

## Chapter Six Study Guide Answers

### Outline

- I. Development of the theory of duality of light
  - A. Problems with the wave theory of light
  - B. Plank's work theory
  - C. Einstein's explanation of the photoelectric effect
  - D. Duality of light
- II. Development of the modern theory of the atom
  - A. Bohr Theory of the atom
  - B. Duality of matter
  - C. Heisenberg's Uncertainty Principle
  - D. Schrodinger's Equation
- III. The Quantum Mechanical Model of the Atom
  - A. Quantum Numbers
    1. The Principle Quantum Number, "n"
    2. The Angular Momentum Quantum Number, "l"
    3. The Magnetic Quantum Number "m<sub>l</sub>"
    4. The Spin Quantum Number, "m<sub>s</sub>"
  - B. Rules for assignment of quantum numbers
    1. Aufbau Principle
    2. Hund's Rules
    3. Pauli Exclusion Principle
    4. Orbital Diagrams
  - C. Electron Configurations
  - D. Terms
    1. Isoelectric
    2. Degeneracy

3. Paramagnetic

4. Dimagnetic

#### Practice Problems

1. What is the frequency of 520. nm light?

$$5.77 \times 10^{14} \text{ s}^{-1}$$

2. What is meant by the duality of light?

**Light has wave properties, but consists of a collection of particles—photons; duality of light means light has both wave and particle properties.**

3. Which of the following scientists developed the uncertainty principle that is used in the quantum mechanical model of the atom?

a. Bohr      **b. Heisenberg**      c. Planck      d. Schrodinger

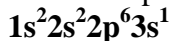
4. True or **False**. Two electrons in the same atom can have the same four quantum numbers.

5. What is the energy of a single photon that has the frequency of  $7.5 \times 10^{14} \text{ s}^{-1}$ ?

$$(h = 6.63 \times 10^{-34} \text{ Js})$$

$$5.0 \times 10^{-19} \text{ J}$$

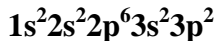
6. Make and complete an Aufbau diagram for Na.



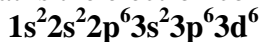
7. What is the maximum number of electrons that can be contained in any subshell (orientation)?

**2**

8. What is the electron configuration for silicon?



9. What is the electron configuration for  $\text{Fe}^{2+}$ ?



10. Write the condensed electron configurations for the following atoms, using the appropriate noble-gas core abbreviations.

- a. Cs      -  $[\text{Xe}]6s^1$   
b. Ni      -  $[\text{Ar}]4s^2 3d^8$   
c. Se      -  $[\text{Ar}]4s^2 3d^{10} 4p^4$   
d. Cd      -  $[\text{Kr}]5s^2 4d^{10}$   
e. Ac      -  $[\text{Rn}]7s^2 6d^1$   
f. Pb      -  $[\text{Xe}]6s^2 4f^{14} 5d^{10} 6p^2$

11. What is the maximum number of electrons that can occupy each of the following subshells?

- a. 3d    - **10**  
b. 4s    - **2**  
c. 2p    - 6  
d. 5f    - **14**

12. What is wrong with the following electron configurations for atoms in their ground states?

- a.  $1s^2 2s^2 3s^1$     **no electrons in the 2p orbital**

- b.  $[\text{Ne}]2s^22p^3$  should be  $[\text{He}]$  not  $[\text{Ne}]$   
c.  $[\text{Ne}]3s^23d^5$  doesn't go from 3s to 3d, goes 3s, 3p, 4s, 3d

13. Calculate the energy of a photon of light, in Joules, with a wavelength of 743 nm.

**$2.68 \times 10^{-26}$**

14. Which of the following is not a valid set of quantum numbers?

a.  $n = 5, l = 1, m_l = 0, m_s = +1/2$

**b.  $n = 4, l = 0, m_l = 1, m_s = +1/2$**

c.  $n = 3, l = 2, m_l = -1, m_s = -1/2$

d.  $n = 2, l = 1, m_l = 1, m_s = -1/2$

e.  $n = 1, l = 0, m_l = 0, m_s = +1/2$

15. What is the maximum number of electrons that can occupy the orbitals represented by  $n = 5, l = 1$ ?

**6**

16. Which of the following ground state electron configurations is incorrect for the atom listed.

a. Argon –  $1s^22s^22p^63s^23p^6$

**b. Sulfur –  $1s^22s^22p^63s^23p^2$**

c. Iron –  $1s^22s^22p^63s^23p^64s^23d^6$

d. Boron –  $1s^22s^22p^1$

e. Chlorine –  $1s^22s^22p^63s^23p^5$

17. Calculate the energy of a mole of photons, in Joules, having a frequency of  $1.79 \times 10^{15}$  Hz.

**$7.14 \times 10^5$**

18. What is the chemical symbol for the atom whose ground state electron configuration has two electrons in the 1s orbital only.



19. The light from one brand of laser used to correct and modify vision has a wavelength in the ultraviolet region of the spectrum. If the wavelength of the Ar-F laser used in LASIK surgery is close to 193.1 nm, what is the energy of a mole of photons having this wavelength?

**$6.20 \times 10^5$**

20. What is the maximum number of electrons that can occupy the orbitals represented by  $n = 4, l = 2, m_l = -2, m_s = -1/2$ ?

**1**

21. What is the chemical symbol for the atom whose ground state electron configuration has five electrons in the 4p orbital?



22. Which of the following is a valid set of quantum numbers for the last electron added to the ground state electron configuration for nickel?

a.  $n = 3, l = 1, m_l = 0, m_s = -1/2$

b.  $n = 4, l = 2, m_l = -1, m_s = +1/2$

**c.  $n = 3, l = 2, m_l = 0, m_s = -1/2$**

d.  $n = 4, l = 3, m_l = -1, m_s = +1/2$

e.  $n = 3, l = 1, m_l = +2, m_s = -1/2$