***Environment: Science Behind the Stories, 3e*** **(Withgott et al.)**
**Chapter 2 Matter, Energy, and the Physical Environment**

2.1 Graph and Figure Interpretation Questions

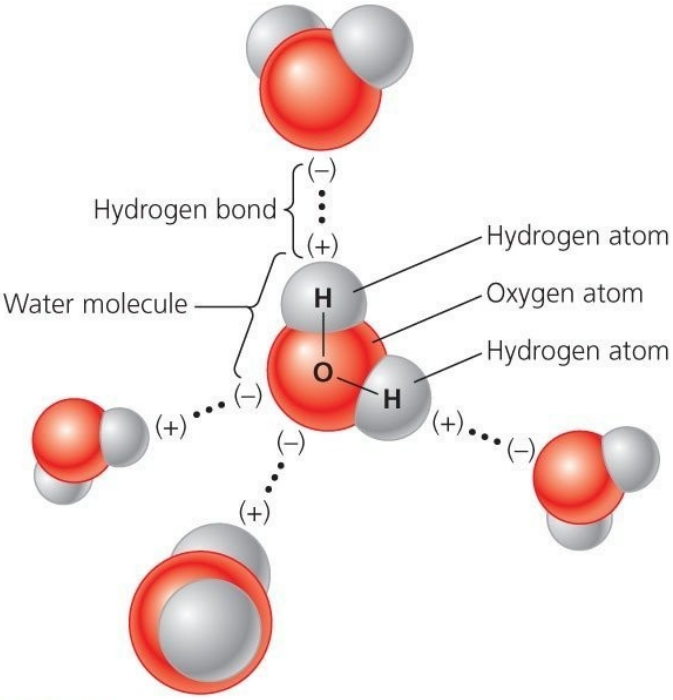


**Figure 2.1**

***Use Figure 2.1 to answer the following questions.***

1) Within the water molecule, _____ bonds connect two hydrogens to every oxygen.
A) polar covalent
B) nonpolar covalent
C) hydrogen
D) ionic
E) dioric
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

2) Why is one end of each water molecule negative and one end positive?
A) Oxygen has a greater pull on the electrons than hydrogen.
B) Oxygen has a greater pull on the protons than hydrogen.
C) The two hydrogens have a greater pull on the electrons than oxygen.
D) The two hydrogens have a greater pull on the protons than oxygen.
E) The hydrogen bonds create a charge difference.
Answer: A
Diff: 3 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

3) What property of water is due to hydrogen bonds?
A) high pH
B) low pH
C) ability to change temperature quickly
D) ability to dissolve lipids
E) ability to form droplets
Answer: E
Diff: 3 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

4) _____ bonds connect adjacent water molecules (hydrogen from one molecule with oxygen of another molecule).
A) Polar covalent
B) Nonpolar covalent
C) Hydrogen
D) Ionic
E) Dioric
Answer: C
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

2.2 Matching Questions

***Match the following.***

A) correlation
B) ions
C) qualitative data
D) ionic bond
E) molecules
F) sedimentary
G) quantitative data
H) hydrogen bond
I) metamorphic
J) isotopes
K) dependent variable
L) probability
M) independent variable
N) covalent bond
O) protons
P) prediction
Q) hypothesis
R) electrons
S) atoms

1) information expressed with numbers
Diff: 1 Type: MA
Bloom's Taxonomy: 2 - Understanding
Objective: 2.1 Matter

2) the variable that is manipulated
Diff: 1 Type: MA
Bloom's Taxonomy: 3 - Applying
Objective: 2.1 Matter

3) expectations of experimental outcome
Diff: 1 Type: MA
Bloom's Taxonomy: 2 - Understanding
Objective: 2.1 Matter

4) numerical expression of the likelihood that a conclusion is true
Diff: 2 Type: MA
Bloom's Taxonomy: 3 - Applying
Objective: 2.1 Matter

5) the smallest components of matter that still maintain the chemical properties of the element
Diff: 1 Type: MA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

6) atoms with the same atomic number but with different atomic masses
Diff: 1 Type: MA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

7) charged subatomic particles located in the nucleus
Diff: 2 Type: MA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

8) bond between atoms sharing electrons
Diff: 2 Type: MA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

9) bond between two atoms of hydrogen that form a molecule of hydrogen gas ($H_2$)
Diff: 3 Type: MA
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

10) rock that form when soils, minerals, and weathered rock particles are deposited, weighted down, and compressed over time
Diff: 1 Type: MA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

Answers: 1) G 2) M 3) P 4) L 5) S 6) J 7) O 8) N 9) N 10) F

2.3 Short Answer Questions

1) Briefly explain the concept of plate tectonics and why it is important for the study of geography.
Answer: Plate tectonics make up the processes that move continental plates, underlie earthquakes and volcanoes, create mountain ranges, and shape shorelines. They determine much of the geography of Earth's surface.
Diff: 3 Type: ES
Bloom's Taxonomy: 6 - Synthesizing
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

2) What is the difference between correlation and causation in scientific experimentation?
Answer: A correlation is a relationship between two variables while a causation shows that changes in the dependent variable are caused by changes in the independent variable. Every causation creates a correlation, but not every correlation is a proof of causation. Manipulative experiments try to establish cause. Natural experiments typically are able to establish only correlation.
Diff: 1 Type: ES
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.1 Matter

3) Give one example of a scientific "paradigm shift."
Answer: adoption of the heliocentric viewpoint; adoption of plate tectonics; adoption of the theory of evolution
Diff: 1 Type: ES
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.1 Matter

4) If in a test of the impact of added fertilizers on the biological productivity of lakes, we add fertilizer to one lake and not to the other, then the second lake serves in this experiment as a _____.
Answer: control
Diff: 2 Type: SA
Bloom's Taxonomy: 3 - Applying
Objective: 2.1 Matter

5) Data not expressible in numbers are called _____.
Answer: qualitative data
Diff: 1 Type: SA
Bloom's Taxonomy: 2 - Understanding
Objective: 2.1 Matter

6) The process of science, called the _____, is used to develop new information in scientific fields.
Answer: scientific method
Diff: 1 Type: SA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.1 Matter

7) Earth's surface consists of a lightweight, thin _____ of rock floating atop a malleable _____.
Answer: crust; mantle
Diff: 1 Type: SA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

8) Convergent plate boundaries are created _____ or by _____.
Answer: subduction; uplift
Diff: 2 Type: SA
Bloom's Taxonomy: 2 - Understanding
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

9) Why does ice float?
Answer: The unique nature of hydrogen bonds creates the crystalline structure of ice. Within this structure, molecules of water are further apart than in liquid water, making the density of ice lower than that of water, which is why ice floats.
Diff: 1 Type: ES
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

10) List four categories of geological hazards.
Answer: earthquakes, tsunamis, volcanic eruptions, and landslides
Diff: 2 Type: ES
Bloom's Taxonomy: 2 - Understanding
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

11) What is the first law of thermodynamics, and why is it important?
Answer: This law says that the total energy in the universe is constant and conserved. This law is important because it says that there is a finite amount of energy on Earth. Humans cannot make new energy. We can only change its form.
Diff: 1 Type: ES
Bloom's Taxonomy: 2 - Understanding
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

12) _____ is that which can change the position, physical composition, or temperature of matter.
Answer: Energy
Diff: 3 Type: SA
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

13) The degree of disorder in a substance, system, or process is called _____.
Answer: entropy
Diff: 2 Type: SA
Bloom's Taxonomy: 1 - Remembering
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

2.4 Multiple-Choice Questions

1) $^{12}C$ and $^{13}C$ differ in _____.
A) atomic mass
B) ionic number
C) atomic number
D) number of protons
E) number of electrons
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

2) A paradigm _____.
A) is a group of several hypotheses that can be tested together
B) is a dominant view in science
C) can only come from qualitative data
D) is synonymous with the scientific method
E) can only come from quantitative data
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 19.5 Compare philosophical approaches to risk and their role in environmental health policy

3) Scientific process and knowledge are based on _____.
A) observation
B) testing hypotheses that are built on observations
C) the fact that hypotheses can be proven
D) just quantitative data
E) educated guesses
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.1 Matter

4) Scientific inquiry is based on _____.
A) an incremental approach to knowledge
B) facts that can be positively proven by testing hypotheses
C) the production of technological advances
D) designing experiments that have never been done before
E) changing paradigms
Answer: A
Diff: 1 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.1 Matter

5) A hypothesis is _____.
A) a prediction about something that is uncertain
B) a testable proposition that explains a phenomenon or answers a question
C) a technique that is used to examine environmental conditions
D) the design of an experiment that can be used for the process of science
E) a proven scientific fact
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.1 Matter

6) Sachiko and Fred are having a discussion about the scientific method. Sachiko makes the comment that every time she sees people carrying open umbrellas, she also sees several small car accidents. This is a(n) _____.
A) hypothesis
B) theory about umbrellas
C) theory about car accidents
D) scientific study
E) observation
Answer: E
Diff: 2 Type: MC
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.1 Matter

7) An experiment _____.
A) is an activity designed to test the validity of a hypothesis
B) often involves manipulating as many variables as possible
C) does not need to be repeated
D) involves only the collection of qualitative data
E) is designed to prove a scientific hypothesis
Answer: A
Diff: 1 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.1 Matter

8) _____ are composed of amino acids.
A) Proteins
B) Nucleic acids
C) Carbohydrates
D) Lipids
E) Bases
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.1 Matter

9) _____ are the primary water−insoluble components of cell membranes.
A) Proteins
B) Nucleic acids
C) Carbohydrates
D) Acids
E) Lipids
Answer: E
Diff: 1 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

10) Finger nails, hair, and enzymes are composed of _____.
A) proteins
B) nucleic acids
C) carbohydrates
D) lipids
E) organelles
Answer: A
Diff: 3 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

11) A denser oceanic plate subducts underneath another less dense oceanic plate. This _____.
A) creates strike-slip plate boundaries
B) creates ocean trenches
C) is caused by volcanoes
D) occurs when plates pull apart
E) results in an uplift
Answer: B
Diff: 3 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

12) A sedimentary rock has been subject to extensive compression and increased temperature. The rock is now best described as _____.
A) heat-resistant
B) igneous
C) decompressive
D) metamorphic
E) deformative
Answer: D
Diff: 1 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

13) The force causing water molecules to adhere to one another in interactions is called _____.
A) Van der Waals attraction
B) a polar covalent bond
C) a nonpolar covalent bond
D) acid–base attraction
E) a hydrogen bond
Answer: E
Diff: 3 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

14) Which of the following describes a property of water necessary for life?
A) changes temperature rapidly
B) is noncohesive
C) is more dense as a solid
D) has high pH
E) dissolves many chemicals
Answer: E
Diff: 2 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

15) Precipitation _____.
A) that is acidic has a low concentration of hydrogen ions
B) that is acidic would have a pH higher than 7
C) that is acidic would have a pH lower than pure water
D) that measures pH = 4 is twice as acidic as precipitation that measures pH = 5
E) has become increasingly basic in the last 100 years because of industrial air pollution
Answer: C
Diff: 2 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

16) Which of the following is NOT a macromolecule?
A) DNA
B) cellulose
C) glucose
D) starch
E) chitin
Answer: C
Diff: 2 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

17) Which of the following describes lipids?
A) dissolve in water
B) include components of the body's immune system
C) include DNA
D) are absent from most animal cells
E) store energy and are in cell membranes
Answer: E
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

18) River water held behind a dam is best described as a form of _____.
A) kinetic energy
B) potential energy
C) chemical energy
D) entropy
E) thermodynamics
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

19) Which of the following is NOT associated with convergent plate boundaries?
A) Hawaiian volcanic islands
B) trenches
C) coastal mountain ranges parallel to the coastline
D) "ring of fire"
E) Japanese volcanic islands
Answer: A
Diff: 3 Type: MC
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

20) Early Earth (4.5 billion years ago) _____.
A) had more abundant and complex life forms compared to today's Earth
B) was stagnant and lifeless
C) was virtually void of oxygen
D) had a very similar atmosphere to today's Earth but lacked water
E) had very high levels of oxygen
Answer: C
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

21) The _____ hypothesis, proposed in the 1930s, says that carbon dioxide, oxygen, and nitrogen dissolved in Earth's water formed simple amino acids and eventually complex organic compounds that self-replicated.
A) heterotrophic
B) extraterrestrial
C) ultraterrestrial
D) homotrophic
E) chemoautotrophic
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

22) Stanley Miller and Harold Urey did experiments in the early 1950s to prove the _____ hypothesis that life evolved from a "primordial soup" of simple inorganic chemicals.
A) heterotrophic
B) extraterrestrial
C) ultraterrestrial
D) homotrophic
E) chemoautotrophic
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

23) The _____ hypothesis, proposed by Svante Arrhenius in the early 1900s, suggests that meteorites delivered life and organic material to Earth.
A) heterotrophic
B) extraterrestrial
C) ultraterrestrial
D) homotrophic
E) chemoautotrophic
Answer: B
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

24) The _____ hypothesis suggests that life on Earth originated in the deep sea where sulphur was abundant.
A) heterotrophic
B) extraterrestrial
C) ultraterrestrial
D) homotrophic
E) chemoautotrophic
Answer: E
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

25) Coal, oil, and natural gas are _____.
A) renewable
B) fossil fuels
C) part of a sustainable energy future
D) inorganic
E) synthetic
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 1 - Remembering
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

26) When you burn a log in your fireplace you are converting _____.
A) chemical to thermal (heat) energy
B) thermal to electromagnetic energy
C) electromagnetic to chemical energy
D) chemical to nuclear energy
E) proteins to amino acids
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

27) Which of the following is NOT associated with divergent plate boundaries?
A) Hawaiian volcanic islands
B) rising magma
C) mid-ocean ridges
D) new crust
E) Iceland
Answer: A
Diff: 3 Type: MC
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

28) Which is NOT true about basalt?
A) It is an intrusive rock.
B) It is the principal rock of the Hawaiian volcanic islands.
C) It has small crystals.
D) It cooled rapidly during its formation.
E) It is the main rock of oceanic crust.
Answer: A
Diff: 3 Type: MC
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

29) Which is NOT true about granite?
A) It is extrusive rock.
B) It is plutonic rock.
C) It has a coarse-grained appearance.
D) It cooled slowly during its formation.
E) It solidified below Earth's surface.
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

30) $^{14}C$ has 6 protons and _____.
A) 8 neutrons
B) 8 electrons
C) 6 neutrons
D) 14 neutrons
E) 14 electrons
Answer: A
Diff: 2 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

31) List four samples of freshwater of different temperatures in order of increasing density (with the least dense first and the densest last). All temperatures are in °C.
A) -5, 20, 4, 1
B) 20, 4, 1, -5
C) 20, 1, 4, -5
D) -5, 1, 4, 20
E) -5, 20, 1, 4
Answer: E
Diff: 3 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

2.5 True/False Questions

1) The heterotrophic hypothesis for the origin of life on Earth argues that the first life forms to evolve were heterotrophs living in deep-ocean vents.
Answer: FALSE
Diff: 2 Type: TF
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

2) The primary goal of science is to positively prove hypotheses.
Answer: FALSE
Diff: 3 Type: TF
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.1 Matter

3) The chemoautotrophic hypothesis is also known as the panspermia hypothesis.
Answer: FALSE
Diff: 2 Type: TF
Bloom's Taxonomy: 1 - Remembering
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

4) Japan is a product of a continental collision.
Answer: FALSE
Diff: 1 Type: TF
Bloom's Taxonomy: 3 - Applying
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

5) The Murchison meteorite, which fell in Australia in 1969, was found to contain bacteria.
Answer: FALSE
Diff: 3 Type: TF
Bloom's Taxonomy: 1 - Remembering
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

6) Mariana Trench, Earth's deepest abyss, was created at a transform plate boundary.
Answer: FALSE
Diff: 3 Type: TF
Bloom's Taxonomy: 3 - Applying
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

2.6 Essay Questions

1) Describe the rock cycle, explaining how the three major types of rock form and break down.
Answer: All rocks can melt. At sufficiently high temperatures, liquid rock occurs, called magma. Magma may cool back into rock underground or may be released above ground through a volcano or vent in the form of ash or lava, which may then cool into rock on Earth's surface. Rock formed from the various types of magma is called igneous rock. Igneous rock can also be altered by heat and pressure into a metamorphic rock. Over time, wind, weather, and physical damage can erode rock into gravel, sand, silt, and clay particles.

The material from igneous or metamorphic rocks that have been broken into small components can be transported and deposited in layers, often in or along water features. Over time, these are compressed into layered rock, called sedimentary rock. This, too, can erode into smaller fragments.

Igneous or sedimentary rock buried underground and exposed to extreme forces of heat or pressure can change form into metamorphic rock, which may be quite different from its original form. It, in turn, may be subject to erosion or melting.
Diff: 3 Type: ES
Bloom's Taxonomy: 2 - Understanding
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

2) Compare manipulative and natural experiments. How are they done and what are their strengths and weaknesses?
Answer: In a manipulative experiment, the researcher chooses and manipulates an independent variable, such as a temperature in a greenhouse, while keeping all other conditions as unchanged as possible. In a natural experiment (or a correlational study) the researcher records data from variables as they are expressed in the natural environment, such as recording plant growth in two geographic locations experiencing different temperatures. The results of manipulative experiments are stronger in suggesting causation because all the changes in the dependent variable can be attributed to the changes in the manipulated independent variable. In natural experiments there may be other factors at play; therefore, these experiments tell us mainly about the correlation between the studied variables. However, the strength of the natural experiments comes from the fact that they preserve natural-world complexity that manipulative experiments typically sacrifice (natural-world plants do not grow in greenhouses, sheltered from wind, snow, hail, and most pests). Furthermore, since large-scale manipulations may be very expensive, difficult, or impossible, natural experiments may often be the only way to address many important environmental questions.
Diff: 2 Type: ES
Bloom's Taxonomy: 5 - Evaluating
Objective: 2.1 Matter

3) How does a scientist tests his or her hypothesis?
Answer: To test a hypothesis, a scientist makes predictions based on this hypothesis and then gathers evidence that could potentially refute these predictions. The strongest form of evidence comes from experiments, in which we observe how the dependent variable changes in response to changes in the independent variable. Experiments could be manipulative or natural (also called "correlational"). A well-designed manipulative experiment would have a control and replicates. The results can be then analyzed using statistical methods. If the analyzed data contradict the predictions, the initial hypothesis is refuted; otherwise the scientist concludes that there are no grounds to reject the hypothesis at this stage.
Diff: 2 Type: ES
Bloom's Taxonomy: 4 - Analyzing
Objective: 2.1 Matter

4) List the four types of macromolecules essential to life. Describe the structures of each and describe their major role(s) in organisms.
Answer: Carbohydrates are made of carbon, hydrogen, and oxygen and have the general formula $CH_2O$. Carbon and water exist in a 1:1 ratio. They are the primary components of cell walls and are the preferred energy source for many organisms.

Proteins are chains of amino acids (amine group + carboxyl group + central carbon). They are primarily structural molecules. They are blood transporters, aid in the function of the immune system, and promote metabolic reactions. All enzymes are proteins.

Nucleic acids are made of chains of nucleotides (phosphate + sugar + nitrogenous bases). They carry genetic information needed to synthesize proteins. They also pass genetic traits from generation to generation.

Lipids are long chains or rings of hydrogen and carbon. They can store high amounts of energy, and are the primary components of cell membranes. Lipids also include the steroid hormones, which regulate sexual function in animals.
Diff: 3 Type: ES
Bloom's Taxonomy: 6 - Synthesizing
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

5) Describe the first and second laws of thermodynamics. Illustrate both laws by using an example of a burning log of firewood.
Answer: The first law states that energy can change from one form to another, but it cannot be created or destroyed. Therefore, total energy in the universe remains constant. The second law states that the form of energy in the universe will change from a more ordered to a less ordered one. In every transfer of energy, some of the energy is converted into a more disorganized and less usable form. Entropy, a measure of disorder, is increasing at the scale of the universe, as energy is converted from high to low quality. When a firewood log is burned, the complex biological polymers that make up the wood are converted, with the help of oxygen, into simpler molecules of carbon dioxide and water, and into carbon ash and smoke. The sum of the energy contained in the chemical bonds of wood polymers making up the log before burning is equal to the sum of the energy contained in the products of the burning, and in the heat and light of the fire (the first law). However, the energy contained in the log was much more organized, and more usable, than the heat, light, and chemical energy of the molecules created by the burning (the second law).
Diff: 3 Type: ES
Bloom's Taxonomy: 3 - Applying
Objective: 2.3 Differentiate among various types of energy, the fundamental properties of energy, and the role of energy in environmental systems

6) Explain why chemistry is important in examining environmental issues and solving environmental problems. Illustrate with examples of such issues/problems.
Answer: Chemistry shows us how various components of our environment combine, separate, and recombine in different forms, as well as what drives these transformations. Given this, chemistry is crucial to an understanding of how gases such as carbon dioxide and methane contribute to global climate change, how pollutants such as sulphur dioxide and nitric oxides cause acid rain, and how pesticides and other artificial compounds we release into the environment affect the health of wildlife and people. Chemistry is central in understanding water pollution and sewage treatment, atmospheric ozone depletion, hazardous waste and its disposal, and energy issues.
Diff: 2 Type: ES
Bloom's Taxonomy: 6 - Synthesizing
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

7) Summarize the heterotrophic hypothesis, the panspermia hypothesis, and the chemoautotrophic hypothesis for the development of life on Earth.
Answer: The heterotrophic or "primordial soup" hypothesis states that life evolved from simple inorganic chemicals—carbon dioxide, oxygen, and nitrogen—dissolved in the surface waters of the oceans or tidal shallows around oceanic margins. Simple amino acids may have formed under these conditions and more complex organic compounds may have followed, including nucleic acids that could replicate and give rise to basic forms of life. It is called the heterotrophic hypothesis because it argues that heterotrophs evolved first.

The panspermia hypothesis is similar, but suggests that early chemical reactions on Earth may have received help from outer space. Bacteria from space may have been deposited on meteorites that crashed to Earth, seeding our planet.

The chemoautotrophic hypothesis suggests that early life was formed by chemoautotrophs that derived their energy from the chemical energy contained in the sulphur compounds abundant in hot deep−sea vents.
Diff: 3 Type: ES
Bloom's Taxonomy: 2 - Understanding
Objective: 2.5 Summarize the characteristics of early Earth and the main hypotheses for the origin of life

8) Explain how isotopes are used in environmental science and provide an example from your text.
Answer: Isotopes are powerful instruments for environmental scientists. There are two groups of isotopes: radioactive and stable. The radioactivity of the former allows them to be quantified and traced. They emit energy that can be traced inside organisms (to follow metabolic pathways, such as photosynthesis). Because radioactive isotopes emit a measurable quantity of radiation and decay over time (according to their half-life), they can be also used to date organic materials such as human remains, grain, shells, tissues of ancient animals, and fossils. We can learn about ancient cultures and Earth's history from them. The text gives an example of the radioactive isotope $^{14}C$. Scientists date fossils, human remains, foodstuffs, and other carbon−containing items by measuring the percentage of $^{14}C$ in them.

Stable isotopes do not emit radiation but are useful because their relative abundance can be enriched or depleted by various biological and physical processes, so by measuring the ratios of the stable isotopes in organisms and environment we can learn about these processes. The text examples are the ratios of stable isotopes of $^{12}C$ and $^{13}C$, which are used to study ecological pathways (food chains), and, together with $^{2}H$ and $^{1}H$, are used to study past climates and geographic origin and migrations of animals.
Diff: 3 Type: ES
Bloom's Taxonomy: 6 - Synthesizing
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

9) Describe several properties of water that explain why the lakes in Canada typically do not freeze all the way to the bottom even during extremely long and cold winters.
Answer: Water has high heat capacity, which means that it takes a lot of winter cooling to lower water temperature.

Density of liquid (fresh) water reaches its maximum at 4°C, which means that as the water cools below 4°C, the coldest water stays close to the surface, preventing the cold from penetrating into deep layers of the lake, and promoting formation of ice on the surface, which insulates the water from frigid air.

Ice is less dense than liquid water, so when it forms, it floats and creates an insulating layer.
Diff: 3 Type: ES
Bloom's Taxonomy: 5 - Evaluating
Objective: 2.2 Summarize the basic properties of matter, the foundation for all materials on Earth

2.7 Scenario-Based Questions

***Read the following scenario and answer the questions below.***

Almost all environmental scientists agree that gases contribute to global climate change. Carbon dioxide, methane, nitrous oxide, ozone, halocarbons (CFCs and HFCs), and water vapour are the main culprits. These "greenhouse gases" have increased dramatically in our atmosphere since the Industrial Revolution. Human activities significantly increase greenhouse gases in our atmosphere. Chief among these is the burning of fossil fuels for energy. When we burn fossil fuels, we combine the carbon in fossil remnants of an organic matter with oxygen and release the resulting gasses into the atmosphere. With rising standards of living in developing countries, emissions of carbon dioxide and other greenhouse gases are expected to continue to rise. If unchecked, it is predicted that carbon dioxide levels will reach twice preindustrial levels by mid-century and double again by the end of the century. Computer models have shown that this increase alone could raise Earth's temperatures by 1 to 3°C by 2100.

1) The burning of fossil fuels is chemically most similar to which of the following biological processes?
A) phytoremediation
B) autotrophy
C) chemosynthesis
D) cellular respiration
E) photosynthesis
Answer: D
Diff: 1 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

2) Nitrous oxide from burning fossil fuels, in addition to being a greenhouse gas, contributes to acid precipitation. This can be explained by _____.
A) its ability to form compounds that raise pH
B) its ability to form compounds that lower pH
C) the ability of acids to raise the temperature of the substances which dissolve them
D) the airborne nature of all compounds containing nitrogen
E) the hydrogen bonds connecting the nitrogen and oxygen atoms in the molecule
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.1 Matter

3) Overpopulation contributes to global warming when _____.
A) most of the population is vegetarian
B) there is also greater consumption of natural resources
C) we compromise our living standards
D) most people use public transportation
E) solar energy is used as the primary source of energy
Answer: B
Diff: 1 Type: MC
Bloom's Taxonomy: 2 - Understanding
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

4) The primary source of increased levels of greenhouse gases on Earth is _____.
A) increased photosynthetic activity
B) loss of heterotrophs
C) modern human lifestyles
D) aerosol spray cans
E) asteroids falling to Earth
Answer: C
Diff: 2 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.4 Explain how plate tectonics and the rock cycle shape the landscape around us and Earth beneath our feet

5) Why does burning fossil fuels increase global warming?
A) Fossils, if left untouched, cool Earth.
B) New energy is created on Earth when fossil fuels are burned.
C) Burning fossil fuels destroys the ozone layer.
D) Carbon present in coal, oil, and natural gas becomes carbon dioxide when these fuels burn.
E) Burning fossil fuels removes water vapour from the atmosphere.
Answer: D
Diff: 1 Type: MC
Bloom's Taxonomy: 3 - Applying
Objective: 2.1 Matter