

## Chapter 13 – Electrons in Atoms

Chapter 13: 1 – 20, 23 – 25, 27, 31, 32, 34 – 38, 41, 45, 47, 48, 52

### Section 13.1 – Models of the Atom

#### Section Review 13.1

1. List in chronological order, a major contribution of each of these scientists to the understanding of the atom:

*Dalton* –

*Thomson* –

*Bohr* –

*Schrodinger* –

*Rutherford* –

2. In general terms, explain how the quantum mechanical model of the atom describes the electronic structure of an atom.

3. The energies of electrons are said to be quantized. Explain what this means.

4. How many orbitals are in the following sublevels?

a. *3p* sublevel \_\_\_\_\_

b. *2s* sublevel \_\_\_\_\_

c. *4f* sublevel \_\_\_\_\_

d. *4p* sublevel \_\_\_\_\_

e. *3d* sublevel \_\_\_\_\_

### Section 13.2 – Electron Arrangement in Atoms

#### Practice Problems

5. Write the complete electron configuration for each atom.

a. carbon

b. argon

6. Write the electron configuration for each atom. How many unpaired electrons does each atom have (electrons residing in orbitals by themselves)?

a. boron

b. silicon

### Section Review 13.2

7. Write the complete electron configuration for each atom.

a. lithium

b. fluorine

c. rubidium

8. Explain why the actual electron configurations for chromium and copper differ from those assigned using the aufbau diagram.

9. Arrange the following sublevels in order of decreasing energy: 2p, 4s, 3s, 3d, and 3p.

10. Why does one electron in a potassium atom go into the fourth energy level instead of squeezing into the third energy level along with the eight already there?

## Section 13.3 – Physics and the Quantum Mechanical Model

### Practice Problems

11. What is the wavelength of radiation with a frequency of  $1.50 \times 10^{13} \text{ s}^{-1}$ ? Does this radiation have a longer or shorter wavelength than red light?

12. What frequency is radiation with a wavelength of  $5.00 \times 10^{-6} \text{ cm}$ ? In what region of the electromagnetic spectrum is this radiation?

13. What is the energy of a photon of microwave radiation with a frequency of  $3.20 \times 10^{11} \text{ s}^{-1}$ ?

14. The threshold photoelectric effect in tungsten is produced by light of wavelength 260 nm. Give the energy of a photon of this light in joules.

### Section Review 13.3

15. A hydrogen lamp emits several lines in the visible region of the spectrum. One of these lines has a wavelength of  $6.56 \times 10^{-5}$  cm. What are the color and frequency of this radiation?

16. Explain the origin of the atomic emission spectrum of an element.

17. Can classical physics explain the photoelectric effect? Explain your answer.

18. Compare the ground state and the excited state of an electron.

19. Arrange the following in order of decreasing wavelength.

- a. infrared radiation from a lamp
- b. dental x-rays
- c. signal from a shortwave radio station

## Chapter 13 Review

### Concept Practice

20. Which subatomic particles did Thomson include in the plum-pudding model of the atom?  
13.1

23. What is the significance of the boundary of an electron cloud?

24. What is an atomic orbital?

25. Sketch  $1s$ ,  $2s$ , and  $2p$  orbitals using the same scale for each. 13.1

$1s$	$2s$	$2p_x$	$2p_y$	$2p_z$

27. What are the three rules that govern the filling of atomic orbitals? 13.2

31. What is the maximum number of electrons that can go into each of the following sublevels?  
13.2

a.  $2s$  \_\_\_\_\_      b.  $3p$  \_\_\_\_\_      c.  $4s$  \_\_\_\_\_      d.  $3d$  \_\_\_\_\_

e.  $4p$  \_\_\_\_\_      f.  $5s$  \_\_\_\_\_      g.  $4f$  \_\_\_\_\_      h.  $5p$  \_\_\_\_\_

32. How many electrons are in the second energy level of an atom of each element? 13.2

a. chlorine –

b. phosphorus –

c. potassium –

34. List the color of the visible spectrum in order of increasing wavelength. 13.3

35. What is meant by the frequency of a wave? What are the units of frequency? Describe the relationship between frequency and wavelength. 13.3

36. Use a diagram to illustrate each term. 13.3

- a. wavelength
- b. amplitude
- c. wave cycle

37. Explain the difference between the laws of classical physics and the quantum concept when describing the energy lost or gained by an object. 13.3

38. What is the energy of a photon of green light with a frequency of  $5.80 \times 10^{14} \text{ s}^{-1}$ ?

41. Explain the difference between a photon and a quantum. 13.3

### Concept Mastery

45. Provide the symbol for the atom that corresponds to each electron configuration.

- a.  $1s^2 2s^2 2p^6 3s^2 3p^6$
- b.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^7 5s^1$
- c.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^7 5s^2 5p^6 5d^1 6s^2$

47. How many paired electrons are there in an atom of each element?

- a. helium
- b. boron
- c. sodium
- d. oxygen

48. An atom of an element has two electrons in the first energy level and five electrons in the second level. Write the electron configuration for this atom and name the element. How many unpaired electrons does an atom of this element have?

52. Provide the symbol and name of the elements that correspond to these configurations.

- a.  $1s^2 2s^2 2p^6 3s^1$
- b.  $1s^2 2s^2 2p^3$
- c.  $1s^2 2s^2 2p^6 3s^2 3p^2$
- d.  $1s^2 2s^2 2p^4$
- e.  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
- f.  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$