Answer Key

Concept Reviews

SECTION: MATTER AND ENERGY

1. a. liquid
   b. gas
   c. solid
   d. plasma
2. The sugar molecules will have a lower speed on average than the water molecules because the sugar molecules are more massive than the water molecules. As the temperature of the mixture increases, the speed of all of the molecules will increase.
3. Coffee at 38°C has more kinetic energy than coffee at 34°C. Although there is less tea than coffee, the temperature of the tea is greater, so the tea has more average kinetic energy than the coffee.
4. The temperature, and therefore the kinetic energy of the particles in 0.5 L of coffee and 0.25 L of coffee are the same, but there are more particles in 0.5 L of coffee, so the total thermal energy is greater.
5. a. 6 cm^3 of ice is a solid, so it retains its shape and has a volume of 6 cm^3.
   b. The melted ice is a liquid. The liquid takes the shape of the beaker, but retains its volume.
   c. The evaporated water is a gas, and has no definite shape and no definite volume.

SECTION: CHANGES OF STATE

1. a. sublimation
   b. condensation
   c. evaporation
2. Answers may vary. Sample answer: Evaporation and sublimation require energy to be used. Energy is released during condensation and freezing.
3. When water evaporates, the total number of water molecules, and therefore the mass, stays the same; the molecules are just spread out over a greater volume.
4. When water evaporates, energy is transferred from the surroundings to the water, so the water molecules are moving faster than they were, but the total amount of energy is the same.
5. The temperature at which water begins to freeze is 0˚C. When ice reaches 0˚C it begins to melt. The temperature at which water freezes and the temperature at which ice melts is the same.

SECTION: FLUIDS

1. An object in a fluid medium displaces a set amount of fluid upon immersion. Archimedes' principle states that the weight of the displaced fluid is equal to the buoyant force exerted on the object.
2. The buoyant force exerted on the wood is equal to the weight of the wood.
3. 150,000 Pa
4. A fluid in equilibrium contained in a vessel exerts a pressure of equal intensity in all directions.
5. 33,250 N
6. As the speed of a moving fluid increases, its pressure decreases.

SECTION: BEHAVIOR OF GASES

1. a. Boyle's law
   b. Charles's law
   c. Gay-Lussac's law
2. Solids have molecules fixed in relation to each other. Liquids have molecules capable of sliding past each other, but still stick together. Gases have molecules that are rarely in contact with each other. A substance as a solid has a definite volume and shape. The same substance as a liquid has a definite volume but takes the shape of its container. The same substance as a gas has no definite shape or volume.
3. a
4. c
5. d
6. Either its pressure or volume must also change. Alternatively, both may change. The amplitude and direction of the changes depends on the original temperature change.

Math Skills

PASCAL'S PRINCIPLE

1. 80.6 N
2. 350.0 N
3. 293.6 N
4. 28 cm^2
5. 63.0 cm^2
6. 64 cm^2
7. 4.05×10^5 N
8. 5.8×10^2 N
9. 1.397×10^5 N
10. 250 N
11. 3.148×10^4 Pa

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BOYLE'S LAW

1. 56.1 kPa
2. 50.9 kPa
3. 1.34×10^4 kPa
4. 449 kPa
5. 711 L
6. 165 L
7. 378 L
8. 0.262 L
9. 3.6 L
10. 101 L
11. 370 kPa
12. 5,478 kPa
13. 70 L

Cross-Disciplinary

INTEGRATING BIOLOGY: DENSITY AND SWIM BLADDERS

1. Less dense objects will float on more dense objects.
2. The swim bladder allows the fish to hover, and does not require it to expend energy to maintain its position in the water.
3. By wearing just the right weight of lead, a scuba diver can adjust his or her density to equal that of the surrounding water so that the diver does not rise or sink in the water.

INTEGRATING PHYSICS: PLASMA

1. Plasma is a mixture of positive ions and free electrons; three examples are the interior of stars, neon signs, and the aurora borealis and aurora australis.
2. Although we usually observe matter in its solid, liquid, and gaseous forms on Earth, most matter in the rest of the universe, including the interiors of stars (which are much more numerous than planets like Earth), is in the plasma state.
3. Plasma is considered to be a separate state of matter because its properties are very different from the properties of gases. Unlike a gas, a plasma is made of free electrons and positively charged ions.

INTEGRATING SPACE SCIENCE: OUR CHANGING UNIVERSE

1. Huge amounts of radiation prevented protons, neutrons, and electrons from binding together immediately after the big bang.
2. Light atoms such as hydrogen, hydrogen's isotopes deuterium and tritium, helium, and lithium were the first atoms to form.
3. Light elements were formed when protons, neutrons, and electrons from the big bang explosion joined together; heavier elements are formed in nuclear reactions that occur in stars.

REAL WORLD APPLICATIONS: GAS LAWS

1. Boyle's law relates the pressure and volume of a gas. Charles's law and Gay-Lussac's law relate the volume and pressure, respectively, of a gas to its temperature.
2. The pressure increases when the sealed-in gas is heated.
3. Heating the air inside a balloon increases its volume, making it less dense than surrounding air. This produces a buoyant force on the balloon.

REAL WORLD APPLICATIONS: SUBMARINES

1. Buoyancy is an upward force produced by the pressure of a fluid on an object.
2. The buoyant force on an object is equal to the weight of the fluid displaced by the object.
3. To make a submarine sink, sea water is pumped into the ballast tanks, making the submarine heavier than the water it displaces. The submarine rises when air replaces the water in the tanks.

SCIENCE AND THE CONSUMER: DRY ICE

1. The snow is subliming, or turning directly from a solid to a gas.
2. Carbon dioxide gas is more dense than air, so it sinks in air.
3. The dry ice keeps the ice cream frozen for a long period of time. The dry ice doesn't melt, which would make the cardboard in the carton get wet.

SCIENCE AND THE CONSUMER: REFRIGERANTS.

1. The body is cooled by using excess body heat to evaporate perspiration from the skin.
2. When a refrigerant condenses in the coils of a refrigerator, heat is given off into the air around the refrigerator.
3. Evaporation requires an input of heat. When perspiration evaporates, heat is removed from skin. When a refrigerant in a refrigerator evaporates, heat is removed from the inside of the refigerator.

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