Name _____ Date _____ Class _____

5.1 MODELS OF THE ATOM

Section Review

Objectives

- Identify inadequacies in the Rutherford atomic model
- Identify the new assumption in the Bohr model of the atom
- Describe the energies and positions of electrons according to the quantum mechanical model
- Describe how the shapes of orbitals at different sublevels vary

Vocabulary

- energy levels
- quantum
- quantum mechanical model
- atomic orbital

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

The chemical properties of atoms, ions, and molecules are related to the arrangement of the __1__ within them.

The first modern atomic theory, proposed by __2__, portrayed the atom as a solid, indivisible mass. After the discovery of the electron by __3__, the atomic model was revised to include them. J.J. Thomson's model is referred to as the __4__ model. Rutherford pictured the atom as a dense __5__ surrounded by electrons. In the Bohr model, the electrons move in __6__ paths. The __7__ model is the modern description of the electrons in atoms. This model estimates the __8__ of finding an electron within a certain volume of space surrounding the nucleus.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

_____ 9. Electrons must have a certain minimum amount of energy called a quantum in order to move from one energy level to the next higher energy level.

_____ 10. The electron probability clouds for atomic orbitals are spherical in shape.

Name _____ Class _____ Date _____

_____ **11.** The number of sublevels in an energy level is equal to the square of the principal quantum number of that energy level.

_____ **12.** The maximum number of electrons that can occupy the fourth principal energy level of an atom is 32.

_____ **13.** The higher the energy level occupied by an electron the more energetic it is.

_____ **14.** The principal quantum number equals the number of sublevels within that principal energy level.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
_____ **15.** quantum	**a.** a region in space around the nucleus of an atom where an electron is likely to be moving
_____ **16.** atomic orbitals	**b.** the regions around the nucleus within which the electrons have the highest probability of being found
_____ **17.** energy level	**c.** the amount of energy required to move an electron from its present energy level to the next higher one
_____ **18.** quantum mechanical model	**d.** the modern description of the behavior of electrons in atoms

Part D Questions and Problems

Answer the following in the space provided.

19. Summarize the development of atomic theory.

_____

_____

_____

_____

_____

20. How many orbitals are in each of the following sublevels?

a. 4*p* sublevel _____

b. 3*d* sublevel _____

c. 4*f* sublevel _____

d. 2*s* sublevel _____

Name _____ Date _____ Class _____

5.3 PHYSICS AND THE QUANTUM MECHANICAL MODEL

Section Review

Objectives

- Describe the relationship between the wavelength and frequency of light
- Explain how the frequencies of light are related to changes in electron energies
- Distinguish between quantum mechanics and classical mechanics
- Identify the cause of the atomic emission spectrum

Vocabulary

- amplitude
- wavelength (λ)
- frequency (ν)
- hertz (Hz)
- electromagnetic radiation
- spectrum
- atomic emission spectrum
- ground state
- photons
- Heisenberg uncertainty principle

Key Equations

- $c = \lambda\nu$
- $E = h \times \nu$
- $\lambda = \dfrac{h}{m\nu}$

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

According to quantum mechanics, the motions of subatomic particles may be described as __1__. The frequency and wavelength of all waves are __2__ related.

Every element emits __3__ if it is heated by passing an electric discharge through its gas or vapor. Passing this emission through a prism gives the __4__ of the element.

The quantum concept developed from Planck's studies of __5__ and Einstein's explanation of the __6__ effect. Planck showed that the amount of radiant energy absorbed or emitted by a body is proportional to the __7__ of the radiation.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Name _____ Class _____ Date _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

_____ **8.** The speed of light is a constant that can be obtained by dividing the frequency of light by its wavelength.

_____ **9.** The amplitude of a wave is the distance between the crests.

_____ **10.** The energy of a body can change only in small discrete units.

_____ **11.** The position and velocity of an electron in an atom can be determined with great certainty.

_____ **12.** The photoelectric effect will occur no matter what frequency of light strikes a metal.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
_____ **13.** photons	**a.** predicts that all matter exhibits wavelike motions
_____ **14.** de Broglie's equation	**b.** the distance between two consecutive wave crests
_____ **15.** visible light	**c.** light quanta
_____ **16.** ground state	**d.** the lowest energy level for a given electron
_____ **17.** wavelength	**e.** example of electromagnetic radiation

Part D Questions and Problems

Answer the following in the space provided.

18. What is the frequency of radiation whose wavelength is 2.40×10^{-5} cm?

19. Apply quantum theory to explain the photoelectric effect.

Name _____ Date _____ Class _____

5 ELECTRONS IN ATOMS

Practice Problems

In your notebook, solve the following problems.

SECTION 5.1 MODELS OF THE ATOM

1. How many sublevels are in the following principal energy levels?
   a. $n = 1$
   b. $n = 2$
   c. $n = 3$
   d. $n = 4$
   e. $n = 5$
   f. $n = 6$
2. How many orbitals are in the following sublevels?
   a. $1s$ sublevel
   b. $5s$ sublevel
   c. $4d$ sublevel
   d. $4f$ sublevel
   e. $7s$ sublevel
   f. $3p$ sublevel
   g. fifth principal energy level
   h. $6d$ sublevel
3. What are the types of sublevels and number of orbitals in the following energy levels?
   a. $n = 1$
   b. $n = 2$
   c. $n = 3$
   d. $n = 4$
   e. $n = 5$

SECTION 5.2 ELECTRON ARRANGEMENT IN ATOMS

1. Write a complete electron configuration of each atom.
   a. hydrogen
   b. vanadium
   c. magnesium
   d. barium
   e. bromine
   f. sulfur
   g. krypton
   h. arsenic
   i. radon

SECTION 5.3 PHYSICS AND THE QUANTUM MECHANICAL MODEL

1. What is the wavelength of the radiation whose frequency is $5.00 \times 10^{15}\ s^{-1}$? In what region of the electromagnetic spectrum is this radiation?
2. An inexpensive laser that is available to the public emits light that has a wavelength of 670 nm. What are the color and frequency of the radiation?
3. What is the energy of a photon whose frequency is $2.22 \times 10^{14}\ s^{-1}$?
4. What is the frequency of a photon whose energy is 6.00×10^{-15} J?
5. Arrange the following types of electromagnetic radiation in order of increasing frequency.
   a. infrared
   b. gamma rays
   c. visible light
   d. radio waves
   e. microwaves
   f. ultraviolet
6. Suppose that your favorite AM radio station broadcasts at a frequency of 1600 kHz. What is the wavelength in meters of the radiation from the station?

Name _____ Date _____ Class _____

5 INTERPRETING GRAPHICS

Use with Section 5.3

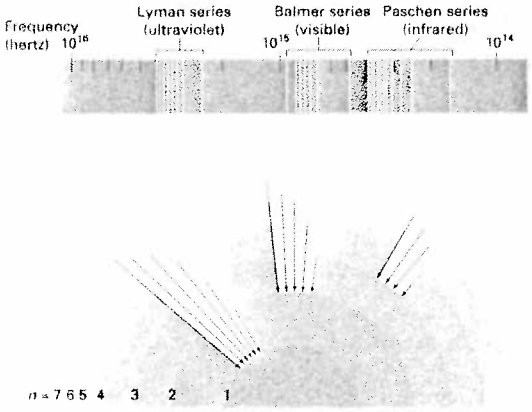

Figure 1 The emission spectrum and orbit-transition diagram for hydrogen.

Table 1

Transition	E (J)	ν (s^{-1})	λ (m)	Type of Radiation
$n = 6 \rightarrow n = 5$	2.66×10^{-20}			
$n = 6 \rightarrow n = 4$	7.57×10^{-20}			
$n = 6 \rightarrow n = 3$	1.82×10^{-19}			
$n = 6 \rightarrow n = 2$	4.84×10^{-19}			
$n = 6 \rightarrow n = 1$	2.12×10^{-18}			
$n = 5 \rightarrow n = 4$	4.91×10^{-20}			
$n = 5 \rightarrow n = 3$	1.55×10^{-19}			
$n = 5 \rightarrow n = 2$	4.56×10^{-19}			
$n = 5 \rightarrow n = 1$	2.09×10^{-18}			
$n = 4 \rightarrow n = 3$	1.06×10^{-19}			
$n = 4 \rightarrow n = 2$	4.09×10^{-19}			
$n = 4 \rightarrow n = 1$	2.04×10^{-18}			
$n = 3 \rightarrow n = 2$	3.03×10^{-19}			
$n = 3 \rightarrow n = 1$	1.94×10^{-18}			
$n = 2 \rightarrow n = 1$	1.64×10^{-18}			