Name _____ Date _____

Virginia SOL Pretest

11-6 81-6 B3 W3 8

1. A scientist wants to study why a local lake has recently grown large amounts of algae. The scientist collected water samples from the lake and added different amounts of weed killer to each one and then observed changes in the amount of algae in each sample. Which aspect of the water sample is an independent variable?

   A. the amount of water in each sample

   B. the amount of weed killer added to the sample

   C. the temperature of the water

   D. the type of container used to collect the water

2. Bromeliads are a type of tropical plant that collects water. A field biologist was gathering data about bromeliads and wanted to measure how much water was stored in one of the plants. Which tool should the biologist use to measure the water?

   F. meterstick

   G. thermometer

   H. graduated cylinder

   J. triple-beam balance

3. A scientist noticed several trees in a patch of forest were losing leaves in the middle of summer. To investigate the situation, the scientist collected a large number of leaves, some from the ground and some from the tree. The scientist then placed all the leaves in a bag to take back to the lab. Which experimental error did the scientist make?

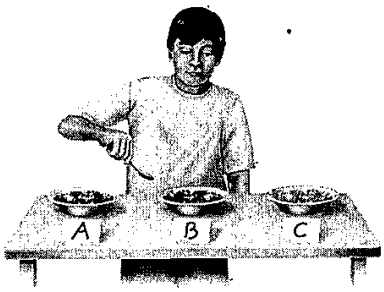
   A. The fallen leaves should have been separated from the ones on the tree.

   B. The leaves should have been collected earlier in the day.

   C. The scientific names of the trees should have been written on the bag.

   D. The scientist should have had someone else collect the leaves.

4. The diagram below shows a boy taste testing three brands of cereal.



At first, the boy set up his test using cereal information as shown in the bottom table. His teacher told him to change the signs to reduce bias in his inquiry, as shown in the top table. Which of the following would not further reduce bias?

F. Change the order of the bowls.

G. Change the color of all of the bowls.

H. Add the same amount of cereal to each of the bowls.

J. Add the same amount of milk to each of the bowls.

GO ON

Name _____ Date _____

5. A scientist collected a large amount of information in data tables for an experiment on spiders. What should the scientists do next with the data?

   A. Analyze the information.

   B. Graph the information.

   C. Draw a conclusion.

   D. Write a hypothesis.

6. A nature guide was teaching a group of people how to identify and classify birds the same way scientists do. Which statement most likely describes the way scientists classify birds?

   F. by how many nests are in the area

   G. by the mass of the bird

   H. by the number of feathers

   J. by several characteristics

7. The data table below shows data collected on the amount of rainfall for the first eight months of a certain year.

Rainfall Data	
January	7.11 cm
February	11.89 cm.
March	9.58 cm
April	8.18 cm
May	7.11 cm
June	1.47 cm
July	18.21 cm
August	8.84 cm

   Which conclusion drawn from the data is most likely correct?

   A. The month of January was drier that August.

   B. The month of June was wetter than April.

   C. The months of April and August had equal amounts of rainfall.

   D. The month of February had half the amount of rainfall as July.

8. A class was having trouble understanding how a tsunami could form in the middle of the ocean. Which approach would be most likely to help students understand?

   F. Ask students to draw pictures of a coastline.

   G. Demonstrate a simulation using a model.

   H. Present graphs showing wave heights from a tsunami.

   J. Show photos of damage caused by the tsunami.

GO ON

Name _____ Date _____

9. Akaya noticed that every day this week, the birds on her bird feeder flew away when she left the house to go to school. Which of the following would NOT help her gather data and identify patterns?

A. She could leave a half an hour earlier and record the birds' reactions.

B. She could leave a half an hour later and record the birds' reactions.

C. She could leave more birdseed for the birds' and record the birds' reactions.

D. She could leave wearing the same colored jacket on each day and record the birds' reactions.

10. A family reads an article about the effects of lawn-care chemicals on the soil. Which of the following is an application of that information to their daily lives?

F. They could stop using weed killers on their lawn.

G. They could choose chemicals that have the least impact on the soil.

H. Both F and G are valid applications.

J. Neither F nor G are valid applications.

11. A muscle cell was not able to make new energy. Which organelle was most likely not working properly?

A. chloroplasts

B. mitochondrion

C. nucleus

D. ribosome

12. Which structure is present in a plant cell, but not in an animal cell?

F. mitochondrion

G. vesicle

H. cell membrane

J. cell wall

13. Which term describes a group of the same type of cells working together?

A. organ

B. tissue

C. organ system

D. stem cell

14. The cells of a maple tree leaf are undergoing photosynthesis. Which of the following captures energy from the Sun?

F. chlorophyll

G. glucose

H. carbon dioxide

J. carbon monoxide

15. Which of the following involves only one organism?

A. competition

B. cooperation

C. sleep cycle

D. territorial imperative

GO ON

Name _____ Date _____

16. Cougars are predators. Which statement about energy flow and the cougar is correct?

F. The cougar receives all of its energy indirectly from producers.

G. The cougar uses less energy than organisms at other levels of the pyramid.

H. The cougar does not consume energy.

J. The cougar provides the largest amount of energy to the food web.

17. A biologist studies an organism in a forest that is unicellular and absorbs food. In which kingdom is this organism?

A. Archaea

B. Bacteria

C. Fungi

D. Protista

18. Ocean coral has a symbiotic relationship with algae. Which statement best describes the relationship between the two organisms?

F. They compete for food.

G. They help each other.

H. They have no effect on each other.

J. They reproduce with each other.

19. A viral disease kills only rabbits in an ecosystem. Which population in the ecosystem would also likely decrease?

A. bacteria

B. coyotes

C. grass

D. mice

20. A section of DNA on a chromosome is called a(n)

F. allele.

G. gene.

H. trait.

J. virus.

21. The table below shows data for four objects.

Object	Area (cm^2)	Density (g/cm)
1	100	0.5
2	500	7.2
3	200	2.5
4	300	4.5

Which statement about the objects is correct?

A. As area increases, density stays the same.

B. As density increases, area stays the same.

C. The greater the area, the lower the density.

D. The lower the area, the lower the density.

22. A person measured the length of a piece of wood to be 250 centimeters. What would the length be in meters?

F. .025 m

G. 0.25 m

H. 2.50 m

J. 25.0 m

GO ON

Name _____ Date _____

23. A chemist was given five solutions and asked to find the densities of each. Which two types of equipment would the chemist need?

A. beaker and Bunsen burner

B. graduated cylinder and electronic balance

C. thermometer and spring scale

D. triple-beam balance and metric ruler

24. During a classroom lab, you spill a chemical on your hand. Which action should you take?

F. Follow your teacher's safety instructions carefully.

G. Immediately wipe your hand on the closest material.

H. Shake the chemical off immediately onto the floor or table.

J. Wait for it to dry, then be sure to wash your hands.

25. Which characteristic is different between a mixture and a compound?

A. Compounds always contain hydrogen and oxygen.

B. Substances in a mixture are not bonded to each other.

C. Only a mixture contains different types of elements.

D. Only compounds can have electrically charged ions.

26. When water is boiled, it evaporates into steam. Which statement describes the difference between liquid water and steam?

F. The hydrogen and oxygen atoms separate in the steam.

G. The molecules in the steam are smaller than in the liquid.

H. The molecules move slower in the liquid than in the steam.

J. The water molecules have a different shape in the liquid form than in steam form.

27. Which scientist discovered the structure of an atom?

A. Bohr

B. Dalton

C. Rutherford

D. Thomson

28. On the periodic table of elements, where are *most* of the nonmetals located?

F. bottom

G. top

H. left side

J. right side

29. To form an ionic bond, what characteristic must an atom have?

A. It must be a metal.

B. It must be electrically charged.

C. It must have a large nucleus.

D. It must have a pair of electrons to share.

GO ON

Name _____ Date _____

30. Which action would cause a chemical change in an egg?

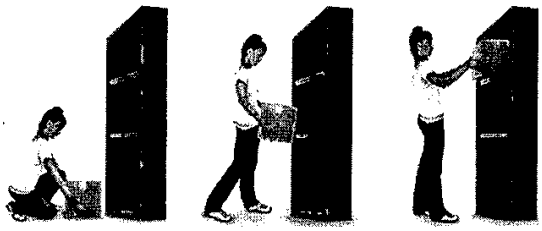
F. boiling

G. cracking

H. refrigerating

J. stirring

31. The diagram below shows a girl lifting a box onto a shelf.



At which point does the box have the most potential energy?

A. when being carried

B. when in motion

C. when on the floor

D. when placed on the shelf

32. In which situation is the convection of heat occurring?

F. heat coming off of a campfire

G. heat warming the outside of a car

H. heat moving inside the water of a teapot

J. heat transferring from a fire to a metal spoon

33. Which statement describes the amplitude of a sound wave?

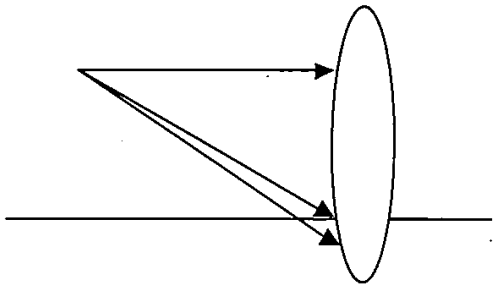
A. the height of the wave

B. the length of the sound wave

C. the speed of the wave

D. the spreading apart of the waves

34. The diagram below shows light rays moving from an object toward a lens.



After the light rays pass through the lens, what will the image of the object look like compared to the original object?

F. exactly the same

G. turned 90 degrees

H. right-side up and larger

J. upside down and smaller

GO ON

Name _____ Date _____

35. The table below shows the time and velocity of a car at different times.

Time (s)	Velocity (m/s)
0	0
1	1
2	4
3	1
4	3

During which period of time did the acceleration decrease?

A. 0 to 1 seconds

B. 1 to 2 seconds

C. 2 to 3 seconds

D. 3 to 4 seconds

36. You push on a wall with all of your strength, but the wall does not move. Which statement about this situation is correct?

F. You did not apply any force.

G. You did not do any work.

H. You did not use any energy.

J. You did not use any mass.

37. A machine was made that worked like a magnet, but only when the power was on. Which statement explains why?

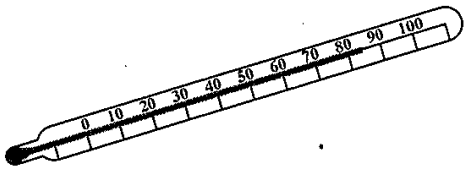
A. A magnet must be attached to a wire to work.

B. A moving electric current forms a magnetic field.

C. The electric current becomes a magnetic field at a certain speed.

D. The machine parts are naturally magnetic and electric power increased their magnetic strength.

38. A scientist collects data outside using the tool shown below.



What is this tool called?

F. barometer

G. thermometer

H. beam balance

J. rain gauge

39. Scientists want to develop a way to use algae as a source of fuel. Which statement describes the best approach for the scientists to use?

A. They chose the best algae and test it for many different variables.

B. They combine types of algae and do not need to test variables.

C. They test many types of variables on several kinds of algae.

D. They test the most important variable on a single type of algae.

40. Why is it important to protect watersheds and conserve water resources?

F. All living things depend on clean water.

G. Fresh water is abundant everywhere on Earth.

H. Water is hard to pollute and very easy to clean.

J. Water remains clean even if the land around it is polluted.

GO ON

Name _____ Date _____

41. What causes seasonal changes on Earth?

A. Earth is tilted on its axis.

B. Earth moves closer to the Sun.

C. Earth spins while orbiting the Sun.

D. Earth's orbital speed increases.

42. What causes surface currents in the ocean?

F. changes in water temperature

G. differences in water density

H. Earth rotating on its axis

J. wind blowing across the water surface

43. Which term listed below is NOT a particle found in an atom?

A. electron

B. ion

C. neutron

D. proton

44. Which energy source could pose an extremely dangerous risk to people and the environment if an accident were to occur?

F. nuclear

G. solar

H. geothermal

J. hydroelectric

45. Which factor is NOT important in the formation of rich soil?

A. climate

B. time

C. living organisms

D. open space

46. Which could be a negative impact of building a dam in a river?

F. producing hydroelectric energy

G. providing a reservoir where people can boat and fish

H. reducing erosion from the riverbanks

J. reducing the amount of water available downstream

47. A research team was analyzing water quality in a river. Which water quality characteristic does NOT impact organisms living in the river?

A. amount of pollutants

B. amount of sediment

C. direction of flow

D. water temperature

48. Which component of the atmosphere do scientists think came from early life-forms?

F. oxygen

G. nitrogen

H. carbon dioxide

J. carbon monoxide

GO ON

Name _____ Date _____

49. Which greenhouse gas has increased due to human activity and most likely contributes to climate change?

A. hydrogen

B. nitrogen

C. carbon dioxide

D. carbon monoxide

50. Which statement best explains how energy from the Sun is related to hurricane formation?

F. Hurricanes form during bright days, when wind directions change suddenly.

G. Hurricanes form over warm water, which is heated by the Sun.

H. Hurricanes form when Sun energy heats thunderstorms.

J. Hurricanes form when the Sun heats the air, causing extreme winds.

STOP

Name _____ Date _____

Virginia SOL Pretest Answer Key

1. B (LS.1f)
2. H (LS.1c)
3. A (LS.1e)
4. F (LS.1g)
5. B (LS.1h)
6. J (LS.1b)
7. A (6.1b)
8. G (LS.1d)
9. C (LS.1g)
10. H (LS.1j)
11. B (LS.2a)
12. J (LS.2b)
13. B (LS.3a)
14. F (LS.2a)
15. C (LS.8a)
16. F (LS.6d)
17. C (LS.5a)
18. G (LS.9d)
19. B (LS.9b)
20. G (LS.13b)
21. D (PS.1k)
22. H (PS.1c)
23. B (PS.1d)
24. G (PS.1a)
25. B (PS.2b)
26. H (PS.2c)
27. A (PS.3a)
28. J (PS.4b)
29. A (PS.4c)
30. F (PS.5c)
31. D (PS.6a)
32. H (PS.7c)
33. A (PS.8a)
34. J (PS.9b)
35. C (PS.10a)
36. G (PS.10c)
37. B (PS.11b)
38. G (PS.1d)
39. C (LS.1g)
40. F (6.7f)
41. A (6.8g)
42. J (6.3c)
43. B (6.4a)
44. F (PS.5b)
45. D (LS.7a)
46. J (6.5f)
47. C (6.7a)
48. F (6.6a)
49. C (6.6d)
50. G (6.3e)

Answers

Scientific Problem Solving

Lesson 1: Scientific Inquiry

Multiple Choice

1. B
2. B
3. C
4. D

Open Response

Answers will vary. Possible answer: A scientific theory explains how or why something happens. A theory is developed after many observations and investigations. A scientific law states that something will happen, and it is true as long as it is never proved untrue.

Lesson 2: Measurement and Scientific Tools

Multiple Choice

1. C
2. A
3. A
4. B

Open Response

Answers will vary. Possible answer: A description tells the facts about an observation. Example: *The sky is blue.* An explanation is an interpretation of the observation. Example: *The sky is blue because of the way sunlight is affected by Earth's atmosphere.*

Lesson 3: Case Study: The Minneapolis Bridge Failure

Multiple Choice

1. C
2. B
3. D
4. C

Open Response

Answers will vary. Possible answer: The dependent variable is whether the egg will break or not. The independent variable is the surface that the egg hits after being dropped. One constant is the height that the egg is dropped from.

Extended Response

Answers will vary, but students should provide a hypothesis that is in the form of a statement that can be tested and is not a question. The dependent variable is whether or not the gusset plates will break. The independent variable is the thickness of the plates. The constant is the amount of weight applied to each plate. Whether or not the hypothesis is supported will vary, depending on the students' stated hypotheses. Methods of communication could include speeches, articles in journals, or posting to the Internet.

Foundations of Chemistry

Lesson 1: Classifying Matter

Multiple Choice

1. A
2. D
3. B
4. C

Open Response

Answers will vary. Possible answer: Air is a mixture of oxygen and other gases. The mixture is homogeneous because the substances are mixed together evenly. Air is not a compound because the substances are not bonded together, although air may have some compounds in it.

Lesson 2: Physical Properties

Multiple Choice

1. C
2. C
3. B
4. B

Open Response

Answers will vary. Possible answer: Melting points and boiling points are temperatures at which substances change from one state of matter to another. The melting point is the temperature when a substance changes from a solid to a liquid. The boiling point is when the substance changes from a liquid to a gas.

Lesson 3: Physical Changes

Multiple Choice

1. C
2. D
3. A
4. C

Open Response

Answers will vary. Possible answer: The amount of thermal energy a substance has determines which state of matter it is in. When a substance has low thermal energy, its atoms are bonded closely together and it is a solid. As thermal energy increases, the atoms become more active and the bonds loosen. The solid becomes a liquid. With even more thermal energy, the bonds break and the liquid becomes a gas.

Lesson 4: Chemical Properties and Changes

Multiple Choice

1. B
2. D
3. C
4. C

Open Response

Answers will vary. Possible answer: Adding heat increases the rate of a chemical reaction, so heating the nail would make it rust more quickly. Increasing the concentration of one substance in the equation will also increase the rate of the reaction. If the nail was placed in air that was pure oxygen, it would also rust more quickly.

Extended Response

1. Answers will vary. Possible answer: Illustration A shows the arrangement of particles in a solid. The particles vibrate, but they do not move around because the bonds between them are strong. Illustration B shows the particles in a liquid. The bonds between them are looser in this state, so they can move around each other more freely. However, the particles are still attracted to each other enough for the substance to stay together. Illustration C shows a gas. The particles move most quickly in this state, and there are no bonds between them. Individual particles can move about freely, and the substance will spread out as far as possible.
2. Answers will vary. Possible answer: Sanding the nail is a physical change. The surface of the nail is scraped away, which changes its mass, but the identity of the nail does not change. The nail rusting in the vinegar is a chemical change. The iron in the nail reacts with the oxygen in the vinegar, and a new substance, Fe_2O_3, is formed. The bubbles of hydrogen that form are a sign that a chemical change is occurring. The iron in the nail is an element because it is made of only one type of atom, Fe. The vinegar is a compound because it is made of three atoms bonded together and it has a chemical formula, $C_2H_4O_2$.

Understanding the Atom

Lesson 1: Discovering Parts of an Atom

Multiple Choice

1. A
2. C
3. D
4. A

Open Response

Answers will vary. Possible answer: Bohr proposed a model of the atom in which electrons move in set orbits around the nucleus of the atom. In the modern model, electrons form an electron cloud around the nucleus.

Lesson 2: Protons, Neutrons, and Electrons—How Atoms Differ

Multiple Choice

1. A
2. D
3. A
4. C

Open Response

Answers will vary. Possible answer: Average atomic mass is the average mass of an element's isotopes, weighted for the abundance of each isotope.

Extended Response

1. Answers will vary. Possible answer: Figure 1 shows gamma decay. The radiation given off during gamma decay is gamma rays, which have a large percentage of energy and can pass through a sheet of lead. The resulting nucleus does not differ from the original nucleus. Figure 2 shows alpha decay, which produces an alpha particle made up of two protons and two neutrons. The resulting nucleus has two fewer protons and neutrons, forming a new element. Figure 3 shows beta decay, during which a neutron changes to a proton and a beta particle. The new proton becomes part of the nucleus, increasing the atomic number by one. The beta particle is released.
2. Answers will vary. Possible answer: The top element has 11 protons and 11 electrons. It loses an electron, giving the ion a positive charge. The bottom element has 9 protons and 9 electrons. It gains an electron, giving the ion a negative charge.

The Periodic Table

Lesson 1: Using the Periodic Table

Multiple Choice

1. A
2. C
3. B
4. A

Open Response

Mendeleev organized elements according to atomic mass. However, some elements seemed out of place using this system. Eventually, Henry Moseley fixed the problem by classifying elements based on atomic number instead of atomic mass.

Lesson 2: Metals

Multiple Choice

1. B
2. D
3. D
4. A

Open Response

Alkali metals are highly reactive metals. They react quickly with other elements, such as oxygen. So, in nature, they are found only in compounds.

Lesson 3: Nonmetals and Metalloids

Multiple Choice

1. D
2. B
3. B
4. D

Open Response

Answers will vary. Possible answer: The element Mei is working with has some characteristics of metals. It has luster and conducts electricity. However, it does not conduct electricity when it is cold, so it is a metalloid semiconductor.

Extended Response

1. Answers will vary. Possible answer: Anish is incorrect. The symbols for state of matter indicate that nearly all naturally occurring metals and metalloids are solid at room temperature. Mercury is the only exception. As for nonmetals, more of them are gases as you move from left to right across the rows on the periodic table.
2. Answers will vary. Possible answer: Hydrogen has many properties of nonmetals, such as being a gas at room temperature. However, in its liquid form, hydrogen conducts electricity as a metal does. Hydrogen is most often classified as a nonmetal because it behaves the way that a nonmetal behaves under conditions found on Earth.

Elements and Chemical Bonds

Lesson 1: Electrons and Energy Levels

Multiple Choice

1. C
2. C
3. B
4. D

Open Response

The diagram should show a Ca with one dot above the Ca and one dot to the right. The atom is unstable and can form two bonds.

Lesson 2: Compounds, Chemical Formulas, and Covalent Bonds

Multiple Choice

1. B
2. D
3. D
4. A

Open Response

The four types of models that can be used to describe the shape of a molecule are (1) dot diagram, which shows atoms and valence electrons; (2) structural formula, which shows atoms and lines with each line representing one shared pair of electrons; (3) ball-and-stick model, which shows balls that represent atoms and sticks that represent bonds and are used to show bond angles; and (4) space-filling model, which shows spheres that represent atoms and is used to show a three-dimensional arrangement of atoms. Students should draw a dot diagram, structural formula, ball-and-stick model, and space-filling model for the molecule H_2O. All of the models except for the dot diagram should show that the molecule is polar.

Lesson 3: Ionic and Metallic Bonds

Multiple Choice

1. B
2. C
3. C
4. A

Open Response

Ionic compounds have high melting and boiling points, whereas covalent compounds have low melting and boiling points. Ionic compounds are usually solid and brittle at room temperature, whereas covalent compounds are usually gas or liquid at room temperature. Ionic compounds are good conductors of electricity, whereas covalent compounds are poor conductors of electricity.

Extended Response

Potassium would lose one electron and become a positive ion. Iodine would gain one electron and become a negative ion. These two ions would form an ionic bond. The chemical formula for this molecule would be KI.

Mixtures, Solubility, and Acid/Base Solutions

Lesson 1: Substances and Mixtures

Multiple Choice

1. A
2. C
3. C
4. C

Open Response

Answers will vary. Possible answer: Salt added to boiling water is a mixture. Neither salt nor water changes chemically in a mixture, so salt does not split into its elements Na and Cl. Therefore, salt retains its own properties instead of taking on the properties of its individual elements.

Lesson 2: Properties of Solutions

Multiple Choice

1. A
2. B
3. A
4. C

Open Response

Answers will vary. Possible answer: The alloy is a homogeneous mixture or a solution. Iron is the solvent and chromium is the solute in this solution.

Lesson 3: Acid and Base Solutions

Multiple Choice

1. A
2. B
3. A
4. D

Open Response

Answers will vary. Possible answer: In a neutral solution (pH = 7), the concentrations of hydronium and hydroxide ions are equal. Acids (pH < 7) contain more hydronium than hydroxide ions. Bases (pH > 7) contain more hydroxide than hydronium ions.

Extended Response

1. Cola is the most acidic and bleach is the most basic. The cola is 10^{10} times more acidic than the bleach, or 10 billion times more acidic.
2. Answers will vary. Possible answer: The most basic substances, such as bleach, ammonia, and hand soap, are cleaning products. Bases must have properties that allow them to clean clothes and surfaces in the home. Many of the most acidic substances are foods. The sour taste of some acids might taste good to people.

Thermal Energy and Changes in Matter

Lesson 1: Forms of Energy

Multiple Choice

1. D
2. A
3. D
4. D

Open Response

Answers will vary. Possible answer: The music from the jukebox produces sound energy. The bowlers and the rolling bowling balls have kinetic energy. The TV uses electric energy.

Lesson 2: Matter and Energy

Multiple Choice

1. B
2. D
3. C
4. C

Open Response

Yes. Molecules, such as water molecules, are composed of atoms that are chemically bonded together. Atoms held together in a chemical bond have potential energy.

Lesson 3: Thermal Energy on the Move

Multiple Choice

1. C
2. C
3. B
4. D

Open Response

Answers will vary. Possible answer: A down jacket keeps my body warm in cold weather because it is filled with feathers, a fibrous material. This material traps pockets of air that slow the flow of heat away from my body.

Lesson 4: Thermal Energy and Matter

Multiple Choice

1. C
2. A
3. C
4. A

Open Response

Answers will vary. Possible answer: When you run hot water over the metal lid of a jar, the particles in the lid move apart, causing the lid to become slightly larger. Since the lid is larger, it is easier to remove.

Extended Response
Answers will vary. Possible answer: Television and radio waves have longer wavelengths than gamma and ultraviolet waves. X-rays can be used to look for broken bones, radar can be used to detect weather, and ultraviolet rays can cause a sunburn.

Extended Response
Liquid water is present at all three points. Point A represents the melting point of water. The kinetic energy of the water is highest at point C. At point C, the water molecules are moving faster than at points A and B because of the higher temperature. Water molecules at 100°C have a higher kinetic energy than water molecules at 50°C or 0°C.

Describing Motion

Lesson 1: Position and Motion

Multiple Choice

1. D
2. C
3. C
4. D

Open Response
My parents are in motion relative only to my friend. Because my parents and I are together on the plane, we are not in motion relative to one another, even though the plane—and therefore the plane and its passengers—are in motion in reference to any person on the ground.

Lesson 2: Speed and Velocity

Multiple Choice

1. A
2. A
3. C
4. A

Open Response
Velocity changed when I pedaled away from the stop sign, when I slowed and stopped at the next stop sign, when I turned right, and when I increased my speed again. Velocity changes each time speed or direction changes.

Lesson 3: Acceleration

Multiple Choice

1. A
2. C

Open Response
No, the statement is not accurate. If the runner is moving at a constant rate in a straight line, she is not accelerating. Acceleration has nothing to do with going fast. The runner is accelerating only if she is changing her velocity—her speed or direction.

Extended Response

1. Object B is at a constant rate of speed. When an object's speed is constant, the distance it travels increases in a linear path with time. The slope of the line equals the speed of the object. Only Line B in the graph is linear, so only Line B can represent an object moving at a constant speed.
2. Answers will vary, but should include reference directions, such as straight ahead, left, or right, and universal distance references, such as feet or meters.

The Laws of Motion

Lesson 1: Gravity and Friction

Multiple Choice

1. A
2. A
3. A
4. B

Open Response

The table would have a mass of approximately 13 kg. An object's weight in Newtons on Earth, at sea level, is about 10 times its mass in kilograms. The table would have a mass of approximately 13 kg on the space station. The mass of an object does not depend on the gravitational force acting on the object.

Lesson 2: Newton's First Law

Multiple Choice

1. A
2. B
3. B
4. B

Open Response

During a head-on collision, the car stops but the driver keeps moving forward due to inertia. The air bag deploys and exerts a force in the opposite direction that will stop the driver from hitting his/her head on the windshield of the car.

Lesson 3: Newton's Second Law

Multiple Choice

1. C
2. A
3. A
4. D

Open Response

A centripetal force would no longer pull the Moon toward Earth. The Moon would travel in a straight path that would cause it to move out of Earth's orbit and into space. It would continue to travel in a straight line with the same velocity until some other force acted on it.

Lesson 4: Newton's Third Law

Multiple Choice

1. D
2. B
3. D
4. B

Open Response

The momentum from your foot is transferred to the soccer ball. The initial momentum of your foot equals the final momentum of your foot plus the soccer ball after you kick it.

Extended Response

1. The net force on the two-wheel cart is 13 N (or −13 N). The cart is moving to the right. A sliding friction force of 12 N (or −12 N) is on each wheel, which adds up to a total sliding friction force of 24 N (or −24 N) on the cart.
2. The momentum of the moving cue ball before it hits the other balls is around 5.7 kg·m/s. When the cue ball hits the other two balls, the cue ball stops completely. Therefore, the cue ball's momentum becomes zero. Because total momentum is conserved, all of the cue ball's original momentum is transferred to the two balls that it hits. Therefore, the total momentum of the two balls after they are hit is also 5.7 kg·m/s.

Work and Simple Machines

Lesson 1: Work and Power

Multiple Choice

1. B
2. B
3. B
4. C

Open Response

Answers will vary. Possible answer: Work is done when force causes an object to move. When someone lifts a wheelbarrow, the vertical force does not produce motion, so it is not used to calculate work. The horizontal force applied to the wheelbarrow produces motion, so it is the only force used to calculate work.

Lesson 2: Using Machines

Multiple Choice

1. D
2. D
3. A
4. B

Open Response

To make work easier, machines can change the size of a force, change the distance over which a force acts, and change the direction of a force.

Lesson 3: Simple Machines

Multiple Choice

1. A
2. D
3. C
4. B

Open Response

For first-class levers, the mechanical advantage may be greater than 1, equal to 1, or less than 1. For second-class levers, the mechanical advantage is always greater than 1. For third-class levers, the mechanical advantage is always less than 1.

Extended Response

1. A compound machine is shown. The wedge makes work easier by changing direction of a force. A wheel and axle and a lever change the size of a force. Efficiency is calculated by finding the product of the efficiencies for each simple machine in the compound machine.
2. Answers will vary. Possible answer: I would use a pulley system to lift the box. The box needs to be lifted 10 m, which is too high to use an inclined plane such as a ramp. Although a ramp could be used, it would need to be much longer than room or convenience may allow. Pulleys could be used to lift the box upward without the need for much room.

Waves

Lesson 1: What are waves?

Multiple Choice

1. D
2. A
3. B

Open Response

No; a mechanical wave moves through a fluid, a solid, or a gas. A mechanical wave must move through matter. It cannot move through the vacuum of space.

Lesson 2: Wave Properties

Multiple Choice

1. B
2. C
3. B
4. C

Open Response

No; a blue whale's voice will be loudest underwater. Sound waves are mechanical waves. Mechanical waves usually travel fastest in solids and slowest in gases. Therefore, the sound waves would travel more slowly in air than in water.

Lesson 3: Wave Interactions

Multiple Choice

1. C
2. C
3. D

Open Response

Waves that pass through matter can transfer some of their energy to the matter. Waves can change direction when they come into contact with matter. Waves also can interact with each other. For example, when two waves overlap, a new wave forms. The new wave frequently has different properties than the original waves.

Extended Response

1. Answers will vary. Possible answer: The three types of mechanical waves are sound waves, water waves, and seismic waves. Sound waves are created by vibrations. An example of a sound wave is a wave produced by a stereo speaker as it vibrates back and forth. Water waves are created when wind pushes on the surface of the water. An example of a water wave is an ocean wave. Seismic waves are created when parts of Earth's upper layers move along a crack called a fault. An example of a seismic wave is a primary, secondary, or surface wave produced by an earthquake.

2. Answers will vary, but students should note that two waves approaching each other from opposite directions can interfere with each other to form a large-amplitude wave that could be dangerous to ships located in the middle of the lake. Two waves can also destructively interfere with each other, at least partially cancelling each other out.

Sound

Lesson 1: Producing and Detecting Sound

Multiple Choice

1. A
2. B
3. B
4. C

Open Response

Answers will vary. Possible answer: Sound travels more quickly through a solid than it does through a gas. Therefore, the character might be able to hear the pounding of horses' hooves through the ground earlier than he could hear the sounds of an enemy approaching through the air.

Lesson 2: Properties of Sound Waves

Multiple Choice

1. B
2. D
3. D
4. A

Open Response

Answers will vary. Possible answer: The MP3 player is 50 dB louder than the conversation. For each 10 decibels, the sound has 10 times more energy. Therefore, the sound of the MP3 player is $10 \times 10 \times 10 \times 10 \times 10 = 100{,}000$ times more energy.

Lesson 3: Using Sound Waves

Multiple Choice

1. B
2. C
3. D
4. B

Open Response

Answers will vary. Possible answer: Therapists can hold an ultrasound device over the injured ankle. The vibrations produced by the device can travel through skin and soft tissue to massage the sprained muscles or other injured tissues in the ankle.

Extended Response

1. Answers will vary. Possible answer: The pitch of the whistle sounds the same to both Person A and Person B. The train is not moving, so sound waves from the whistle spread out evenly in all directions and have the same frequency and pitch.
2. Answers will vary. Possible answer: The frequency of the sound waves increases as the train and the sound move toward a listener and decreases as the train and the sound move away from a listener. Therefore, the train whistle would sound lower to Person C and higher to Person D.

Electromagnetic Waves

Lesson 1: Electromagnetic Radiation

Multiple Choice

1. D
2. B
3. C
4. D

Open Response

Answers will vary. Possible answer: Photons are particles of electromagnetic radiation. The photons in sunlight carry enough energy to burn skin, but the photons in light from a flashlight carry much less energy. These photons do not have enough energy to do damage.

Lesson 2: The Electromagnetic Spectrum

Multiple Choice

1. C
2. C
3. B
4. A

Open Response

Answers will vary. Possible answer: Electromagnetic waves are the same because the changing motion of an electric charge produces each type of electromagnetic wave. They are different because each type of wave has a different frequency and wavelength. Each electromagnetic wave also carries a different amount of energy.

Lesson 3: Using Electromagnetic Waves

Multiple Choice

1. C
2. B
3. D
4. A

Open Response

Answers will vary. Possible answer: Television signals are modulated electromagnetic waves, whether they are received by antenna or cable. When the signals are received by antenna, the waves traveled through space to reach the home. When they are received by cable, the waves traveled through the cable.

Extended Response

Answers will vary. Possible answer: **A.** Star B shines brighter than Star A because more of its energy is emitted as visible light than Star A. **B.** Most of Star A's energy is ultraviolet waves, X-rays, and gamma rays, which are higher levels of energy. Most of Star B's energy is radio waves, microwaves, infrared waves, and visible light, which are lower levels of energy. Star A most likely has more total energy than Star B. **C.** Since electromagnetic waves travel through space at the same rate, the waves from both stars would reach Earth at about the same time because the stars are equal distance from Earth.

Light

Lesson 1: Light, Matter, and Color

Multiple Choice

1. D
2. B
3. A
4. D

Open Response

Answers will vary. Possible answer: Both the black book and the green glass reflect and absorb some light. However, since the black book absorbs all wavelengths of visible light while the green glass reflects green wavelengths, the black book absorbs more of the light's energy. The green glass also absorbs less energy because it is translucent and some light is transmitted. The black book is opaque and does not transmit any light. Therefore, the black book becomes hotter because it absorbs more of the sunlight.

Lesson 2: Reflection and Mirrors

Multiple Choice

1. D
2. A
3. B
4. C

Open Response

Answers will vary. Possible answer: The curve of a concave mirror can be thought of as one part of a larger sphere. The focal point is halfway between the mirror's surface and the center of the larger sphere. The focal length is the distance between the mirror and the focal point.

Lesson 3: Refraction and Lenses

Multiple Choice

1. D
2. C
3. C
4. A

Open Response

Answers will vary. Possible answer: Refraction happens when light waves change speed as they move from one medium to another. White light is made up of different colors of light, each with a different wavelength and frequency. When white light passes through a prism, each wavelength is refracted slightly more or less than the others, so the colors of light are separated and produce a rainbow.

Lesson 4: Optical Technology

Multiple Choice

1. C
2. C
3. B
4. A

Open Response

Answers will vary. Possible answer: The inside of an optical fiber is coated with a reflective material. When a light beam is sent into the fiber, it reflects off the insides. When the beam hits at greater than a certain angle, then all the light reflects back into the fiber. This is called total internal reflection. The beam pulses to create signals that can carry information. The light can travel long distances through the cable.

Extended Response

1. Answers will vary. Possible answer: A is the cornea. It has a higher index of refraction than air, so light waves refract as they move from air into the cornea. B is the iris, which has an opening in the center called the pupil. The pupil changes size to allow more or fewer light waves into the eye. C is the lens, which is convex and focuses light waves onto the retina at the back of the eye. D is the ciliary muscles that change the shape of the lens so that it can focus on objects at various distances. E is the retina where the light waves hit rods and cones and are changed into information that will be sent to the brain. Cones are nerve cells that respond to color, and rods are nerve cells that respond to low light.
   F is the optic nerve, which carries information from the retina to the brain.
2. Answers will vary. Possible answer: Light emitted by a regular bulb contains the wavelengths of many colors and is sent out in all directions. Laser light is coherent light, which means that it contains all the same wavelengths and they all move together in one direction. A special material inside the laser is hit with bursts of energy. This energy causes atoms of the material to emit a single wavelength of light. This part is called the stimulated emission. The light waves emitted by the atoms bounce back and forth inside the laser because it has mirrors on each end. As the light bounces back and forth, it causes more of the atoms to emit the same wavelengths of light, and the light energy inside the laser builds up. This part is called light amplification. Finally, the laser light has enough energy to pass through the translucent mirror on one end, and a coherent beam of light shoots out.

Electricity

Lesson 1: Electric Charge and Electric Forces

Multiple Choice

1. A
2. D
3. A
4. A

Open Response

Answers will vary. Possible answer: Convection causes negative charges to accumulate at the bottom of a cloud. These negative charges repel negative charges on the ground, leaving the ground positively charged. When the electric force is strong enough, the positive charges from the ground surge upward and connect the ground to the cloud. This connection is seen as a flash of lightning.

Lesson 2: Electric Current and Simple Circuits

Multiple Choice

1. D
2. C
3. A
4. D

Open Response

Answers will vary. Possible answer: A closed circuit is a complete path that an electric current travels through. In an open circuit, there is a break somewhere along the path, and the current will not flow.

Lesson 3: Describing Circuits

Multiple Choice

1. D
2. A
3. A
4. C

Open Response

Answers will vary. Possible answer: Both circuit breakers and fuses are designed to prevent overheating in an electric circuit. A fuse contains a small piece of metal that is part of the circuit. When it becomes overheated, it breaks and the circuit breaks as well. A circuit breaker is a switch that opens the circuit if it becomes overheated. Fuses need to be replaced. Circuit breakers just need to be reset.

Extended Response

1. Answers will vary. Possible answer: When devices are added to a series circuit, the resistance increases. This causes the amount of current to decrease. In a parallel circuit, devices can be added without increasing the resistance. However, as devices are added, the amount of current flowing through the circuit will increase.

The circuit shown in the illustration is a parallel circuit. In order to make just the center bulb go out, the circuit can be cut at either S or K. In order to make all of the bulbs go out, the circuit can be cut at either U or M.

2. Answers will vary. Possible answer: Never use an electric device with a damaged cord. Do not use electric devices in the rain or when you are near water. Never climb utility poles or play near electric boxes or electricity substations. Never plug more than two devices into the same outlet.

Magnetism

Lesson 1: Magnets and Magnetic Fields

Multiple Choice

1. A
2. B
3. C
4. B

Open Response

Answers will vary. Possible answer: Amy explains that the Northern Lights are auroras that form when large numbers of charged particles are emitted from the Sun and travel along Earth's magnetic field lines to concentrate at the poles. When these particles collide with atoms of gases in Earth's atmosphere, they cause the atmosphere to glow with different colors.

Lesson 2: Making Magnets with an Electric Current

Multiple Choice

1. C
2. A
3. C
4. B

Open Response

Answers will vary. Possible answer: Magnetic forces between the two magnets make the electromagnet spin, which turns the motor and allows it to work.

Lesson 3: Making an Electric Current with Magnets

Multiple Choice

1. D
2. A
3. A
4. B

Open Response

Answers will vary. Possible answer: A simple generator has a single wire loop to produce an electric current. Power plants use generators that have several large wire coils. Each coil might have thousands of loops. This is useful because increasing the number of coils and the number of loops increases the amount of current produced by the generators.

Extended Response

1. The device is a generator that produces alternating electric current.
2. An electric motor uses an electric current to produce motion. A generator uses motion to produce an electric current. These devices are similar in that they both use a wire coil that rotates within a magnetic field to convert energy.