Lesson 1. 1

Skeletal, Muscular, and Nervous Systems, p. 2

1. **B** Each bone is composed of living, growing tissue. If a bone breaks, one type of bone cell breaks down the damaged tissue while another type of bone cell begins to rebuild the bone.
2. Bone marrow produces blood cells. The patient who receives a bone-marrow transplant would make blood from the donor's marrow. Assuming the donor's marrow makes healthy blood cells, the patient could then start making healthy blood cells.
3. **A** As people grow older, cartilage can wear down and cause bones to rub together at the knee joint. This can cause pain.
4. The knee would be able to rotate in many directions instead of bending and straightening in only one direction.
5. C The skeletal and muscular systems are interrelated. The muscular system uses muscles to move the bones of the skeletal system.
6. **A** Muscles that are used to control bone movement are all voluntary muscles you can consciously control. These muscles are connected to bones by tendons, which are bands of strong, fibrous connective tissue.
7. **A** Muscles are tissues that contract, which occurs when muscle fibers shorten and pull together. Muscles attach to bones, allowing you to walk, run, throw, dance, or do any other type of activity.
8. If the smooth muscles of the intestines were voluntary, you would have to think to direct the muscles' movement in order for food to be digested and waste to be removed. It might be possible to stay alive this way, but it would be a lot more difficult than just having a system that works without conscious control.
9. Muscles receive electrical signals from the nervous system which enables them to contract or relax.
10. Tendons connect muscles, bones, and joints. If a person had tendon damage, he or she would probably have pain and limited use of the corresponding joint.
11. B At the gap between neurons, called a synapse, the electrical message is changed to a chemical message that is picked up by the next nerve cell.
12. C The nerve pulse travels from the dendrite (C), to the cell body (B), to the synapse (D), and finally to the axon endings.
13. **A** The brain is a complex organ that contains 90 percent of the neurons in the body. And, different portions of the brain control different body functions.
14. The movement away from the cool surface most likely took longer than the movement away from the hot surface. The hot surface likely triggered a reflex response, which bypasses the brain and is therefore faster than other responses.

Lesson 1. 2

Digestive, Excretory, Respiratory, and Circulatory Systems, p. 5

1. **D** The gallbladder helps digest fatty foods. The pepperoni and cheese on the pizza are both sources of fat. The other foods listed consist mainly of either protein or carbohydrates.
2. C Absorption of nutrients occurs in the small intestine.
3.

BEGINNING	mouth	esophagus	stomach	small intestine	large intestine	rectum	END

4. **B** Each nephron is surrounded by a network of capillaries that are critical to the elimination of wastes.
5. **B** Each kidney has about **1** million nephrons—the number is critical to the task of reabsorbing materials and eliminating wastes.

6. **D** Diffusion moves from high pressure to low, so at lower air pressures the gradient between inside and outside the lungs is reduced.

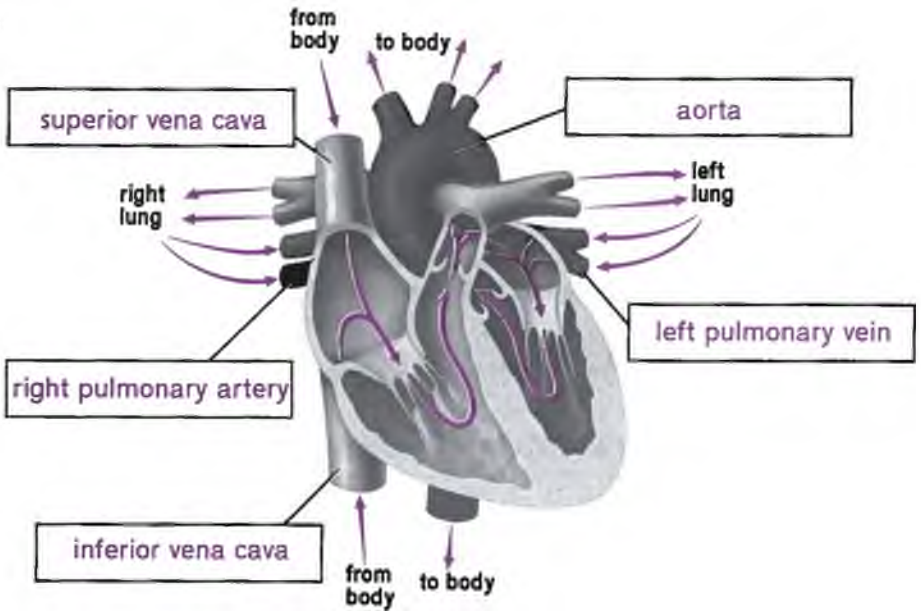
7. **B** Both nephrons and alveoli are tiny structures through which molecules diffuse.

8. **C** The tasks of the circulatory system are to transport and deliver nutrients, gases, and wastes throughout the body.

9. **A** A larger body requires additional oxygen and thus more demand on the heart.

10. **D** The left pulmonary artery transports deoxygenated blood, which has a high percentage of carbon dioxide, to the lung.

11.



12. Blood in vessels drawn in a lighter shade, is returning from different body parts back to the heart and lungs. This blood lacks oxygen. Blood in vessels drawn in a darker has already passed through the lungs and carries oxygen.

Lesson 1. 3

Endocrine and Reproductive Systems, p. 8

1. **C** The stress hormone epinephrine is released from the adrenal gland which means that pathway F is the correct answer choice.

2. The hypothalamus is the part of the brain that controls the pituitary gland, which secretes multiple hormones. These hormones, in turn, trigger body processes either directly at multiple sites, or by controlling other glands that release hormones.

3. **B** Bones, which are part of pathway **C,** release growth hormones. Even if you did not know this fact you could reason that bones increase in size as you grow, so the pathway including bones would be a logical choice.

4. **A** Glands in the endocrine system release chemicals called hormones which travel through the bloodstream to specific cells throughout the body where they carry out their function.

5. The structures that link the endocrine and reproductive systems are called endocrine glands.

6. **C** The fallopian tube is the pathway for an egg to travel from the ovary to he uterus in the female reproductive system, and the urethra is the pathway for sperm to travel outside the body in the male reproductive system.

7. **A** In males, sperm mature in the testes which descend from the lower abdominal region. They are not located in the abdomen.

8. **B** Fertilization of the egg must first occur for reproduction to begin.

9. D Because the mother's and fetus's circulatory systems are linked, substances that enter the mother's bloodstream are transported to the fetus.

10. D Because the mother's and fetus's circulatory systems are linked, waste gases are released by the mother.

11.

Hormone	Site where released	What it affects
testosterone	Testes	sperm production
Estrogen	Ovary	breast development
Progesterone	Ovary	thickening of uterine lining

Lesson 1. 4

Homeostasis, p. 11

1. B The body responds to changes in blood pH by regulating the amount of carbon dioxide in the bloodstream. There is no similar stimulus-response mechanism related to the other physical characteristics listed.

2. A Mobility in the joints cannot be regulated by a stimulus-response system whereas the other examples can be regulated by such a system.

3.

1 D
2 A
3 C
4 B

4. B Because a response is triggered by a stimulus, the stimulus must always occur before the response.

5. Internal stimuli would include hunger, thirst, or a rise or drop in body temperature. Possible external stimuli could include heat, sunlight, cold, and inclement weather.

6. D The maintenance of relatively constant oxygen levels is similar to homeostasis that occurs within the human body. Homeostasis within the body involves maintaining a steady internal environment.

7. The body produces sweat in order to cool down the skin and reduce body temperature.

8. C Unlike nonliving things, living things can exhibit a homeostatic response by regulating changes in order to maintain an internal balance.

9. D Positive feedback involves acceleration of a change in the body. A fever accelerates an increase in body temperature in order to kill an invading pathogen.

10. C From the diagram one can infer that the body functions best with lower levels of blood glucose. When levels are too high, the body responds to lower the levels.

11. Releasing insulin is **the** body's response to the stimulus of absolution of glucose.

12. If the body does not produce insulin, the glucose level in the blood can get dangerously high.

13. B The definition of negative feedback is a mechanism to slow or reverse changes in the body in order to maintain homeostasis.

14. The doctor would need to test the patient's fasting glucose level, then test the patient's level after ingesting glucose, and then test the patient's glucose levels at regular intervals thereafter to determine if the glucose levels are returning to normal.

Lesson 1. 5

Nutrition, p. 14

1. C Fiber is only found in carbohydrates and is necessary for healthy body functioning. The body may not get enough fiber with a diet extremely low in carbohydrates.

2. B In order to receive all of the necessary amino acids, humans should consume plant and animal based proteins since many amino acids are lacking in plants.

3. A Saturated fats are known to raise blood cholesterol, which can lead to health problems such as heart disease.

4. B Minerals such as calcium and potassium are inorganic, meaning they cannot be created by plants or animals, and are essential for many metabolic functions.

5. B In order to determine the healthfulness of a food, it is essential to know its effects, including the health risks and benefits.

6. B Canola oil is lower in saturated fat than olive oil. Each of the other substitutions would increase the individual's consumption of saturated fat.

7. C Canola oil is the highest in polyunsaturated fat according to the graph.

8.

Lunch	Bagel	Nectarine	yogurt
Dinner	Spaghetti	salad	eggs

9. C Based on a 2, 000 calorie diet, two servings with milk would give you 16% of your recommended daily amount of potassium.

10. A Consuming 2 servings of dry cereal would equal 180 calories.

11. If Jiang bums 1, 800 calories per day but consumes only 1, 550 calories per day, it will take him 14 days to lose one pound of fat.

Lesson 1. 6

Disease Prevention, p. 17

1. D Hepatitis is an infectious disease transmitted through the blood. Infectious diseases are caused by pathogens.

2. The sneeze spreads virus-filled saliva through the air. This airborne saliva can be breathed in by an individual, allowing the pathogen to enter and infect that person's body.

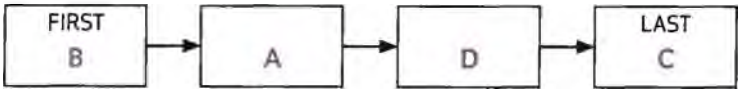
3. D Both infectious and non-infectious diseases disrupt the normal functioning of the body. However, invading pathogens cause infectious diseases like influenza, while non-infectious diseases like cancer are linked to behavior or genetics.

4. B *E. coli* is caused by a pathogen; the other diseases are not. Pathogens must be carried from one host to another. In other words, they require a vector. In this case, contaminated food is the vector.

5. Malaria and bubonic plague are classified as infectious diseases because they are caused by pathogens that invade the body and produce an infection. A pathogen must be carried from one host to another. A vector carries a pathogen from one host to another.

6. D Mucous membrane lines all body cavities exposed to the outside world. The membrane and associated glands secrete a sticky liquid that traps germs and other foreign particles before they can invade cells.

7. C When a pathogen invades the body, antigens on the walls of the pathogen trigger an immune response. White blood cells called B cells and T cells are produced. B cells produce antibodies that attach to the antigens, thereby marking the pathogen for identification and destruction by T cells.

8. 

9. **A** Syphilis is a disease passed on during sexual activity. At this time, there is no vaccine for this STD, and the only preventive measures against acquiring it are behavioral.

10. D *Salmonella* is a food-borne illness caused by bacteria. The pathogen will readily contaminate items, such as knives, used to prepare infected food. Washing the items thoroughly after use and before using them to prepare other food will prevent spread of the bacteria.

11. D Although all cases of disease listed in the chart were dramatically reduced by 1998 attributable to vaccines, only one case of diphtheria was recorded. This suggests that the vaccine was highly effective and the disease was nearly eradicated.

12. In all instances, the number of cases of each disease declined dramatically with the introduction of a vaccine. However, not all vaccines were equally effective. The vaccine for diphtheria seems to have been the most effective, as cases of the disease were reduced to 1 in 1998. The reduction in mumps is also impressive. The least effective vaccine appears to be the pertussis vaccine, where the number of cases after the vaccine remained relatively high after use of the vaccine in 1998.

Lesson 2. 1

Living Things and Their Environment, p. 20

1. **B** This is the only factor listed that does not involve living things, which are considered biotic factors.

2. No, because a population by definition includes only individuals of the same species. You might find two species of lizards but they would not be part of the same population.

3. **C** In a stable ecosystem, the duck and bass populations would not change much in size.

4. Ducks and bass have similar niches in that they both eat small fishes, but their niches differ in other ways. If small fish became scarce, ducks might eat less desirable foods (insects, snails) on the edge of the pond, and bass may go to different depths and/or choose smaller fish, tadpoles, etc.

5.

Research Question	Level of Ecology Studied
How does hurricane damage in a wetland affect the food chain there?	A. ecosystem
How do birds in a flock behave to prevent predators from taking their eggs?	B. population
How does the addition of a bass to a pond affect the populations of other fish species?	C. community

6. **C** Niches are the specific roles organisms play as determined by their adaptations, in this case their means of feeding.

7. **A** This is the only true answer; plants can grow in shallow waters where light can penetrate.

8. **D** Both biomes are highly diverse and lack severe environmental conditions.

9. The labeled biome that is both coldest and driest is A.

10. **B** Tundra is dry and temperate rain forest is wet; the other sequences are incorrect.

11. **D** Desert has highest temperatures and lowest amounts of precipitation.

Lesson 2. 2

Energy Flow and Cycles of Matter, p. 23

1. **B** Producers are the base of food webs in all ecosystems.

2. **D** The role of decomposers is to release nutrients as they sustain themselves on dead matter.

3. **D** The grasshopper is a first-order heterotrophs because it eats producers.

4. A food web could show many other examples of producers besides lettuce, such as radishes, celery, or other crop plants. It could also show other producers that the grasshopper consumes or that are eaten by other consumers in the community. It may also show that consumers other than the mouse feed on grasshoppers, and that consumers other than the hawk feed on mice. A food web would show whether any of the consumers within the community are omnivores or feed at more than one trophic level.

5. **A** Mountain lions are secondary consumers. When ranchers reduced the population of mountain lions, they reduced the population of secondary consumers.

6. **B** Mountain lions, which are second-order heterotrophs, decreased in population size. Deer, which are first-order heterotrophs, increased in population size.

7. **B** Because plants release oxygen, decreasing their numbers would decrease the oxygen released.

8. **D** The scenario, including the overgrowth of algae, is an example of eutrophication.

9.

Effect of ecosystem alteration	Process affected
Loss of trees	Decreased transpiration
Loss of lake	Decreased runoff
Decrease in percolation	Decreased groundwater
Decrease in evaporation	Decreased condensation

Lesson 2.3

Interactions Among Populations, p. 26

1. [1] Select . . . ▼

B. water

[2] Select . . . ▼

C. increase

2. In this scenario, food became a limiting factor. As the **cougar population declined** due to hunting, the deer population increased due to reduced predation. As the deer **population** increased, the availability of food diminished due to competition. Eventually the deer population declined because there was not enough food available to feed all of the deer.

3. According to the following figures, the estimated carrying capacity for this stable moose population in the park is 144. 8 .

4. **A** The graph shows that the population fluctuates only slightly around the line of carrying capacity, meaning that it will remain relatively stable over time.

5. **D** Because the insects are outside of the lake and do not interact with the fish, their population is least likely to affect the population of fish.

6. C The graph shows that in the absence of population-limiting factors, the population would increase exponential, far exceeding the carrying capacity.

7. C In a commensal relationship, one organism benefits from a second organism while the second organism neither benefits nor is harmed. The beetles benefit from the ants, but because the food is not missed, they do not harm the ants.

8. A In a parasitic relationship, one organism takes nutrients from the living body of another organism and, in doing so, may harm but does not immediately kill the other organism. Because the fungus damages and ultimately kills the tree, it is considered a parasite.

9. A In this scenario, hawks are predators of mice. Therefore, as the population of hawks increases, predation increases and the population of mice decreases.

10. A Prey are most likely to benefit from camouflage because they can use it to remain undetected by predators.

Lesson 2. 4

Disruptions to Ecosystems, p. 29

1. C For a time, the volcanic event displaced animals when they fled to safety. When they returned to the area, they carried and dropped, in their dung, seeds of plants new to the recovering ecosystem of Mount St. Helens.

2. D One definition of *avalanche* is a sudden, overwhelming quantity of something. The eruption of Mount St. Helen was preceded by an earthquake. This caused the north face of the mountain to tumble down in a mass of rock and debris—an *avalanche.*

3. D When a river rises above its banks and flows over a floodplain, the floodwaters deposit a layer of nutrient-rich sediment. This adds much-needed nourishing substances to soil depleted by farming.

4. D Among threats to the bald eagle's survival was lead poisoning from eating waterfowl that had been shot with lead bullets by hunters. Therefore, in 1991, lead shot was phased out for hunting waterfowl.

5. DDT was a pesticide. It was banned because birds that were exposed to DDT began to lay eggs with fragile shells. Fragile eggshells may have been one cause of the bald eagle's shrinking population. DDT was banned in 1972, and according to the chart, the bald eagle population began to rise a year or so later. This is most likely because the DDT was no longer affecting the eggshells, so more of the young were hatching successfully.

6. B The release of carbon dioxide into the atmosphere from the burning of fossil fuels has contributed to a rise in global temperatures. This has led to increased melting of polar ice caps and an associated rise in sea levels. These are linked to loss of habitat along shorelines, due to rising water levels.

7. B No matter how well intended the effort, there can be unintended consequences linked to altering an ecosystem. Every organism in an ecosystem plays an important role. When organisms are removed or a new one is introduced, it is not always possible to accurately predict how others in the food chain will be affected.

8. B An ecosystem is a community of organisms that interact with each other and their environment. Whenever overhunting significantly reduces one species, other species in the food chain are affected. These changes influence a community's biodiversity and can disrupt the entire ecosystem.

9. Biodiversity is the variety of species in an area. Before wolves were reintroduced into the park, the elk population had grown sufficiently large to negatively impact the environment. The elk were damaging the cottonwood and aspen trees, which fed beaver and provided homes for birds. This disruption of the ecosystem reduced the populations of beaver and birds, and reduced the biodiversity within the park.

10. According to the passage, wolves increased the biodiversitu of Yellowstone National Park.

11. A In an ecosystem, whenever one species is removed, other species in the food chain are affected. Removal of the wolves from Yellowstone National Park upset the natural balance and reduced the biodiversity of the ecosystem. While the elk seemed to thrive, other species of plants and animals declined. By reintroducing the wolves into the ecosystem, this imbalance may be corrected and equilibrium restored.

Lesson 3. 1

Cells: Basic Units of Life, p. 32

1. **B** Both paragraphs address various ways in which the theory that microscopic life can arise on its own out of nonliving matter was disproven.

2. **A** The passage explains that spontaneous generation was disproved by the fact that once microbes such as bacteria are killed, they do not lead to new life forms. Therefore, spontaneous generation holds that living things can be created from nonliving things.

3. Once all of the bacteria on the instruments are killed, they do not reappear. This shows that living organisms cannot create themselves out of nonliving matter.

4.

Variable	Type
Time	Independent
Cheesecloth	Independent
Maggots	Dependent

5. **D** Redi's experiment shows that maggots cannot arise out of thin air, which is the basic tenet of the theory of spontaneous generation.

6. **C** Allowing the meat to be exposed to air, but not the flies, proved that maggots were created by flies. This showed that maggots do not spontaneously appear and are not created by microorganisms in the air.

7. **B** Nerve tissue is responsible for relaying sensory information.

8.

1. A

2. C

3. B

4. D

9. **D** Large cells require a large surface area in order to absorb enough materials to support cell metabolism. They require more materials than small cells because they have greater metabolic needs.

10. **C** Epithelial tissue is responsible for forming linings and coverings for body parts.

11. Blood **is** considered a type of connective tissue.

12. Cell specialization allows each cell to function more effectively because it is equipped to do a specific job.

13.

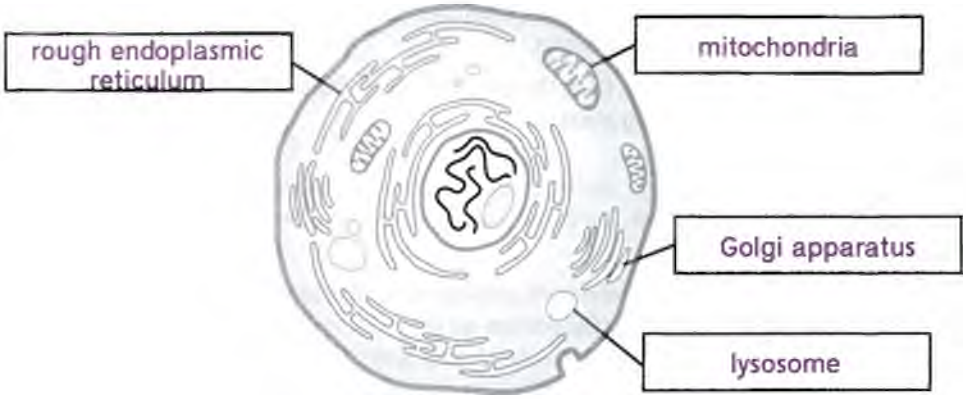
Tissue type	Function
Connective	A
Epithelial	B
Muscle	D
Nerve	C

Lesson 3. 2

Cell Structure and Function, p. 35

1. **B** The cell membrane controls how substances pass into and out of a cell.

2. **A** Vacuoles are a place where cells can store resources and wastes. Therefore, cells in an orange would use vacuoles to store water.

3. 

4. **D** The purpose of chloroplasts is to convert sunlight into energy in the form of glucose. Organisms that obtain energy in the form of glucose from other sources do not require chloroplasts.

5. Unlike prokaryotic cells, eukaryotic cells have a nucleus and organelles enclosed by membranes.

6. **B** The cell wall is a rigid outer layer that supports the cell and protects it from harm.

7. **B** The cell wall is the only cell part listed that plant and animal cells do not share.

8. **A** The passage states that bacterial cells do not contain a nucleus.

9. **D** Binary fission applies to genetic material that is not bound by a nucleus. Therefore, eukaryotic cells cannot engage in binary fission.

10. **D** In diffusion, substances move from areas of high concentration to low concentration until equilibrium is reached. Therefore, diffusion allows substances to spread evenly throughout the body.

11. In active transport, carrier proteins are needed to move materials across the cell membrane. Active transport involves the movement of materials from an area of low concentration to an area of high concentration. Because the materials are moving in the direction that is against their concentration gradient, carrier proteins must use energy and do the work of transporting them.

12. **D** The passage states that diffusion works by moving the substance from an area of high concentration to an area of lower concentration.

13. **C** Cells use active transport to reverse diffusion, and carrier proteins are essential to the function of active transport.

Lesson 3. 3

Plant Structure and Function, p. 38

1. **A** Mosses are nonvascular plants, lacking vascular tissue to move water and other materials inside the plant. They must take water directly into their cells through osmosis, so they must grow close to a water source. Their life cycles are tied to damp places.

2. **C** Gymnosperms are vascular plants that produce seeds that are not enclosed within a fruit, but form seeds in cones. The leaves of most gymnosperms are scale-like or needle like.

3. **B** In science, a dependent variable is the variable that reacts to other variables, specifically the independent or manipulated variable, in an experiment. In this experiment, plant movement is influenced by, or dependent upon, the amount of light (manipulated variable) to which the plant is subjected.

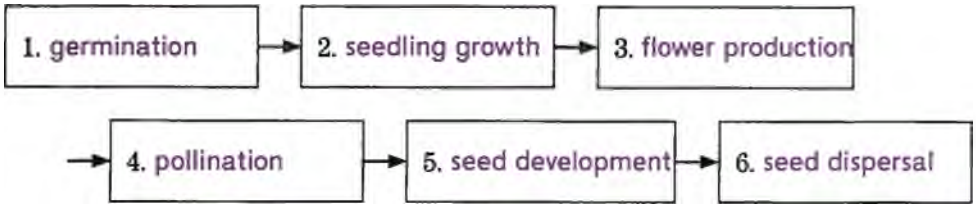
4. Ferns, redwoods, and orchids are all example of vascular plants.

5. Both gymnosperms and angiosperms are vascular plants. They both produce seeds. However, the seeds of a gymnosperm are not enclosed within a fruit, as they are with an angiosperm. Also, a gymnosperm does not produce flowers, while an angiosperm does.

6. D When conducting a study, well-focused questions will yield the best data. Maple tree fruit is designed to be dispersed by wind. Therefore, to study the dispersal range of the maple tree seeds, a key question to consider is how the winged traits of the fruit will interact with wind, affecting the dispersal.

7. Nonvascular plants take in water only through osmosis. They must stay in contact with moisture so that water can flow in or out of their cells as needed. Therefore, they are tied to damp places and grow close to the source of water.

8. A Nonvascular plants take in water from their surroundings through osmosis. Hot, dry conditions would increase the evaporation rate of water from the surrounding environment and thus lower the water concentration in the environment. Therefore, water molecules would move from a place of higher concentration of water inside the plant cells to a place of lower concentration of water in the environment.

9. 

10. C An organic molecule is any compound of carbon and another element or a radical. A carbohydrate is a large organic molecule consisting of carbon (C), hydrogen (H), and oxygen (0) atoms.

11. B Unused energy in plants takes the form of carbohydrates, such as starch and sugar, and lipids. Taproots serve primarily as a storage organ for the food and energy sources produced by plants.

12. D In angiosperms, flowers are the main reproductive organs of a plant. Sepals are the green leaf-like structures surrounding the bud. Their function is to protect the delicate tissues inside.

13. D In angiosperms, flowers are the main reproductive organs of a plant. The stamen, the male reproductive organ, consists of an anther, which produces pollen grains. Pollen grains contain the sperm that will fertilize the plant eggs.

Lesson 3. 4

Energy and Cells, p. 41

1. **B** According to the graph, the blue and orange ranges contain the highest spikes in the percent of light absorbed.

2. D A speculative statement cannot be substantiated by the evidence provided. Although chlorophyll that absorbs blue light is mentioned in the data, the concept of evolution is not.

3. D The graph shows that green light is not absorbed by the chlorophyll. Therefore, the plant most likely is green in color, and mushrooms are the only option that is not green in color.

4. B The passage states that during photosynthesis, plant cells use sunlight as an energy source to produce sugar, which is considered a form of chemical energy.

5. C A speculative statement cannot be substantiated by the evidence provided. Although respiration is mentioned in the passage, its potential to power medical devices is not.

6. C Cellular respiration breaks down glucose whereas photosynthesis creates glucose. Therefore, the reactions work in reverse of each other.

7.

Stages of Cellular Respiration
1. A
2. D
3. B
4. C

8. **C** Oxygen does not appear in the equation; therefore it is considered anaerobic (a term applied to chemical processes that do not require oxygen).

9. Oxygen does not appear in the fermentation equation. Therefore, cells that lack access to oxygen can utilize this process to release stored energy.

10. **A** Cellular respiration is a more efficient process than fermentation; therefore it produces more energy than fermentation.

11. **A** Whereas cheese and yogurt rely on lactic acid fermentation and alcohol relies on alcohol fermentation, butter relies on the process of churning cream, not fermenting it.

12. **C** In cellular respiration, two molecules of ATP provide the energy to break a glucose molecule down into two molecules of pyruvate and produces two molecules of ATP. However, during lactic acid fermentation, the pyruvate is changed into lactic acid instead of more ATP molecules.

Lesson 3. 5

Mitosis and Meiosis, p. 44

1. Prokaryotes reproduce through binary fission while eukaryotes undergo a process known as the cell cycle. The DNA of eukaryotes is contained in a nucleus whereas in prokaryotes it is not bound to a nucleus.

2. **A** During the gap phases, cells must expand in size in order to accommodate the processes of replication and dividing in the other phases.

3. **A** The purpose of cell division is to create two identical cells. Therefore, in preparation the cell must create two sets of identical genetic information and create enough cellular material to create two cells.

4.

First
C
B
D
A
Last
E

5. **B** The purpose of the diagram is to show the process of cell replication, the most important feature of which is the duplication of genetic material, or chromosomes.

6. **B** During anaphase, the third stage, spindle fibers shorten and split the centromeres apart. As the fibers continue to shorten, sister chromatids move to opposite ends of the cell.

7. C Each sentence in the passage is focused on the various circumstances under which mutations can arise during cell replication.

8. C The passage states that after a chromosome is replicated, a mutated gene can be passed on. Therefore, it can be inferred that genes are part of a chromosome.

9. C During telophase I, spindle fibers break down. Chromosomes uncoil and nuclear envelopes form, creating two nuclei.

10. The two cells created in the diagram must undergo a second round of cell division, known as meiosis **II**, in order to create a total of four cells. Each of these four cells has only half the number of chromosomes as the two cells shown in telophase I in the diagram.

11. **A** During meiosis, or sexual reproduction, the nucleus divides twice to reduce the number of chromosomes by half. Sister chromatids must be split apart in Meiosis II in order to split the number of chromosomes in half.

12. The protein structures responsible for pulling apart the chromosomes during cell division are known as spindle fibers.

13. All of the cells in the human body contain 46 chromosomes except for the gametes, which cannot carry the same number of chromosomes as those of other parts of the body.

14. **B** Zygote cells, created by the union of gametes, reproduce by mitosis because they have the full number of required chromosomes. Gametes, or sex cells, must reproduce by meiosis because they have only half the number of chromosomes.

Lesson 4. 1

Basic Principles of Genetics, p. 47

1. **C** 20 percent of the population has the dominant trait, so 80 percent has the recessive trait.

2. **B** The data show that dominant alleles are not the most common type of allele in the three populations shown so it is reasonable to conclude that dominant alleles are not always the most common type of allele in a population. There is not enough information, however, to make the conclusion that dominant alleles are almost never the most common type of allele.

3. Population **C** has the greatest number of individuals with the dominant trait. In this population, there are 40 individuals with the dominant trait.

4.

Traits Exhibited	Allele Combination
tall plant with white flowers, round seeds, and green pods	GgppTTWW
tall plant with purple flowers, round seeds, and green pods	GGPPTtWw
short plant with purple flowers, wrinkled seeds, and yellow pods	ggPpttww

5. **A** The table shows pea plant traits that have two forms, one dominant and one recessive. Most traits are not inherited through such simple patterns.

6. **B** All statements are false except the statement that sister chromatids are present only after replication. During replication, a strand of DNA makes an exact copy. The two exact copies are called sister chromatids.

7. Heredity occurs through chromosomes, which are passed from parent to offspring. A person has homologous pairs of chromosomes, one from each parent. Genes are found along the chromosomes. Genes determine traits. For example, Mendel's pea plants had genes for flower color and seed shape. Alleles are different forms of a gene. Mendel's pea plants had two alleles for each trait he studied. Flower color, for example, had an allele for white flower color and an allele for purple flower color.

8. 1 Select . . . ▼

D. chromosomes

2 Select . . . ▼

B. mitosis

9. D Gametes are necessary to the process of sexual reproduction, such as pollination and fertilization. The other processes listed do not involve the production of gametes.

10. C Meiosis reduces the number of chromosomes in a cell by one half. This allows the preservation of the appropriate chromosome count when two gametes unite in fertilization.

11. **B** This is the only combination that includes one allele from each of the allele pairs possessed by the parent—the gamete must have one and only one allele from each pair.

Lesson 4. 2

Probability of Traits, p. 50

1. **B** In pea plants, green seed color is the recessive trait. In order to express the recessive trait, a pea plant that has a green phenotype must have two recessive alleles, as represented by the genotype *yy*.

2. C An organism with two different alleles for a trait is heterozygous for that trait. The genotype *Pp* denotes a trait expressed by one dominant allele and one recessive allele.

3. The phenotype of an organism describes its physical traits. Genotype describes the genetic makeup of an organism. Genotype determines the phenotype of an organism based upon what combination of dominant and recessive alleles the genotype contains. For example, tallness is a dominant trait in pea plants. The phenotype of a tall plant is described as tall, but its genotype may be made up of two alleles for tallness (*TT)* or one allele for tallness and one for shortness (*TV*). By contrast, a pea plant whose phenotype is short, can have only one genotype (*tt*) because this plant must inherit two recessive alleles in order to display the shortness trait.

4. **D** A combination of alleles influences an organism's phenotype. In order to express a recessive trait, such as standard ears, an organism must have two recessive alleles. Based on the Punnett square predictions, each kitten has only a 25% change of inheriting two recessive alleles for standard ears. Each kitten has a 75% change of inheriting at least one dominant allele and, therefore, expressing the curled ear trait.

5.

	Y	y
Y	YY	Yy
y	Yy	yy

6.

	R	***R***
R	RR	RR
r	Rr	Rr

7. In the cross shown, *R* represents round seeds and r represents wrinkled seeds. Based upon this information, the probability that an offspring from this cross will have wrinkled seeds is 0%.

8. The Punnett square indicates that 100% of the offspring will have round seeds because each offspring inherits at least one dominant allele (*R*) for the trait. Of the offspring produced, 50% are expected to be homozygous for round seeds (*RR)* because each of these offspring will inherit a dominant allele from each parent. The remaining 50% will be heterozygous for round seeds because they will inherit only one dominant allele for the trait from the two parents.

9. **C** Blood groups in humans are determined by more than one pair of alleles.

10. **A** *X* and *Y* chromosomes are sex chromosomes that determine sex (male or female). Genetic males carry one *X* and one *Y* chromosome.

11. The probability is 12. 5%.
2 16 = 0. 125
1. 25 x 100 = 12. 5%

12. **B** To be a carrier for colorblindness, a daughter needs to receive the allele combination X^CX^c. There is only a 25% change for an offspring resulting from this cross to have this genotype.

13. The designation X^c and/or X^c in the Punnett square indicates that color blindness is a sex-linked trait carried on the X chromosome.

14. **D** Like color blindness, hairy ears is a sex-linked trait. However, the recessive gene for hairy ears is carried on the *Y* chromosome. Genetic males carry one *X* and one *Y* chromosome. Genetic females carry two *X* chromosomes. Therefore, only male children are able to inherit the Y-linked trait for hairy ears, whereas male and female children can inherit the genotype for color blindness.

Lesson 4.3

Common Ancestry, p. 53

1. **A** Trilobite fossils have been found in layers of sedimentary rock deep in the Grand Canyon, while coral fossils are found in layers along rim of the canyon. Lower layers of rock are older than upper layers. Therefore, a fossil in a lower layer must be older than a fossil in an upper layer.

2. **A** Darwin proposed that all forms of life change over time. He also proposed that, as the environment changes, organisms must adapt in order to survive. Organisms that are not able to adapt will die out.

3. 1 Select . . . ▼ A. species

2 Select . . . ▼ B. interbreed

3 Select . . . ▼ C. offspring

4. **D** The theory of UCA proposes that every living organism may be linked back to a single common ancestor. The similarity in genetic material shared by seemingly unrelated organisms offers support of this theory of a shared common ancestor.

5. Adaptation is a change in a species that makes it better suited for its environment. As organisms adapt, they develop and pass on new traits to the next generation. In time, some members of a population may become isolated from the original population. Through adaptation, this new group will develop its own distinct traits, passing them on until the group is so changed that it no longer is able to reproduce with the original population. It is then considered a new species and has added to the biodiversity of life.

6. **A** The theory of UCA suggests that the ancestry of every organism that ever lived can be traced back to a single primitive ancestor. A cladogram shows evolutionary relationships and the points where species appear to have diverged from common ancestors.

7. **B** Cladograms demonstrate the evolutionary relationships among organisms. They are organized around structural traits shared by related organisms. The more structural traits that two organisms share, the closer their evolutionary relationship.

8.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Choose the species you would like to compare.	Choose structural traits to compare.	Make a table matching organisms and traits.	List or draw each organism.	Draw circles around the species that share a trait.	Use this information to construct a cladogram.

Lesson 4. 4

Heredity: Genetic Variations and Expression, p. 56

1. **C** The illustration shows the process of crossing over. During this process, DNA from the father and DNA from the mother is exchanged along the chromosomes. As a result, each gamete receives a new combination of genes, which adds to the variety of traits within a population.

2. **C** Linked genes are genes that are found on the same chromosome. Because they are found on the same chromosome, linked genes are usually inherited together. If crossing over occurs between the positions of two linked genes, then the linked genes can be separated.

3. **A** Before a cell can reproduce, it must first replicate, or make a copy of, its DNA. Chemicals in the body induce cells at the site of a wound to begin the process of replication and reproduction to repair the injury.

4. **C** A mutation is a random, permanent change that occurs in the genetic material of a cell. Mutations can be caused by errors during normal processes related to genetic material and are often expressed in serious diseases, such as cancer or cystic fibrosis.

5.

Genetic Information Lost (switched or added at the chromosome level)	Error in DNA Coding within Egg or Sperm Cells	Errors During Replication that affect Body Cells
1. Down Syndrome 2. May be passed on, parent to child.	3. Cystic fibrosis 4. May be passed on, parent to child	5. Cancer 6. Cannot be passed on, parent to child.

6. 1 Select . . . ▼

A. crossing over

2 Select . . . ▼

D. matching chromosomes

7. **C** During the process of cell replication, an extra copy of DNA is made. When the bacteria cell containing human DNA reproduces, a copy of all the DNA in the cell is made. As the bacteria cells continue to reproduce, the DNA of each cell copy will contain human **DNA.**

8. **As** used **in** the passage above, the word trait means **a quality or characteristic that is genetically determined.**

9. **A** During the process of cell replication, an extra copy of DNA is made. As the cells continue to divide, each new cell contains another copy of the DNA. When the bacterial cell containing human DNA reproduces, every cell produced also contains human DNA

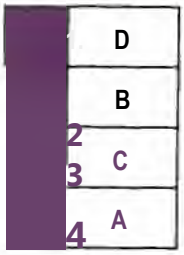
Lesson 4. 5

Selection and Adaptation, p. 59

1. **C** Darwin's observations of variations in the shells and necks of the tortoises on the Galapagos caused him to question why and how these differences arose in the species.

2. **A** Darwin's observations of the different finch species enabled him to recognize that the beak shapes of the finches differed according to the types of food they ate.

3.



4. C Mimicry occurs when a harmless organism looks like a different, more dangerous organism. The ability of a nonpoisonous pine snake to vibrate and rattle its tail helps it to escape predators that mistake the snake for a poisonous rattlesnake.

5. D The birds with large beaks would starve because their beaks are not well suited for the small seeds. They have too much beak mass to easily manipulate small seeds.

6. 1 Select . . .

B. camouflage

2 Select . . .

A. mimicry

7. A Observations of the foots structure of the birds and the ways in which the birds move about in their environments reveal that the webbed feet of the duck is an adaptation that is suited to swimming and the long, wide toes of the heron are adapted to walking or wading through water.

8. Kangaroos and koalas are examples of adaptive radiation because both species evolved from a common ancestor, but have adapted different structures that help them survive in their environments. Both kangaroos and koalas are marsupials, a characteristic which indicates that they share a common ancestry. However, each animal is suited to a very different lifestyle. For example, a kangaroo is suited to life on the ground and is able to travel long distances to obtain food. By contrast, a koala is small and spends most of its time in the eucalyptus trees it uses as food.

9. C A species is defined as a group of potentially interbreeding individuals. When the environment has changed so much that new species arise, it is unlikely they will still be able to reproduce with each other. Each species' genetics will be different enough that they are not compatible with each other.

Lesson 5. 1

Motion, p. 62

1. C There are three points on the graph where the speed is 7. 8 m/s: 4 s, 22 s, and 31 s. Of these, only 31 s is given as an answer choice.

2. B Deceleration is indicated by a line with a negative slope, such as between 0 and 5 seconds, and again between 30 and 35 seconds.

3. A The car's initial speed is 6 m/s at 10 s, and its final speed at 30 s is 9 m/s. Acceleration = $\frac{(9\text{ m/s} - 6\text{ m/s})}{(30\text{ s} - 10\text{ s})} = \frac{(3\text{ m/s})}{20\text{ s}} = 0.15\text{ m/s}^2$

4. D The difference between the plane's final and initial positions is 75 km, and the difference in the plane's final and initial times is 9. 0 min. Convert the time to hours by dividing 9. 0 min by 60 min/h, and recall that velocity consists of speed and direction.

$$\text{velocity} = \frac{(75\text{ km, east})}{(9\text{ min}/60\text{ min/h})} = \frac{(75\text{ km, east})}{(0.15\text{ h})} = 500\text{ km/h, east}$$

5. If the cart has no acceleration, it has constant velocity. As velocity has both speed and direction information, and velocity is constant, then both speed and direction are unchanging. Because an object at rest has a constant speed of 0, the cart at rest is a special case of zero acceleration.

6. C Because force is the slope of the line, it follows that the smaller the force required to change the momentum of an object, the greater the interval of time that is required to make that change. Another way of putting this is that the line with the smallest slope (force) is the line that extends over the longest interval of time.

7. B Find the position on the horizontal axis that corresponds to 7. 50 s (halfway between 5. 00 and 10. 0 s), and note which point on each line corresponds to 4700 kg • m/s (slightly below the 5. 00 x 10^3 kg • m/s mark). This point is designated B.

8. C You need to use the information provided to calculate momentum:
momentum = mv = (52. 0 kg)(4. 5 m/s, south) = 234 kg • m/s, south

9. C From the law of conservation of momentum, initial momentum of the system = final momentum of the system, or

$$m_{water}v_{water,initial} + m_{student/bucket/board}v_{student/bucket/board,initial} =$$
$$m_{water}v_{water,final} + m_{student/bucket/board}v_{student/bucket/board,final}$$

Because everything is initially at rest, this equation simplifies to

$$-m_{water}v_{water,final} = m_{student/bucket/board}v_{student/bucket/board,final}$$

Inserting the values, and noting that the mass of water must be subtracted from the total system mass, $-(10.0\text{ kg})(2.50\text{ m/s, south}) = (80.0\text{ kg} - 10.0\text{ kg})v_{student/bucket/board,final}$

Rearranging the equation:

$$v_{student/bucket/board,final} = \frac{(-25.0\text{ kg} \cdot \text{m/s, south})}{(70.0\text{ kg})} = -0.357\text{ m/s, south, or}$$
$$v_{student/bucket/board,final} = 0.357\text{ m/s, north.}$$

10. Suppose the mass of the balloon equals 0. 010 kg, and the balloon moves to the right with a uniform speed of 0. 10 m/s. The total momentum (momentum = mass x velocity) of the balloon-air system is 0 kg • m/S. The law of conservation of momentum states that if no other forces act on the objects, their total momentum remains the same after they interact. Because the balloon and air are initially at rest (a constant speed of 0 kg • m/s), the combined momentum of the released air and the moving balloon equals 0 kg • m/s.

11. B When the system is initially at rest, the balloon moves to the right with the same momentum as the air moves toward the left. If the balloon already has motion to the right, the extra momentum will cause it to continue even faster in that direction.

Lesson 5. 2

Forces and Newton's Laws of Motion, p. 65

1. The man exerts a force of 40 N on the table (F_A), while the woman exerts a force of 60 N (F_B). The net force (F_{net}) acting on the table is 100 N.

2. C You need to calculate acceleration using the information given:

$$a = \frac{F_{net}}{m};\ a = 60\text{ N} + 60\text{ N} \div 10\text{ kg};\ a = 120\text{ kg} \cdot \text{m/s}^2 \div 10\text{ kg};\ a = 12\text{ m/s}^2$$

3. D The more mass an object has, the greater its inertia.

4. The water exerts a reaction force of equal magnitude in the opposite direction on the boat which causes it to begin moving. To remain in one place, the action and reaction forces need to balance each other by acting on the same object with the same magnitude of force in opposing directions. Here, the action and reaction forces have the same magnitude per Newton's third law of motion, but the forces are not acting on the same object because the action force is transmitted by the oars to the water, but the reaction force acts on the boat. As a result, the boat is pushed through the water.

5. **D** **You need to calculate average acceleration using the information given:**
$\frac{a = F_{net}}{m}$; $a = 15\ N + 30\ N \div 30\ kg$; $a = 45\ kg \cdot m/s^2 \div 30\ kg$; $a = 0.75\ m/s^2$

6. Gravity and magnetism are examples of action — at — a — distance forces. Such forces are able to exert a push or a pull on another object without being in direct contact with the object. By contrast, friction is a contact force that acts only on objects that are physically touching or in contact with each other.

7. The force is less than 30 N to the right. The rope will move in the direction of the larger force, so the pulling force of 30N to the left must be greater than the pulling force to the right.

8. **D** Motion results when unbalanced forces act on an object Thus when the forces acting on an object are balanced and the net force is 0, no movement occurs.

9. The diagram shows five pairs of balls. The gravitational force is weakest between the balls shown in pair number 1 and strongest between the balls shown in pair number 4.

10. 1 Select . . .

D. decrease by one-fourth

2 Select . . .

A. double

11. **C** You need to calculate weight using the information given:
$W = mg$; $W = 50\ kg \times 9.8\ m/s^2$; $W = 490\ kg \cdot m/s^2$; $W = 490\ N$

12. **D** You need to calculate mass of the individual on Earth and acceleration due to gravity on Jupiter using the information given:

To find mass on Earth:
$W = mg$ or $\frac{W}{g} = m$; Earth weight is $\frac{539\ N}{9.8\ m/s^2} = m$; $539\ kg \cdot m/s^2 \div 9.8\ m/s^2 = m$; $m = 55\ kg$.

To find acceleration due to gravity on Jupiter:
$\frac{W_{Jupiter}}{m} = g$; $1{,}273.8\ kg \cdot m/s^2 \div 55\ kg = 23.16\ m/s^2$

Lesson 5. 3

Work and Simple Machines, p. 68

1. **A** Work is measured in newton-meters, or joules (J). The newton (N) is a unit of force. The watt (W) is a unit of power. Meter per second squared (m/s^2) is a unit of acceleration.

2. **D** First find force. $F = 10\ kg \times 4\ m/s^2 = 40\ N$. Then use the force to find work.
$W = 40\ N \times 30\ m = 1200\ J$.

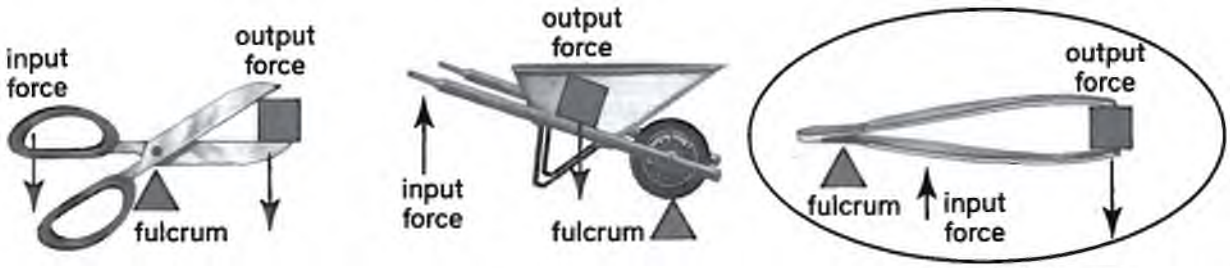
3. LEAST 1. Trey → 2. Sameel → 3. Sarina → GREATEST 4. Carlos

4. **B** An inclined plane is a simple machine that requires the user to exert a smaller force over a longer distance. Wedges and screws are both types of inclined planes.

5. Although the distance and force change, the work is the same in each case—10 J. So they need to revise their hypothesis to indicate that the ramp decreases the force they need to exert to do the work, but does not change the amount of work they need to do. A new hypothesis might be: If the length of the ramp increases, then the force required to move the box decreases.

6. 1) All three levers are simple machines are levers that consist of a rigid part that rotates about a fulcrum. 2) They all make work easier in some way.

7.



8. A Substitute the given information into the equation for mechanical advantage: $MA = \frac{720\ \text{N}}{60\text{N}} = 12.$

9. C Mechanical advantage is equal to the output force divided by the input force. If distance is multiplied, then force is decreased. As a result, the output force is less than the input force so the mechanical advantage is less than 1.

10. B The force required is least for Setup A and greatest for Setup C. This means that the mechanical advantage is also greatest for Setup A and least for Setup C. In terms of lengths, the diagram shows that length x is least and y greatest for Setup A. Therefore, the ratio of y to x is greatest for Setup A. As this ratio increases, the mechanical advantage must increase.

11. A Substitute the given information into the equation for mechanical advantage: $MA = \frac{1800\ \text{N}}{900\ \text{N}} = 2.$

12. If the mechanic alters the design of the pulley system, the mechanical advantage becomes 6. **The** force that will he required to lift the engine will be 300 **N** _____.

Lesson 6. 1

Types of Energy and Energy Transformations, p. 71

1. D The skateboard has a gravitational force acting on it, and which will do work on the skateboard in pulling it downward to the bottom of the incline. Therefore its initial potential energy is gravitational.

2. A You need to calculate gravitational potential energy given the information provided:
$GPE = mgh = (6.50\ \text{kg})(9.81\ \text{m/s}^2)(3.20\ \text{m}) = 204\ \text{J}$

3.

KE (J)	Mass (kg)	Speed (m/s)
6. 00	0. 750	4. 00
4. 69	1. 50	2. 50
12. 00	1. 50	4. 00
2. 34	0. 750	2. 50
0. 844	0. 750	1. 50

4. **A** photovoltaic cell uses energy from **sunlight** _____.

5. B The photocell converts incoming radiant energy (such as sunlight) to electrical energy.

6. A The magnetic field that 0rsted observed was present around a wire carrying electric current. Therefore, the current (moving electrons) are believed to cause the magnetic field.

7. D The electrical current from the wire would create a magnetic field, which would cause the magnetic compass needle to move.

8. B At $d = 0$, the block is at the highest point on the incline plane, so all of its energy is gravitational potential energy.

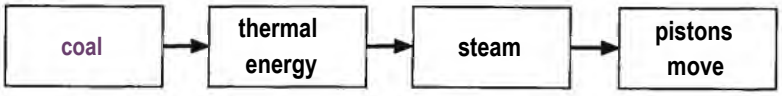
9. D Kinetic and potential energy change as the speed and position of the block change. As potential energy decreases, kinetic energy increases. However, the total mechanical energy (the sum of potential and kinetic energies) is a constant.

10. The sloping line would indicate a decrease in total mechanical energy (that is, kinetic plus gravitational potential energy). Because energy is conserved, this means that the "lost" energy takes a different form, which in this system would be a gain in heat, caused by an increase in the kinetic energy of the particles making up the block and plane. This increase would be caused by friction between the block and the plane.

Lesson 6. 2

Sources of Energy, p. 74

1. B Atoms split apart, or decay, when hit by high-speed neutrons in a nuclear reactor.

2. 

3. A The use of nuclear energy does not pollute the air since there is no combustion of fossil fuels.

4. The word **finite** as used in the statement means **nonrenewable or limited**.

5. Based on the statement, you can infer that the use of natural energy sources causes **pollution or air pollution**.

6. A Biomass is organic matter. When either burned directly or processed into another type of fuel it is burned and then causes pollution.

7. A Since the population of the planet is growing and there are people with not enough to eat some people are concerned that using land that is currently growing food crops to grow crops for energy could cause food shortages.

8. C Since biomass can be converted into fuels it then can be easily transported.

9. I would not support the measure. I think it would be good if people could do so, but making it so people had to use a renewable energy source for heating and cooling would be unfair. It could be too expensive for some people. Also it mag be difficult in some areas to obtain a source of renewable energy.

10. B If you were to draw a line in the direction that both petroleum and natural gas are going, the lines would cross around the mark for 2020.

11. C Nuclear is about at 8 quadrillion btu and natural gas is about 26 quadrillion btu. Petroleum is close to 34 quadrillion btu which is the same as nuclear and natural gas added together.

12. A These are political situations and the technology requires spending. Since there is a limited amount of money and other areas that need money it involves money and some of that is taxpayer money.

13. Technology can have causes that have political considerations. Fracking is a process that is controversial because of possible harm to the environment. It is a political question because people must make decisions after judging both the plus and minuses of a development.

Lesson 6. 3

Heat, p. 77

1. A The greater the average kinetic energy of particles in a substance, the greater the temperature of the substance. Heat flows from substances at higher temperature to the substances at lower temperature. Therefore, heat involves the transfer of the kinetic energy between particles in substances at different temperatures.

2. B The iron atoms have greater average kinetic energies than do the water molecules, so the energy is transferred by heat from the iron to the water. This continues until both substances are at the same temperature.

3.

Energy	4.3×10^{-21} J	2.4×10^{-20} J	1.9×10^{-21} J	3.2×10^{-21} J	1.2×10^{-20} J
Temperature	205 K	1140 K	90 K	155 K	575 K

4. C In the radiator, heat conducts energy from the parts of the radiator that are at higher temperatures (the fluid inside the radiator), to the outer surface, which is closer to the temperature of the surrounding air.

5. C In convection, a fluid that is heated expands and becomes less dense. This causes it to move upward from the heat source and displace the fluid that is there. This cooler fluid moves downward, where it is heated, expands, and rises upward.

6. A Thermal conduction in a crystal requires particles that can move easily through the material, and so transfer kinetic energy from one part to another. The electrons in substance A can do this, so substance A is a better conductor of heat than substance B.

7. C As the car moves along the road, friction between the road and tires causes the rubber of the tires to heat. This heat is transferred to the air inside the tires, which causes it to expand. If the tires are overinflated when the air is cool, the expanded heated air may cause the tire to rupture in a "blowout."

8. A If the drill bit becomes too hot, it can be damaged. Friction between the rotating drill bit and the material being drilled increases the temperature of both as mechanical energy is converted to thermal energy. By spraying water, which has a large specific heat capacity, onto the bit, the bit's temperature can be kept low and damage prevented.

Lesson 6. 4

Waves, p. 80

1. C All waves, whether they require a medium (mechanical waves) or not (electromagnetic waves), involve vibrations.

2. B The disturbance in a medium indicates that energy is present, yet there is no loss of energy in an ideal wave. The amount of energy that causes the disturbance is transferred entirely to the end of the wave.

3. The energy from the explosion is carried through air by waves. These waves are heard as a boom through sound waves in the air, but also transfer energy to the windows, shaking them. This energy is transferred back as a sound wave in the air, and is heard as the rattle of the glass.

4. The disturbance is evidence that suggests the presence of mechanical energy, which has caused the disturbance. The motion of uniform, repeated disturbances in the form of rising and falling water is evidence that indicates the presence of waves, which are transferring the energy from the point of disturbance to another location. The motion of the buoy, which rises and falls but does not move forward with the disturbances, indicates that matter is not transferred with the energy. Given this evidence, I can conclude that the disturbance is a wave.

5. C $v = f \times \lambda = 25\ \text{Hz} \times 0.030\ \text{m} = 0.75\ \text{m/s}$

6. 1 Select . . . ▼ A. crest
2 Select . . . ▼ B. trough
3 Select . . . ▼ A. transverse
4 Select . . . ▼ C. amplitude

7. D The light from a lightning flash travels at 300, 000, 000 meters per second, so it is seen almost at the same instant that it occurs. The sound of thunder caused by the heating and rapid contraction of the air during the flash travels about 1, 100 meters per second, and so always arrives later. The farther away the lightning is, the longer it takes to hear the thunder.

8. A If the speed of light were so much slower that it would take several seconds to see the flash, then this time of travel would have to be taken into account along with the speed of sound waves in air in order to determine the distance to the lightning.

9.

LOWEST ENERGY			HIGHEST ENERGY
95 m	8.5×10^1 m	7.5×10^2 m	3.0×10^3 m

Lesson 7. 1

The Structure of Matter, p. 83

1. **B** Scientists have known about electrons, protons, and neutrons for more than 100 years (1897 for electrons, 1911 for protons and neutrons). It is only recently that we discovered there were subatomic particles, and scientists have yet to fully determine their roles.

2. **B** Because each product is made up of only one kind of atom, the products are elements.

3. Overall, the helium atom is electrically neutral because the positive charges of the two protons in the nucleus are cancelled by the negative charges of the two electrons that orbit the nucleus. Neutrons are electrically neutral, so the presence of the neutrons does not impact the overall electrical charge of the atom.

4. **B** Because chlorine is located to the right of the zigzag section of the periodic table, it is a nonmetal.

5. **A** The periodic table indicates that chlorine has 17 protons because its atomic number is 17, so to be neutral, an atom of chlorine must also have 17 electrons.

6. The number of neutrons in the nucleus of an atom of an element can be determined by subtracting the atomic number of the element provided by the periodic table from its atomic mass or mass number.

7. **A** Because metals are generally good conductors of electricity, using the sample in place of a piece of wire in a working electrical circuit can be used to identify whether the sample is a metal. If the circuit works with the sample in place, the sample is most likely a metal. If the sample does not work, it is most likely not a metal.

8. **A** Because the ratio of carbon (C) to hydrogen (H) in methane gas is 1 to 4, the formula for methane is CH_4.

9. $CaC0_3$

10. Because it had the greatest increase in mass, Sample 3 had the highest iron content

Lesson 7. 2

Physical and Chemical Properties of Matter, p. 86

1. **D** A chemical property is one that can be observed only through changing the composition of matter. An antacid undergoes a chemical change as it reacts with water.

2. **C** The density of a substance is the best property to use to distinguish it from others. Many substances can share the other properties listed.

3.

Stayed the Same	Changed
Color Temperature Density	Volume Mass Shape

4. The sample begins in the liquid state and chancres to the gas state.

5. This type of change occurs when the sample absorbs thermal energy, thereby causing the particles of matter to move faster and to be farther apart.

6. According to the graph, the melting **point** for the substance is 60 degrees **and the** boiling **point** is 120 degrees.

7. The statement is not supported by the graph. In sections A, C, and E of the graph, the temperature does increase as thermal energy is absorbed. However, in sections B and D, thermal energy is absorbed, but the temperature does not change. Instead, the energy either separates the particles of matter out of the crystal lattice or spreads them farther apart.

8. D The horizontal line labeled as section **D** indicates a change of state. If energy is being absorbed from left to right across the graph, a liquid is changing to a gas through vaporization. If energy is being released from right to left across the graph, a gas is changing to a liquid through condensation.

9. D Elements are most likely to have similar physical and chemical properties if they are in the same group of the periodic table. A group is a vertical column of the table. Magnesium and calcium are the only two elements listed that are in the same group.

10. B An element acts like a metal when it conducts electricity and a nonmetal when it does not. An element that can have some properties of a metal and some properties of a nonmetal is a metalloid. Silicon is the only metalloid listed.

11. The statement is incorrect. The stability of elements increases from left to right across the periodic table. The elements in Group 1 at the left side of the table have one outermost electron. They are likely to give up their electron to become stable so they are highly reactive. The elements in Group 18 at the right side of the table have eight outermost electrons. They do not need to share electrons to have a complete set so they are very unreactive. So the elements along the left side of the table are highly reactive, but the elements along the right side of the table are not.

12. C Generally, elements in the same group have similar properties. Exceptions to this rule occur in the region of the periodic table where elements fall into different categories. In this case, carbon is in the nonmetal region of the table whereas lead is in the metal region.

Lesson 7. 3

Chemical Reactions, p. 89

1. **D** The mass before and after the reaction differed because some matter escaped as gases. By stretching a balloon over the opening of the bottle, those gases can be captured. If the student then compares the masses of all the materials before and after, they should be the same.

2. A A chemical reaction involves a change in the composition of matter. When iron rusts, it reacts with air to form a new substance known as an iron oxide. The other changes involve only the appearance of matter.

3. B The paragraph relates to all of the topics, but its focus is to compare coefficients and subscripts.

4. In the chemical equation for photosynthesis shown below, 6 molecules of water enter into the reaction.

5. C In the product, there are 2 molecules of aluminum oxide as shown by the coefficient. Each molecule contains 3 atoms of oxygen, as shown by the subscript. Therefore, 2x3 = 6.

6. $2CH_4 + 4O_2 \longrightarrow 2CO_2 + 4H_2O$

7. $2H_2O_2 \longrightarrow 2H_2O + O_2$

8. D The process represented would have to release energy. The only process listed that releases energy instead of absorbing it is cellular respiration, which is described as the process in which an animal uses glucose and oxygen.

9. Based on the change of energy shown, the graph represents an exothermic chemical reaction. The energy of the reactants is greater than the energy of the products. Therefore, energy was released during the reaction. A chemical reaction that releases energy is exothermic.

10. **B** The graph represents the reaction rate. It increases up to some peak, and then decreases. That peak is determined by temperature.

11. If the student raises the temperature to 30°C, the student will conclude that the rate increases continuously with temperature. The error is not raising the temperature enough to observe a limit in the rate of reaction. The student can correct the error by raising the temperature to at least 50°C before concluding the investigation.

Lesson 7. 4

Solutions, p. 92

1.

Solute	Solvent	Solution
carbon dioxide	water	club soda
Zinc	copper	brass
Soap	water	detergent
oxygen	nitrogen	air

2. B Oxygen dissolved in water is an example of a gas dissolved in a liquid.

3. A A solute is soluble if its molecules have the same polarity as the solvent molecules ("like dissolves like"). Increasing solute surface area and stirring the solution or increase solvent contact with solute surfaces improve the solubility of the solute. Solubility is determined by the greatest amount of solute that can be dissolved in a solvent at given conditions, such as temperature. While the solubility of a gas in a gas or liquid depends on pressure, this is not important for liquid solvents and solid or liquid solutes. Gases dissolve more easily in liquids when temperatures are lower and pressures are greater.

4. In the graph, temperature is the independent variable, and solubility is the dependent variable.

5. C Using the curve for potassium bromide (the purple line) and reading upward from 90°C, the amount of solute is found to lie about halfway between 80 g and 120 g, or nearly 100 g.

6. Under normal conditions, the pH of blood is slightly higher than that of water. This makes blood more basic than water. Even in a severe case of acidosis, when the pH of blood is 7. 15, water is, by comparison, a(n) acid.

7. C Hydrochloric acid is specifically mentioned as a strong acid, and by definition strong acids are those that dissociate completely.

8. A Alkalosis occurs when blood pH is greater than 7. 45, as in the case of a pH of 7. 55.

9. B For a given concentration of hydronium ions ([H+]), the pH may be found by taking the whole logarithm of [H+] and multiplying the result by -1.

Therefore, pH depends on [H+], or put differently, [H+] is the independent variable, and pH is the dependent variable.

Lesson 8. 1

The Atmosphere, p. 95

1. B Sustaining life depends on the elements oxygen and nitrogen. Without those elements, neither animals nor plants could exist.

2. C Choices A, B, and C would have a negative effect on promoting energy conservation. Choice C, reducing dependence on fossil fuels, is correct because there is a positive correlation between fossil fuel use and global warming.

3. A The graph indicates that $C0_2$ levels showed a steady increase from 1880 through 2000.

4. B The passage indicates that ultraviolet rays are the most damaging to living organisms, so the absorption of 97-99 percent of UV rays would be a major function of the ozone layer.

5. D The passage states that living organisms are harmed by too much UV radiation, so ultraviolet radiation is energy harmful to humans.

6. D The troposphere does not receive much UV radiation as the radiation is filtered out before reaching the troposphere, so it would not be possible for a layer such as the ionosphere to exist in the troposphere.

7. C Students must read the diagram and compute rates of absorption and reflection. Half of the sun's energy is directly or indirectly absorbed by Earth's surfaces.

8. Earth's atmosphere and surface absorb 65 percent of the Sun's energy.

9. D The pattern that shows increased temperature levels over a prolonged period of time is called global warming.

10. Answers may vary but should include sound scientific principles. Responses may include reduced solar energy reaching Earth resulting in death of plant and animal life, destruction of crops, inability to replace food supplies, drastic changes in weather patterns, and/or an increasingly colder climate in formerly temperate or tropical zones.

Lesson 8. 2

The Oceans, p. 98

1. A The diagram illustrates that precipitation falls as various forms of water.

2. C The diagram shows the movement of water from evaporation to condensation to precipitation and collection, all of which are movements of Earth's water.

3. C An estuary is a region where fresh river water meets salty ocean water, creating a less salty brackish water. The meltwater of a glacier also adds fresh water to salty ocean water, reducing the salinity of seawater.

4. In this scenario, the salinity of the water is the dependent variable and the location along the coast is the independent variable.

5. B Gravity is a force of attraction. The side of Earth closest to the Moon is affected by the Moon's gravitational field, which pulls or attracts the ocean water, causing changes in tides.

6. D Temperature depends on depth, with colder water in the depths of the ocean. Density also depends on depth, with less density at the ocean's surface.

7. A Plants depend on sunlight to produce food. Thus, plants will only survive in the ocean where they have adequate sunlight for photosynthesis.

8. In shallow areas of the ocean, sunlight may be transmitted through to the sea floor. Animal and plant life that depend on sunlight can exist at all depths of a shallow area of the sea. In the deep ocean, no light penetrates through to the ocean floor. The animals that exist at that depth will differ from the species that live in the shallow areas. In the deep ocean, plant life will exist only in areas reached by sunlight.

9.

Human Influences	Natural Influences
Overfishing	glacial meltwater
water pollution	surface evaporation
global warming	coral bleaching
	ebb tides

Lesson 8. 3

Earth's Structure, Composition, and Landforms, p. 101

1. B The measurements shown on the diagram indicate that the mantle is the thickest lay of Earth.

2. A The thickness of the crust varies due to the presence of mountain ranges, valleys, trenches, and other major land features.

3. C Earth most closely resembles a golf ball because it has a hard center (the core), a thick middle section (the mantle), and a thin, uneven surface (the crust).

4. D Because Earth's crust is brittle and easily cracked, it is most like the plaster surface.

5. **B** The mantle discussed in this test is geological, a lager of Earth between the core and the crust.

6. Hematite is a mineral with a specific chemical makeup and a specific crystalline structure. She should test for iron content in each sample because hematite is an iron-based mineral. She should also compare the crystalline structures of the samples she has with the sample she knows to be hematite. All hematite has the same crystalline structure.

7.

Examples of Deposition	Examples of Weathering
soil laid down at the mouth of a river rocks and soil at the base of a landslide rubble left after a glacier recedes	underground water dissolving limestone ice cracking the surface of a rock a natural bridge carved by wind

8. According to the map, the Mid-Atlantic Ridge lies between the North American plate and the Eurasian plate.

9. **D** The two plates lie either side of the Mid-Atlantic Ridge, which passes directly under Iceland; thus, Iceland straddles both plates and the ridge itself.

10. **D** Convergent boundaries lie at the edges of two tectonic plates. Their movement causes them to collide, which usually results in the production of mountains, such as the Indian Plate and the Eurasian Plate producing the Himalaya Mountains.

Lesson 8. 4

Earth Resources, p. 104

1.

Renewable Natural Resources	Nonrenewable Natural Resources
corn, flowers, oxygen, river water, sunlight, wind	coal, diamonds, gold, oil, silver

2. **C** Only the Environmental Protection Agency does research into clean water, clean air, and reduced pollution.

3. **D** The use of fossil fuels in a major environmental and economic issue. There is only a limited supply of fossil fuels, and when that runs out, humans will need alternative fuel sources.

4. **C** The graph shows flat data concerning the use of oil to produce electricity.

5. **A** A coal-burning power plant produces high levels of air pollution. There is always a danger of pollutants affecting living organisms around such a plant. Nuclear plants do not emit pollutants, but when an accident occurs, radiation leaks threatened all living things.

6. Burning fossil fuels produces ash, smoke, and gases that pollute the atmosphere. Burning fossil fuels releases carbon dioxide into the atmosphere, which results in global warming.

7. **C** You must differentiate between economic value and environmental value. Ethanol's environmental value is that is reduces pollution and is based on renewable resources.

8. **D** You can draw the conclusion that Texas and California have invested heavily in wind power technology because they are the two largest producers of wind-power energy generation, topping the nearest competition dramatically.

9. **A** Midwest states generate more wind-powered energy than states in the East, many of which do not take advantage of this energy alternative.

Lesson 8. 5

Interactions Between Earth's Systems, p. 107

1.

Type of Weather Data	Weather Occurrence
high humidity	Tropical rain storms
Temperature	A heat wave
high barometric pressure	Clear, pleasant weather
heavy winds	Broken tree branches and falling limbs

2. A Erosion is the act of moving particles from one place to another. Weathering is the break-down of rock into particles. The ripple pattern comes from erosion, and only wind will create the pattern.
3. C Planting trees reduces erosion by building a windbreak to hold the soil.
4. C Two forces act on the beach cliff. The first is physical weathering in which the wind and water break down the cliff face. The second is water erosion that carries the particles away from the cliff.
5. B The result of weathering and erosion on the beach cliff is that the face of the cliff recedes, while the area that is beach increases.
6. Answers will vary, but should include moderate wind, rain, and flood damage in the Bahamas, and extreme wind, rain, and flood damage in the United States. The wind speeds between the first and second sites increases by about 40 mph. The storm surge increases by 5-10 feet, which means the area damaged by flood will be larger in the U.S.
7. A According to the chart, 85 mph winds are typical of a Category 1 hurricane.
8. B A thunderstorm is the energy source that lifts a tornado from swirling air at ground level to a vertical funnel.
9. D Hurricanes needs a large supply of warm water to "feed" the storm system, which is why hurricanes begin over tropical waters.

Lesson 9. 1

Structures in the Universe, p. 110

1. D The Big Bang theory states that over time, the universe's temperature has declined as the universe has expanded.
2. C Based on the timeline, galaxies formed about 3 billion years ago.
3.

1. Nebula	2. Protostar	3. Fusion	4. Red giant	5. White dwarf

4. C When a supernova occurs, among the end products are heavy, metallic elements.
5. Every star in every galaxy in the universe is a source of energy. Within each star, including the Sun, nuclear energy heats the star and keeps it from collapsing due to the force of gravity. Meanwhile, each star's own energy and the gravitational force between the star and other stars work together to keep the star within a path inside its own galaxy.
6. C As part of the process of building a new star, a protostar collects material and forms a denser, hot, glowing center.
7. D This is a comparison between a black hole that sucks material inward and downward and a common everyday occurrence. Of the items listed, the only one that sucks material both inward and downward is a whirlpool.

8. 1 Select . . . ▼ C. gravity

3 Select . . . ▼ D. the Milky Way

2 Select . . . ▼ A. spiral

4 Select . . . ▼ A. stars

9. Answers will vary, but the primary factor determining failure would be the scope of the project. First, our technology is far too limited for such a venture. The rockets would not be able to gather sufficient data to fully map each star or solar system, the cost would be enormous, and the project would take much longer than a hundred human life spans to complete.

10. B All matter has mass. All mass has gravity. While the gravitational force differs from body to body, all bodies in the universe have some level of gravity.

Lesson 9. 2

Structures in the Solar System, p. 113

1.

Slowest			Fastest
1. Venus	2. Earth	3. Neptune	4. Jupiter

2. Neptune is about six times farther away from the Sun than Jupiter is.

3. An asteroid is a solid object smaller than a planet that orbits the Sun.

4. B The passage states that all the asteroids together would be less massive than Earth's Moon. Earth's Moon is not massive enough to be an independent planet so it is unlikely that the asteroids once formed an independent planet.

5. C Earth spins, or rotates, on its axis. One complete rotation takes 24 hours, or one day. If Earth were to spin more slowly, one day would take more than 24 hours so a day on Earth would last longer.

6. B Earth is tilted on its axis. As Earth revolves around the Sun, one hemisphere sometimes tilts toward the Sun whereas the other tilts away from the Sun. Locations in the hemisphere tilting away from the Sun experience winter.

7. D The information provided states that the gravitational force on the Moon is one-sixth that of Earth's force. By multiplying the astronaut's weight by one-sixth, the astronaut's weight on the Moon can be determined. Knowing the astronaut's mass would be useful if the information included an exact measure of the acceleration due to gravity on the Moon. However, this information is not provided.

8. B According to the graph, 5. 2 billion years represents 4 half-lives. After 1 half-life, 50% remains. After 2 half-lives, half of that, or 25%, remains. After 3 half-lives, half of that, or 12. 5%, remains. And after 4 half-lives, half of that, or 6. 25%, remains.

9. According to the graph, the half-life of potassium-40 is 1.3 billion years. To find the amount remaining, divide the amount by half for each half-life. According to the graph, 2. 6 billion years is two half-lives. So after the first half-life, there will be 100 g 2, or 50 g remaining. After the second half-life, there will be 50 g -s- 2, or 25 g remaining.

10. C According to the Law of Superposition, sedimentary rock forms in layers. If the layers are undisturbed, the age of the layers increases from top to bottom. Therefore, Layer **C** is younger and formed later than Layer E.

11. B Relative dating can be used to identify the order in which organisms lived, but not their actual ages or other specific details about the organisms.

TI-30XS MultiView™ Calculator Reference Sheet

Order of Operations

The TI-30XS MultiView™ automatically evaluates numerical expressions using the Order of Operations based on how the expression is entered.

Example

$12 \div 2 \times 3 + 5 =$

[1] [2] [÷] [2] [×] [3] [+] [5] [enter]

Note that the 2 is not multiplied to the 3 before division occurs.

The correct answer is 23.

Decimals

To calculate with decimals, enter the whole number, then [.], then the fractional part.

Example

$11.526 + 5.89 - 0.4 =$

[1] [1] [.] [5] [2] [6] [+] [5] [.] [8] [9] [−] [0] [.] [4] [enter]

The decimal point helps line up the place value.

The correct answer is 17.016.

Fractions

To calculate with fractions, use the [$\frac{\square}{\square}$] button. The answer will automatically be in its simplest form.

Example

$\frac{3}{7} \div \frac{4}{5} =$

[3] [$\frac{\square}{\square}$] [7] [◂▸] [÷] [4] [$\frac{\square}{\square}$] [5] [sto▸] [enter]

This key combination works if the calculator is in Classic mode or MathPrint™ mode.

The correct answer is $\frac{15}{28}$.

Mixed Numbers

To calculate with mixed numbers, use the [2nd] [$\frac{\square}{\square}$] button. To see the fraction as an improper fraction, don't press the [2nd] [x10ⁿ] buttons in sequence below.

Example

$8\frac{2}{3} \times 4\frac{3}{5} =$

[8] [2nd] [$\frac{\square}{\square}$] [2] [sto▸] [3] [sto▸] [×] [4] [2nd] [$\frac{\square}{\square}$] [3] [◂▸] [5] [sto▸] [2nd] [x10ⁿ] [enter]

This key combination only works if the calculator is in MathPrint™ mode.

The correct answer is $39\frac{13}{15}$.

Percentages

To calculate with percentages, enter the percent number, then [2nd] [(].

Example

$72\% \times 500 =$

[7] [2] [2nd] [(] [×] [5] [0] [0] [enter]

The correct answer is 360.

TI-30XS MultiView™ Calculator Reference Sheet

Powers & Roots

To calculate with powers and roots, use the x^2 and $\wedge$ buttons for powers and the 2nd x^2 and 2nd $\wedge$ buttons for roots.

Example
$21^2 =$
2 1 x^2 enter

The correct answer is 441.

Example
$2^8 =$
2 $\wedge$ 8 enter

The correct answer is 256.

Example
$\sqrt{729} =$
2nd x^2 7 2 9 enter

The correct answer is 27.

Example
$\sqrt[5]{16807} =$
5 2nd $\wedge$ 1 6 8 0 7 enter

The correct answer is 7.

You can use the 2nd x^2 and 2nd $\wedge$ buttons to also compute squares and square roots.

Scientific Notation

To calculate in scientific notation, use the $\times 10^x$ button as well as make sure your calculator is in Scientific notation in the mode menu.

The correct answer is 1. 2011 x 10^5.

Example
$6.81 \times 10^4 + 5.201 \times 10^4 =$
6 . 8 1 $\times 10^x$ 4 sto$\blacktriangleright$ +
5 . 2 0 1 $\times 10^x$ 4 sto$\blacktriangleright$ enter

When you are done using scientific notation, make sure to change back to Normal in the mode menu.

Toggle

In MathPrint™ mode, you can use the toggle button $\blacktriangleleft\blacktriangleright$ to switch back and forth from exact answers (fractions, roots, π, etc.) and decimal approximations.

The correct answer is 0. 428571429.

Example
$\frac{3}{7} =$
3 $\frac{\square}{\square}$ 7 enter $\blacktriangleleft\blacktriangleright$

If an exact answer is not required, you can press the toggle button $\blacktriangleleft\blacktriangleright$ immediately to get a decimal approximation from an exact answer without reentering the expression.