Chapter 14 Answers

14.1 Section Review

1. b
2. Charge is a property of all atoms.
3. C
4. strong nuclear force; electromagnetic force; weak force; gravity
5. The neutron has zero electric charge.
6. b
7. a
8. C
9. b

14.2 Section Review

10. c
11. Lithium's spectrum is represented by the middle diagram.
12. a
13. The 2nd and 3rd energy levels.
14. 18
15. B
16. c
17. a

Connection

1. Electrical energy, mechanical energy, and chemical energy can be absorbed by atoms to produce light. Bioluminescence is produced using chemical energy.
2. No one knows for sure why no bioluminescence has been found in these kinds of organisms, but it may have something to do with the energy needed to make light. More complex living organisms tend to require more energy for life functions; perhaps they can't spare enough energy for bioluminescence.
3. Blue or blue-green is the most common color in marine bioluminescence. Red is sometimes found in deep water jellyfish. All of the colors of the rainbow have been found, but blue is by far the most common. Milky seas are caused by bioluminescent bacteria that glow with a milky-white light. Satellite images have recorded this phenomenon. Sea creatures that swim near the surface often have bioluminescent undersides. This helps them hide from predators below, preventing them from appearing as a dark silhouette against the surface of the water.

Chapter 14 Assessment

Vocabulary

Section 14.1

1. mass number
2. elementary charge
3. nucleus
4. electron
5. neutron
6. atomic number
7. radioactive
8. isotopes

Section 14.2

9. energy level
10. quantum theory
11. spectral line
12. spectroscope

Concepts

Section 14.1

1. Rutherford assumed most of the atom was empty space because most of the alpha particles passed through the gold foil without any deflection at all.
2. Every once and a while the alpha particles bounced back at sharp angles. The only way to explain this result was to conclude that most of the mass was concentrated in a small dense area.
3. Thomson's model of the atom correctly predicted the existence of electrons but he believed the positive portion of the atom was spread out evenly. The electrons were like raisins in a loaf of raisin bread. The bread represented the positive portion of the atom. Rutherford's model theorized that the positive charge was concentrated, instead of spread out, in a small dense core of the atom called the nucleus.
4.

Particle	Place in Atom	Charge	Relative Mass
electron	outside nucleus	−1	1
proton	in nucleus	+1	1,836
neutron	in nucleus	0	1,839

5. Strongest: Strong nuclear force > electric force > weak force > gravity.
6. Electromagnetic (electric) forces are the forces of attraction between protons and electrons. These electromagnetic forces keep the electrons from leaving the atom. The strong nuclear force is the force of attraction among the particles of the nucleus: the protons and neutrons. These strong forces hold the nucleus together and overcome the electromagnetic forces of repulsion between protons (like charges).
7. The atomic number tells you the number of protons in the atom and therefore the identity of the atom. The mass number is the sum of the protons plus the number of neutrons for the atom.
8. In a neutral atom the number of protons and electrons are equal.
9. For isotopes of the same element the atomic numbers are the same. However, the mass numbers for the isotopes differ because each isotope has a different number of neutrons.
10. Alpha decay occurs when the nucleus ejects two protons and two neutrons (a helium-4 nucleus). Beta decay occurs when a neutron in the nucleus splits into a proton and an electron. The proton stays in the nucleus, but the high energy electron is ejected (beta radiation). Gamma decay the process by which the nucleus gets rid of excess energy. Gamma radiation is pure energy that ejected from the nucleus.

Section 14.2

11. The electron is the particle that is most responsible for its chemical properties. Electrons are involved in chemical bonding, so they determine how an atom combines with other atoms to form compounds.
12. Almost all the light we see comes from atoms.
13. A spectroscope is a device that separates light into a spectrum. When atoms are heated to incandescence they emit only certain colors of light. Since each element emits only certain colors the spectrum is unique to that element.
14. The specific colors of the spectral lines correspond to differences in energy between energy levels. The fact that the spectrum is not continuous is further evidence that electrons cannot be between energy levels.
15. Bohr explained that specific colors of spectral lines are the result of electrons that are transitioning from higher energy levels to lower energy levels. The difference in these energy levels is emitted as a light. The specific color corresponds to the particular energy level from which the electron originates and the energy level to which the electron falls.
16. An electron in the ground state is in the lowest possible energy level. An excited electron is in a higher energy level and unstable. Electrons in excited states will eventually fall back down to the ground state.
17. When an electron falls from a higher to a lower energy level, energy is released in the form of light of a specific color.
18. Heisenberg's uncertainty principle states that a subatomic particle's position, momentum, energy, and time can never be known simultaneously. Any attempt to gather information about an electron's position in an atom, for example, makes it impossible to know other variables such as its momentum or energy.
19. It is not possible to find the position of an electron with any certainty without sacrificing information about the other variables. This is due to the fact that in order to "see" an electron you need to bounce a photon of light off of it. If you manage to hit an electron with the photon, you can determine the position of the electron at that moment. However, electrons are so small that a photon of light can alter an electron's speed, momentum, energy and position.
20. The location of an electron is described as "smeared out" into a wave-like "cloud."

Problems

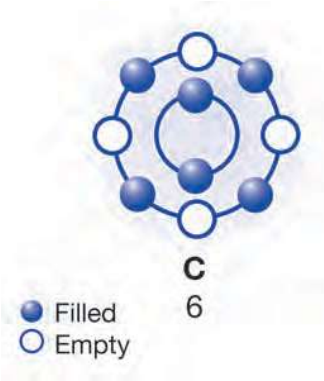
Section 14.1

1. b, d, e (charge exists only as whole number quantities)
2. +1
3. Atom A = chlorine; atomic no. 17; mass no. 35
   Atom B = calcium; atomic no. 20; mass no. 40
   Atom C = copper; atomic no. 29; mass no. 63
   Atom D = bromine; atomic no. 35; mass no. 80
4. Answers: a. 15 b. 7 c. 7
5. Answers: a. 10 b. 4 c. 4 d. 6
6. Answers: a. 234 b. 90 c. 90 d. 144

Section 14.2

7. Answers: a. 5 to 2 b. violet

8. Diagram illustrating the filled energy levels for a carbon atom:



Applying Your Knowledge

Section 14.1

1. Ask students to conduct research on the Internet or in the library. Student work should illustrate that the Thomson model of the atom reflected his discovery of the electron which carries a negative charge. The Rutherford model, based on his gold foil experiment, introduced the nucleus to the atomic model. The Bohr model introduced the idea that electrons have fixed amounts of energy. You may also ask students to research the Schrödinger model which reflected discoveries of the wavelike nature of electrons.
2. Have students conduct Internet and library research. Keywords to use in a search engine include nuclear medicine, radioisotopes, radioactive isotopes, and medical radioactive isotopes. Diseases which are diagnosed or treatable with nuclear medicine include Alzheimer's disease, many forms of cancer, heart disease, Parkinson's disease, and neurological diseases. Nuclear medicine procedures are beneficial to patients because they are non-invasive (for example, surgery is not required).

Section 14.2

3. Answer:

The red lines are to the left in the graphic and the blue/violet are to the right. The shortest wavelength corresponds to the highest energy. Violet lines have the highest energy and red have the lowest energy.

Wavelength of line on spectrum (nm)	Color	Energy
389	violet	highest
402	violet	
447	blue	
471	blue green	
502	green	
588	yellow	
668	red	
707	deep red	lowest

4. The Atom Building Game is modeled after the Bohr atom. The most challenging part of this project will be for your students to figure out how to show that the electrons orbit in different energy levels. This aspect of the project makes it suitable as a group project. Students enjoy working together to solve problems such as how to accurately model an atom. Challenge them to try to be as accurate as possible. For an extra challenge, have them see if they can model an atom with a high atomic number.