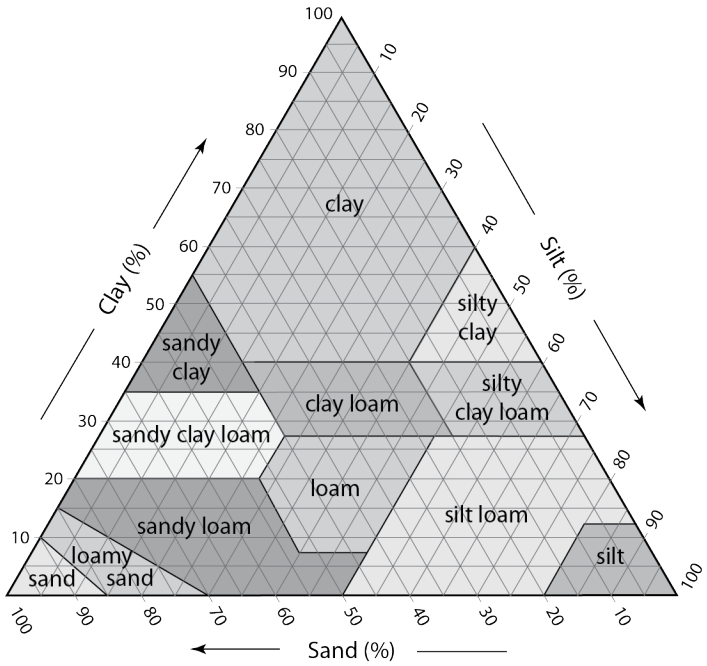
2. Describe three ways fossils form. (20)

3. Briefly describe the composition of seawater. (20)

4. Sketch and name the three typical drainage patterns formed by streams. (20)

5. Use the soil triangle shown on the back to complete the chart below: (20)

Soil Sample	% Sand	% Silt	% Clay	Texture
1	50	40		
2	20		70	


Clay (%)
Silt (%)
Sand (%)
clay
silty clay
sandy clay
clay loam
silty clay loam
sandy clay loam
loam
silt loam
sandy loam
silt
loamy sand
sand