

## CHAPTER 2—SCIENCE, MATTER, ENERGY, AND SYSTEMS

---

### MULTIPLE CHOICE

1. In an experiment, which of the following would not change the chosen variable?
- experimental group
  - controlled experiment
  - observation
  - control group
  - variables

ANS: D                      PTS: 1                      DIF: Moderate                      TOP: 2-0 Core Case Study

2. In 1963 Bormann and Likens compared the output of two river valleys, one forested and the other clear cut. Which of the following reports their findings?
- deforested valley had higher water flow, decrease of nutrient loss
  - forested valley had higher water flow, decrease of nutrient loss
  - forested valley had lower water flow, increase of nutrient loss
  - deforested valley had lower water flow, increase of nutrient loss
  - deforested valley had higher water flow, increase of nutrient loss

ANS: E                      PTS: 1                      DIF: Difficult                      TOP: 2-0 Core Case Study

3. Which of the following is the usual order of applying the scientific process to a problem?
- hypothesis–question–observation–experimentation–conclusion–analysis
  - hypothesis–conclusion–question–observation–experimentation–analysis
  - observation–hypothesis–conclusion–experimentation–analysis–question
  - observation–question–hypothesis–experimentation–analysis–conclusion
  - hypothesis–experimentation–observation–analysis–question–conclusion

ANS: D                      PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

4. Which of the following is the definition of a scientific hypothesis?
- a simulation of a system being studied
  - a possible explanation for an observation or experimentation
  - information needed to answer questions
  - procedures carried out under controlled conditions to gather information
  - all of these

ANS: B                      PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

5. Science has limitations, including all of the following, *except*
- science can always prove or disprove anything
  - scientists are not totally free of bias
  - testing can involve a huge number of variables
  - some situations require the use of statistical tools
  - science is limited to the natural world

ANS: A                      PTS: 1                      DIF: Difficult                      TOP: 2-1 What Do Scientists Do?

6. When an overwhelming body of observations and measurements supports a scientific hypothesis or group of related hypotheses, it becomes a(n)
- hypothesis
  - scientific law
  - scientific variable
  - scientific theory
  - conclusion

ANS: D                      PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

7. A well-tested and widely accepted description of what scientists find happening repeatedly in nature in the same way, is called a(n)
- theory
  - scientific law
  - hypothesis
  - conclusion
  - none of these

ANS: B                      PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

8. Which of the following is supported by data, hypotheses, models, theories, and laws that are widely accepted by scientists considered experts in the field under study?
- frontier science
  - tentative science
  - reliable science
  - unreliable science
  - guess

ANS: C                      PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

9. Matter is anything that
- has mass and takes up space
  - has the capacity to do work
  - can be changed in form
  - can produce change
  - moves mass

ANS: A                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

10. Which of the following is *not* identified by the author as a building block of matter?
- molecules
  - compounds
  - ions
  - atoms
  - none of these

ANS: B                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

11. Fundamental types of matter that have unique sets of properties and can not be broken down into simpler substances by chemical means are called
- mixtures
  - compounds
  - isotopes
  - elements
  - atoms

ANS: D                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

12. All of the following are elements *except*
- water
  - oxygen
  - nitrogen
  - hydrogen
  - carbon

ANS: A                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

13. The most basic building block of matter is a(n)
- atom
  - element
  - molecule
  - compound
  - ion

ANS: A                      PTS: 1                      DIF: easy                      TOP: 2-2 What Is Matter?

14. Protons, neutrons, and electrons are all
- forms of energy
  - equal in mass
  - subatomic particles
  - negative ions
  - charged particles

ANS: C                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

15. The atomic number is the number of
- atoms in a molecule
  - protons in an atom
  - neutrons in a molecule
  - electrons in an atom
  - protons, electrons, and neutrons

ANS: B                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

16. The mass number is equal to the sum of the
- neutrons and isotopes
  - neutrons and electrons
  - neutrons and protons
  - protons and electrons
  - ions and isotopes

ANS: C                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

17. Isotopes are forms of an element that differ from one another by having different
- atomic numbers
  - numbers of electrons
  - numbers of protons
  - mass numbers
  - electrical charges

ANS: D                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

18. An atom or group of atoms with one or more net positive or negative charges is a(n)
- base
  - isotope
  - ion
  - acid
  - none of these

ANS: C                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

19. The measurement of the concentration of hydrogen ions compared to the concentration of hydroxide ions in a solution is called
- ionization
  - pH
  - alkalinity
  - covalent bonding
  - isotope

ANS: B                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

20. An example of an organic compound would be
- H<sub>2</sub>O
  - NaCl
  - H<sub>2</sub>SO<sub>4</sub>
  - N<sub>2</sub>O
  - CH<sub>4</sub>

ANS: E                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

21. Which of the following would not be organic molecules?
- lipids
  - nucleic acids
  - hydrocarbons
  - proteins
  - water

ANS: E                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

22. Which of the following is/are not a macromolecule?
- lipids
  - simple carbohydrates
  - proteins
  - nucleic acids
  - complex carbohydrates

ANS: B                      PTS: 1                      DIF: easy                      TOP: 2-2 What Is Matter?

23. The macromolecules that make up living organisms are

- a. proteins
- b. lipids
- c. carbohydrates
- d. nucleic acids
- e. all of these

ANS: E                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

24. The distinct piece of DNA containing instructions for making proteins is

- a. the chromosome
- b. the nucleotide
- c. the amino acid
- d. the cell membrane
- e. the hydrocarbon

ANS: C                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

25. The monomer for the protein polymer is the

- a. hydrocarbon
- b. glycerol
- c. amino acid
- d. carbohydrate
- e. nucleotide

ANS: C                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

26. Which of the following is the fundamental structural and functional unit of life?

- a. atom
- b. macromolecule
- c. DNA
- d. cell
- e. organism

ANS: D                      PTS: 1                      DIF: easy                      TOP: 2-2 What Is Matter?

27. Which of the following sources of iron would be of the highest quality?

- a. iron deposits on the ocean floor
- b. a field of spinach
- c. a large, scrap metal junkyard
- d. a one-half mile deep deposit of iron ore
- e. iron in water

ANS: D                      PTS: 1                      DIF: Difficult                      TOP: 2-2 What Is Matter?

28. Which of the following statements is *not* an example of a physical change?

- a. Confetti is cut from pieces of paper.
- b. Water evaporates from a lake.
- c. Ice cubes are formed in the freezer.
- d. A plant converts carbon dioxide into carbohydrate.
- e. A tree is cut down in the forest.

ANS: D                      PTS: 1                      DIF: Moderate  
TOP: 2-3 What Happens When Matter Undergoes Change?

29. Which of the following is *not* one of the nuclear changes matter can undergo?
- fission
  - evaporation
  - decay
  - fusion
  - All of these are nuclear changes.

ANS: B                    PTS: 1                    DIF: Easy  
TOP: 2-3 What Happens When Matter Undergoes Change?

30. All of the following statements can be concluded from the law of conservation of matter *except*
- We can't throw anything away because there is "no away."
  - Eventually we will run out of matter if we keep consuming it.
  - There will always be pollution of some sort.
  - Everything must go somewhere.
  - We do not consume matter.

ANS: B                    PTS: 1                    DIF: Difficult  
TOP: 2-3 What Happens When Matter Undergoes Change?

31. Scientists classify energy as either
- chemical or physical
  - kinetic or mechanical
  - potential or mechanical
  - potential or kinetic
  - chemical or kinetic

ANS: D                    PTS: 1                    DIF: Moderate  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

32. Energy can be formally defined as
- the random motion of molecules
  - the ability to do work and transfer heat
  - a force that is exerted over some distance
  - the movement of molecules
  - the loss of matter

ANS: B                    PTS: 1                    DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

33. Which of the following does *not* represent kinetic energy?
- the wind blowing
  - water in a stream
  - steam
  - a car at the top of a hill
  - electricity

ANS: D                    PTS: 1                    DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

34. Which of the following is an example of low-quality energy?
- electricity
  - heat in the ocean
  - nuclear fission
  - gasoline
  - food

ANS: B                    PTS: 1                    DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

35. What percentage of the energy used to produce food for living organisms, and to heat the earth, comes from the sun?
- 10
  - 29
  - 49
  - 79
  - 99

ANS: E                    PTS: 1                    DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

36. An example of potential energy is
- electricity lighting a lamp
  - sugar in a sugar bowl
  - a snowball thrown at a tree
  - a leaf falling from a tree
  - water powering a turbine

ANS: B                    PTS: 1                    DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

37. Which of the following statements is *false*?
- Energy can be converted from one form to another.
  - Energy and matter can generally be converted into each other.
  - Energy input always equals energy output.
  - The laws of thermodynamics can be applied to living systems.
  - Energy conversion results in lower quality energy.

ANS: B                    PTS: 1                    DIF: Difficult  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

38. The first law of thermodynamics tells us that
- Doing work always creates heat.
  - Altering matter is the best source of energy.
  - Energy cannot be recycled.
  - Energy is neither created nor destroyed.
  - Energy cannot be converted.

ANS: D                    PTS: 1                    DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

39. Which of the following statements does *not* apply to the second law of energy?
- Energy goes from useful to less useful forms.
  - Energy is neither created nor destroyed.
  - Energy conversions results in lower-quality energy.
  - Heat is given off from energy conversions.
  - We can not recycle or reuse high-quality energy.

ANS: B                      PTS: 1                      DIF: Difficult  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

40. Energy input is
- usually greater than energy output
  - always greater than energy output
  - always equal to energy output
  - usually less than energy output
  - always less than energy output

ANS: C                      PTS: 1                      DIF: Easy  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

41. Earth's supply of concentrated, usable energy is being steadily
- depleted
  - recycled
  - reused
  - converted to more usable forms
  - converted to higher-quality forms

ANS: A                      PTS: 1                      DIF: Moderate  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

42. The matter and energy laws tell us that we can recycle
- both matter and energy
  - neither matter nor energy
  - matter but not energy
  - energy but not matter
  - none of these

ANS: C                      PTS: 1                      DIF: Moderate  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

43. The energy "lost" by a system is
- converted into an equal amount of matter
  - equal to the energy the system creates
  - converted to lower-quality energy
  - returned to the system, eventually
  - converted to higher-quality energy

ANS: C                      PTS: 1                      DIF: Moderate  
TOP: 2-5 What Are Systems and How Do They Respond to Change?



44. Which of the following is *not* a key component of a system?
- throughputs
  - inputs
  - outputs
  - All are key components.
  - None are key components.

ANS: D                    PTS: 1                    DIF: Easy  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

45. Which of the following is a property of a system?
- functions in a regular and predictable manner
  - highly random in its function
  - cannot be accurately modeled
  - consists solely of inputs and outputs
  - none of these

ANS: A                    PTS: 1                    DIF: Easy  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

46. A positive feedback loop is illustrated by all of the following *except*
- melting polar ice
  - exponential population growth
  - a thermostat maintaining a certain temperature in your house
  - the greenhouse effect
  - none of these

ANS: C                    PTS: 1                    DIF: Easy  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

47. Which one of the following does *not* illustrate a time delay?
- A smoker develops lung cancer.
  - CFCs deplete the ozone layer.
  - Increased carbon dioxide levels enhance the greenhouse effect.
  - A fox eats a rabbit.
  - Polar ice melting increases absorption of sunlight.

ANS: D                    PTS: 1                    DIF: Difficult  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

48. Time delays in feedback systems allow changes in the environment to build slowly until the changes reach a(n)
- synergy point
  - input
  - throughput
  - tipping point
  - bioaccumulation point

ANS: D                    PTS: 1                    DIF: Easy  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

49. Which of the following is *not* an example of an environmental threshold having been crossed?
- Fishing in some parts of the world is no longer profitable.
  - Deforested areas are becoming deserts.
  - Loss of biodiversity.
  - Sea levels rise.
  - Water pollution levels in developed countries have decreased.

ANS: E                      PTS: 1                      DIF: Moderate  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

50. Two or more processes interacting such that the combined effect is greater than the sum of the individual effects is called
- homeostasis
  - a synergistic interaction
  - negative feedback
  - entropy
  - time delay

ANS: B                      PTS: 1                      DIF: Moderate  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

51. Which of the following does *not* represent a synergistic interaction?
- Smokers who inhale asbestos die of lung cancer.
  - Combinations of pollutants increase health hazards.
  - Bartender who doesn't smoke gets lung cancer from secondary smoke.
  - Running further when running with a partner.
  - Studying for a test with a group of students.

ANS: C                      PTS: 1                      DIF: Moderate  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

52. The community knew the effects of chemical X when it was used alone. They knew the same for chemical Z, so they set safe limits for use for both chemicals. When the chemicals were released at safe levels on the same day there was a massive fish kill. The most likely explanation is
- homeostasis
  - a synergistic interaction
  - negative feedback
  - positive feedback
  - entropy

ANS: B                      PTS: 1                      DIF: Difficult  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

53. Human events that affect the environment are generally characterized by
- predictability in what happens because the environment is so large
  - many experiences that allow for accurate generalizations
  - long delays between events and responses
  - obvious and immediate feedback
  - all of these

ANS: C                      PTS: 1                      DIF: Moderate  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

54. Which of the following must obey the laws of thermodynamics?
- organic life
  - living systems
  - economics
  - humans
  - all of these

ANS: E                      PTS: 1                      DIF: Easy  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

### TRUE/FALSE

1. Scientists tend to be highly skeptical of new data, hypotheses, and models until they can be tested and verified.

ANS: T                      PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

2. Deductive reasoning goes from the specific to the general, e.g., from the "bottom up."

ANS: F                      PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

3. When someone says that evolution is not important, "after all, it's just a theory," it is probable that they do not understand how scientists use the term "theory."

ANS: T                      PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

4. Tentative or frontier science is always science done by incompetent scientists whose work will never be accepted by their peers.

ANS: F                      PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

5. Scientists can disprove things but they cannot prove anything absolutely, which means there is always some uncertainty in science.

ANS: T                      PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

6. Scientists use the statistical concept of probability to evaluate the results of experimentation.

ANS: T                      PTS: 1                      DIF: Easy  
TOP: Science Focus: Statistics and Probability

7. Atoms have a net positive electrical charge.

ANS: F                      PTS: 1                      DIF: easy                      TOP: 2-2 What Is Matter?

8. A chemical formula is a shorthand way of writing the symbols for atoms or ions in a compound.

ANS: T                      PTS: 1                      DIF: Moderate                      TOP: 2-2 What Is Matter?

9. Methane, a hydrocarbon, is considered an organic molecule even though it contains only one carbon atom.

ANS: T                      PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

10. How useful matter is to humans as a resource is determined by its concentration, availability for use, and its potential.
- ANS: T                    PTS: 1                    DIF: Easy                    TOP: 2-2 What Is Matter?
11. In a nuclear fission reaction atoms are destroyed.
- ANS: F                    PTS: 1                    DIF: easy  
TOP: 2-3 What Happens When Matter Undergoes Change?
12. A nuclear change in which two isotopes of light elements are forced together, releasing huge amounts of energy, is called nuclear fission.
- ANS: F                    PTS: 1                    DIF: Moderate  
TOP: 2-3 What Happens When Matter Undergoes Change?
13. In a chemical reaction, there is a change in the arrangement of atoms, ions, or molecules of the substances involved
- ANS: T                    PTS: 1                    DIF: Easy  
TOP: 2-3 What Happens When Matter Undergoes Change?
14. According to the law of conservation of matter, once trash decomposes in a landfill we have completely gotten rid of the matter which made up the trash.
- ANS: F                    PTS: 1                    DIF: easy  
TOP: 2-3 What Happens When Matter Undergoes Change?
15. Energy consumption does not mean the disappearance of energy; rather it is the conversion of energy from one form to another with no net loss.
- ANS: T                    PTS: 1                    DIF: Moderate  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?
16. Energy cannot be recycled.
- ANS: T                    PTS: 1                    DIF: Moderate  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?
17. Burning coal demonstrates the conversion of energy from kinetic to potential.
- ANS: F                    PTS: 1                    DIF: Difficult  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?
18. The scientific principles of sustainability show that everything we do affects someone or something in the environment in some way.
- ANS: T                    PTS: 1                    DIF: Easy  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

19. A negative feedback loop causes a system to further change in the same direction.

ANS: F                      PTS: 1                      DIF: Moderate  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

20. A very useful tool in studying living systems is the use of computer models or simulations.

ANS: T                      PTS: 1                      DIF: easy  
TOP: Science Focus: the Usefulness of Models

## COMPLETION

1. Science is based on the assumption that events in the natural world follow \_\_\_\_\_ patterns that can be understood.

ANS: cause-and-effect

PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

2. \_\_\_\_\_ happens when scientists report details of their research and other scientists evaluate it.

ANS: Peer review

PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

3. Watching a variety of objects fall to earth, we can use \_\_\_\_\_ reasoning to propose that all objects fall to the earth's surface when dropped.

ANS: inductive

PTS: 1                      DIF: Easy                      TOP: 2-1 What Do Scientists Do?

4. A(n) \_\_\_\_\_ occurs when an accepted theory or law of science is changed as a result of new discoveries or ideas.

ANS: paradigm shift

PTS: 1                      DIF: Moderate                      TOP: 2-1 What Do Scientists Do?

5. A molecule is a combination of two or more atoms held together by forces called \_\_\_\_\_.

ANS: chemical bonds, bonds

PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

6. Compounds are combinations of two or more different elements held together in \_\_\_\_\_ proportions.

ANS: fixed

PTS: 1                      DIF: Easy                      TOP: 2-2 What Is Matter?

7. A(n) \_\_\_\_\_ has more hydrogen ions than hydroxide ions and has a pH \_\_\_\_\_ 7.

ANS: acidic solution; less than

PTS: 1 DIF: Difficult TOP: 2-2 What Is Matter?

8. An organic compound is one that contains one or more \_\_\_\_\_ atoms combined with atoms of one or more other elements.

ANS: carbon

PTS: 1 DIF: Easy TOP: 2-2 What Is Matter?

9. If a macromolecule was a brick wall it would be called a(n) \_\_\_\_\_ made up of repeating units called \_\_\_\_\_.

ANS: polymer; monomers

PTS: 1 DIF: Moderate TOP: 2-2 What Is Matter?

10. Thousands of genes make up a single \_\_\_\_\_, a double helix DNA molecule wrapped around proteins.

ANS: chromosome

PTS: 1 DIF: easy TOP: 2-2 What Is Matter?

11. \_\_\_\_\_ are segments of DNA on chromosomes that contain instructions to make proteins.

ANS: Genes

PTS: 1 DIF: Moderate TOP: 2-2 What Is Matter?

12. Matter quality is a measure of how useful a form of matter is to humans as a resource and is based on its \_\_\_\_\_ and \_\_\_\_\_ in a given area or volume.

ANS: availability; concentration

PTS: 1 DIF: Moderate TOP: 2-2 What Is Matter?

13. According to the \_\_\_\_\_, when a physical or chemical change occurs, no atoms are created or destroyed.

ANS: law of conservation of matter

PTS: 1 DIF: Moderate  
TOP: 2-3 What Happens When Matter Undergoes Change?

14. Body fat of a human or other animal is a type of \_\_\_\_\_ energy.

ANS: potential

PTS: 1 DIF: Moderate

TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

15. Most of the energy from burning a gallon of gasoline is lost as \_\_\_\_\_ energy called heat.

ANS: low-quality

PTS: 1 DIF: Easy

TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

16. Scientists estimate that only \_\_\_\_\_% of the energy used in the U.S. ends up performing useful work.

ANS: 16

PTS: 1 DIF: Moderate

TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

17. A(n) \_\_\_\_\_ occurs when an output of matter, energy, or information is fed back into the system as an input and leads to changes in the system.

ANS: feedback loop

PTS: 1 DIF: Easy

TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

18. There are many types of electromagnetic radiation, each with a different \_\_\_\_\_ and energy content.

ANS: wavelength

PTS: 1 DIF: Moderate

TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

19. A \_\_\_\_\_ is a set of components that function and interact in some regular way.

ANS: system

PTS: 1 DIF: Easy

TOP: 2-5 What Are Systems and How Do They Respond to Change?

20. Any process that increases or decreases a change to a system is called \_\_\_\_\_.

ANS:  
feedback  
feedback loop

PTS: 1 DIF: Moderate

TOP: 2-5 What Are Systems and How Do They Respond to Change?

## ESSAY

1. In recent years, the controversy over whether humans play a major role in global warming was fueled by critics who stated "not enough good science" had been done. Using such concepts as the scientific process, peer review, and reliable science discuss why this may or may not have been an accurate statement.

ANS:

The suggestion that "not enough good science" has two possible emphases: "**not enough** good science" or "not enough **good** science." It is possible to argue that one needs a substantial amount of science before one takes dramatic steps. However, there comes a point at which action must take over from contemplation. As these statements were being made, at least a couple of decades of research had led a substantial number of scientists to conclude humans were substantially responsible for the changes that had been observed. Nothing was to be gained by adding to the volume of work except to delay implementation of steps to counteract the problems.

The second emphasis, that good science had not been done, flies in the face of the scientific process. No scientist would want to be accused of doing "bad" science as that would be very damaging to his or her career. Even more to the point, the process of doing science is self-correcting. After completing research, scientists seek to have their work published in peer-reviewed journals. In those journals peers closely examine and comment on the research and results. When the process is completed, there exists a general agreement on the reliability of the data.

PTS: 1                      DIF: Moderate              OBJ: Critical Thinking  
TOP: 2-1 What Do Scientists Do?

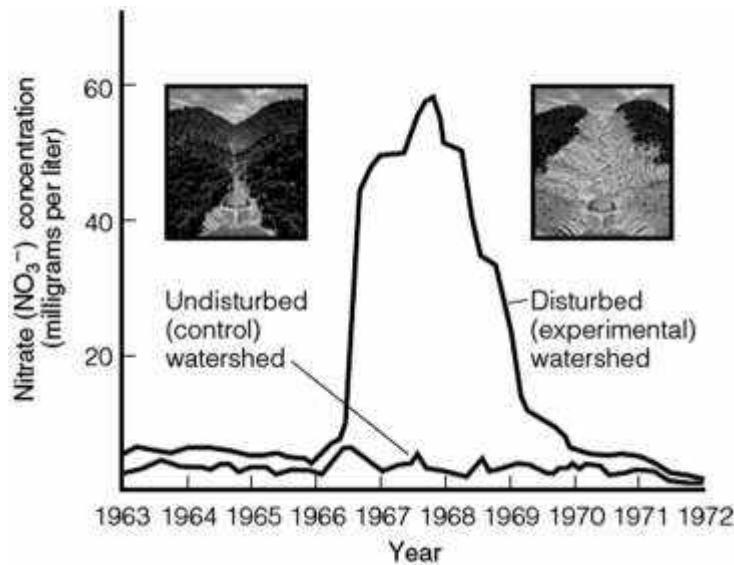
2. Explain how the human body is intimately connected to the two laws of thermodynamics.

ANS:

The first law of thermodynamics says that energy can neither be created nor destroyed, only transformed. This is the basis of the flow of energy from the sun through living systems on earth, including humans. We take in energy in the form of chemicals assembled by other living organisms and transform it, using the energy to do the many things required to live. If any living organism fails to take in and transform energy for their purposes, the second law of thermodynamics takes over. The second law says entropy (randomness or disorder) tends to increase in energy systems. In shortened form, the second law means we will die and decompose. Energy is required to keep a system functioning. When the system is no longer taking in energy, randomness or disorder will increase.

PTS: 1                      DIF: Moderate              OBJ: Critical Thinking  
TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?





3. After looking at the figure above, explain the significant difference that occurred between 1966 and 1970 in terms of the two lines representing the control watershed and the experimental watershed.

ANS:

The line labeled "Disturbed (experimental) watershed" represents the level of loss of nitrates following the removal of vegetation in the experimental watershed. Without vegetation the soil rapidly lost the nitrates to rainfall until they were substantially gone.

PTS: 1                    DIF: Easy                    OBJ: Critical Thinking  
 TOP: Figure 2-6 2-2 What Is Matter?

4. Much of the energy produced is lost before it can become useful. Explain how energy efficiency, or energy productivity, and the second law of thermodynamics may be useful in a discussion with another person on how to reduce CO<sub>2</sub> and other greenhouse gas emissions.

ANS:

Machines that use fossil fuels are very energy-inefficient, converting a small percentage of the energy in the fuel source to useful activities. An effort to increase the level of efficiency would substantially reduce the amount of fossil fuel that needed to be converted and would reduce the amount of emissions of CO<sub>2</sub> and other greenhouse gases.

PTS: 1                    DIF: Moderate                    OBJ: Critical Thinking  
 TOP: 2-4 What Is Energy and What Happens When It Undergoes Change?

5. The population of any organism will increase, if the conditions are correct, until it reaches a point where the population cannot be sustained. This is a type of feedback loop. What type of feedback loop is this and what are the conditions that cause the feedback loop to function?

ANS:

Populations will increase as long as sufficient resources are available. Taking food as an example, the population will increase as long as food is available. At some point the number of organisms will exceed the ability of the system to provide sufficient food. A portion of the population will be weakened and begin to die. If the increase has been very rapid, the population will continue to increase well past where food is insufficient. When enough of the population has died off that food is sufficient, the population will stabilize and may begin to increase once again. This is a negative feedback loop.

PTS: 1                    DIF: Moderate            OBJ: Critical Thinking  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

6. How is the concept of an environmental threshold or tipping point important in regards to global warming?

ANS:

A tipping point is a level at which a critical mass has been reached that causes an event to occur, an event that may be irreversible. If humans cause the climate of the earth to warm beyond a certain level, it may be impossible to correct the situation, and the climate may be irreversibly altered for the worse.

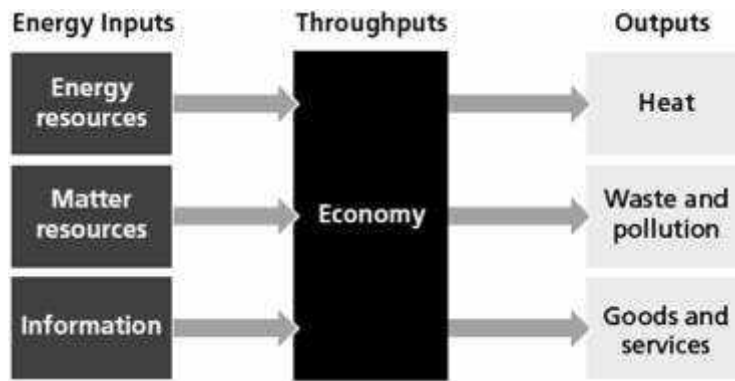
PTS: 1                    DIF: Moderate            OBJ: Critical Thinking  
TOP: 2-5 What Are Systems and How Do They Respond to Change?

7. Differentiate between a hypothesis, a guess, and a theory. Explain why it is important for non-scientists to understand how scientists use these terms when discussing something like global warming or evolution. Why might it be incorrect when a non-scientist dismisses a topic like these as being "just a theory"?

ANS:

A hypothesis is an effort to explain phenomenon based on prior experience with the same or similar phenomena. It is often defined as an educated guess. The usual way to define a "guess" is the suggestion of an answer without prior experience. A theory is a structure intended to explain a series of phenomena, and is constructed from hypotheses that have been tested and not proven wrong. As such, a theory is based on substantial amounts of data.

PTS: 1                    DIF: Moderate            OBJ: Critical Thinking  
TOP: 2-1 What Do Scientists Do?



8. The figure above indicates the general flow within an economic system. For many years this concept has been thought of as indicative of individual nations, or subunits of nations. Now it is increasingly indicative of a global economy. What changes are occurring as a result of this change to the global economy?

ANS:

One change has been the increased volume of resource use, and the increase in the amount of waste heat, waste, and pollution that are generated. As the size of the economy has increased, so too has the volume of input and output. Secondly, the ability to control the system has become much more difficult. Efforts to stem pollution, for example, have become more difficult as the headquarters of a company may be in one country and the factories in another. Thirdly, pollution and resource utilization laws vary from country to country. Making a concerted effort to change is therefore made more difficult. Lastly, it is difficult to suggest to the developing world that they should be made responsible for pollution that has, until recently, been significantly created by the developed world.

PTS: 1                    DIF: Moderate            OBJ: Critical Thinking  
 TOP: 2-5 What Are Systems and How Do They Respond to Change?