

Chemistry 105, Chapter 6 Exercises

Light

1. Magnetic resonance imaging (MRI) operates at a frequency of 4.00×10^2 MHz (1MHz = 10^6 Hz). Calculate:
 - a. the wavelength.
 - b. the energy in joules per photon.
 - c. the energy in kilojoules per mole of photons.
2. A photon of violet light has a wavelength of 423. nm. Calculate:
 - a. the frequency.
 - b. the energy in joules per photon.
 - c. the energy in kilojoules per mole of photons.
3. Carbon dioxide absorbs energy at a wavelength of 1498. nm.
 - a. In what spectral range does the absorption occur?
 - b. Calculate the frequency of this absorption.
 - c. What is the energy of one of these photons?

Bohr Model

4. Consider the transition from the energy levels $n = 1$ to $n = 3$.
 - a. What is the energy per photon, frequency, and wavelength in nm associated with this transition?
 - b. In what spectral region does this transition occur?
 - c. Is the energy absorbed or emitted?
5. Consider the transition from the energy levels $n = 4$ to $n = 2$.
 - a. What is the energy per photon, frequency, and wavelength in nm associated with this transition?
 - b. In what spectral region does this transition occur?
 - c. Is the energy absorbed or emitted?

Shells, Subshells, and Orbitals

6. For the following pairs of orbitals, indicate which is higher in energy in a many-electron atom.
 - a. 3s or 3p
 - b. 4p or 4d
 - c. 2s or 3d
 - d. 5s or 4s
7. What is the maximum number of electrons that can fit in:
 - a. $n = 4$?
 - b. a 3s subshell?
 - c. a d subshell?
 - d. a p orbital?
 - e. a f subshell?
 - f. a 4p orbital?

Electron Configurations

8. Write the ground state electron configuration and the abbreviated ground state electron configuration for each of the following. Also, indicate the number of unpaired electrons for each.
 - a. Be
 - b. F
 - c. Mg
 - d. P
 - e. V
 - f. Se
 - g. Rb
 - h. Zr
 - i. Sn

Periodic Trends

9. Arrange the elements Rb, Te, and I in order of
 - a. increasing atomic radius.
 - b. increasing first ionization energy.
 - c. increasing electronegativity.

10. Arrange the elements Mg, S, and Cl in order of
 - a. increasing atomic radius.
 - b. increasing first ionization energy.
 - c. increasing electronegativity.

11. Which of the four atoms Na, P, Cl or K
 - a. has the largest atomic radius?
 - b. has the highest ionization energy?
 - c. is the most electronegativity?

12. Which of the four atoms Rb, Sr, Sb, or Cs
 - a. has the smallest atomic radius?
 - b. has the lowest ionization energy?
 - c. is the least electronegative?

13. Select the larger member of each pair.
 - a. K and K^+
 - b. O and O^{2-}
 - c. Tl and Tl^{3+}
 - d. Cu^+ and Cu^{2+}

14. Select the smaller member of each pair.
 - a. N and N^{3-}
 - b. Ba and Ba^{2+}
 - c. Se and Se^{2-}
 - d. Co^{2+} and Co^{3+}

15. List the following species in order of decreasing radius.
 - a. K, Ca, Ca^{2+} , Rb
 - b. S, Te^{2-} , Se, Te

16. List the following species in order of increasing radius.
 - a. Co, Co^{2+} , Co^{3+}
 - b. Cl, Cl^- , Br^-

Answers

1. a. 0.750m b. $2.65 \times 10^{-25}\text{J}$ c. $1.60 \times 10^{-4}\text{KJ/mol}$

2a. $7.09 \times 10^{14}\text{s}^{-1}$ b. $4.70 \times 10^{-19}\text{J}$ c. 283. KJ/mol

3. a. IR b. $2.001 \times 10^{14}\text{s}^{-1}$ c. $1.326 \times 10^{-19}\text{J}$

4a. $1.938 \times 10^{-18}\text{J}$, $2.925 \times 10^{15}\text{s}^{-1}$, 102.5nm b. UV c. absorbed

5a. $4.088 \times 10^{-19}\text{J}$, $6.169 \times 10^{14}\text{s}^{-1}$, 486.0 nm b. visible c. emitted

6a. 3p b. 4d c. 3d d. 5s

7a. 32 b. 2 c. 10 d. 2 e. 14 f. 2

8a. Be $1s^2 2s^2$ [He] $2s^2$ no unpaired electrons

b. F $1s^2 2s^2 2p^5$ [He] $2s^2 2p^5$ one unpaired

c. Mg $1s^2 2s^2 2p^6 3s^2$ [Ne] $3s^2$ no unpaired

d. P $1s^2 2s^2 2p^6 3s^2 3p^3$ [Ne] $3s^2 3p^3$ three unpaired

e. V $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$ [Ar] $4s^2 3d^3$ three unpaired

f. Se $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$ [Ar] $4s^2 3d^{10} 4p^4$ two unpaired

g. Rb $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ [Kr] $5s^1$ one unpaired

h. Zr $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^2$ [Kr] $5s^2 4d^2$ two unpaired

i. Sn $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^2$ [Kr] $5s^2 4d^{10} 5p^2$ two unpaired

9a. I < Te < Rb b. Rb < Te < I c. Rb < Te < I

10a. Cl < S < Mg b. Mg < S < Cl c. Mg < S < Cl

11a. K b. Cl c. Cl

12. a. Sb b. Cs c. Cs

13a. K b. O^{2-} c. Tl d. Cu^+

14a. N b. Ba^{2+} c. Se d. Co^{3+}

15a. Rb > K > Ca > Ca^{2+} b. Te^{2-} > Te > Se > S

16a. Co^{3+} < Co^{2+} < Co b. Cl < Cl < Br^-