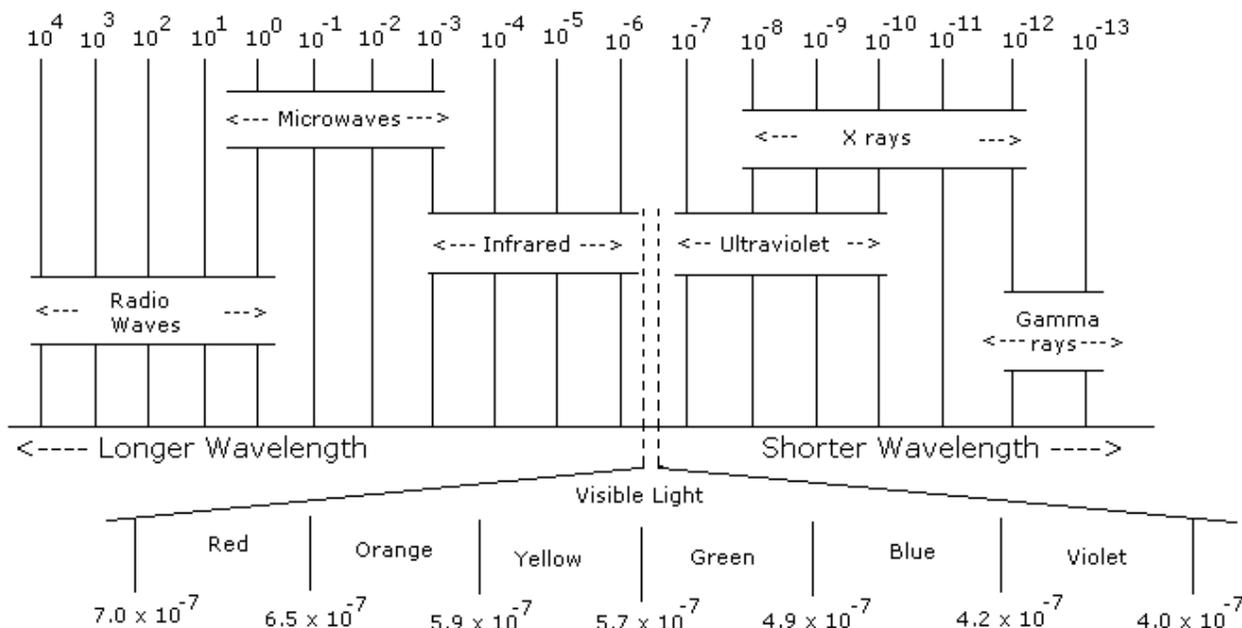


**Electromagnetic Spectrum**  
(measurement in meters)



Notice that the spectrum is shown from the longer wavelengths on the left to the shorter wavelengths on the right. Because wavelength and frequency are inversely proportional, the longer the wavelength, the lower the frequency. Because frequency and energy are directly proportional, the lower the frequency, the lower the energy.

Use the EM Spectrum diagram to answer these questions:

- 1.) As you move across the visible light spectrum from red to violet...
  - (A) Does the wavelength increase or decrease?
  - (B) Does the frequency increase or decrease?
  - (C) Does the energy increase or decrease?
- 2.) Which has a longer wavelength, orange or violet light?
- 3.) Which has a higher energy, x-rays or gamma rays?
- 4.) Which has a lower frequency, radio waves or green light?
- 5.) Which has the shortest wavelength, violet or ultraviolet light?
- 6.) Which has lower energy, infrared light or x-rays?

**ELECTRON ARRANGEMENT WORKSHEET**

1. What is an electron cloud?
2. Name the three major divisions within an electron cloud with respect to the energy of an electron.
3. What letter represents the principal quantum number?
4. What does the principal quantum number tell about an electron?
5. What formula is used to determine the maximum number of electrons that can occupy any energy level?
6. What is the maximum number of electrons for each of the following?  
(A) 1st energy level    (B) 4th energy level    (C)  $n = 3$     (D)  $n = 5$
7. Energy levels are divided into \_\_\_\_\_.
8. How can we determine the possible number of sublevels in any energy level?

9. Name the four primary sublevels in order of increasing energy.
10. Circle the sublevel that represents the lowest energy in each pair.  
 (A) 1s or 2s      (B) 2s or 2p      (C) 4f or 4d      (D) 3d or 4s      (E) 7s or 5d  
 (F) 6s or 4s      (G) 4p or 5p      (H) 3s or 3d      (I) 2p or 3s
11. Sublevels are divided into \_\_\_\_\_.
12. Each orbital can hold up to \_\_\_\_\_ electrons.
13. Sketch the shapes of the orbitals for the sublevels listed.  
 (A) s:                      (B)  $p_x$ :                      (C)  $p_y$ :                      (D)  $p_z$ :
14. How many orbitals are in each sublevel?  
 (A) s \_\_\_\_\_      (B) p \_\_\_\_\_      (C) d \_\_\_\_\_      (D) f \_\_\_\_\_

**Unit 4 Review Worksheet**

Section I - Electromagnetic Spectrum

1. Label both ends of the spectrum with high/low frequency, high/low energy, and long/short wavelength  
radio waves    microwaves    infrared light    ROYGBIV    ultraviolet light    x-rays    gamma rays
2. Which has a higher energy, gamma or x-rays?
3. Which has a shorter wavelength, radio or ultraviolet?
4. Which has a lower frequency, yellow or green light?
5. In the equation  $E = h \cdot \nu$ , energy and frequency are \_\_\_\_\_ proportional.
6. In the equation  $c = \lambda \cdot \nu$ , wavelength and frequency are \_\_\_\_\_ proportional.
7. The symbol for wavelength is \_\_\_\_\_.
8. Electrons give off energy in the form of a \_\_\_\_\_ when returning to the ground state.
9. Which scientist proposed the idea that electrons travel around the nucleus in fixed paths?
10. When an electron moves from the ground state to the excited state, energy is \_\_\_\_\_.
11. Bohr chose the element \_\_\_\_\_ to prove his theory.
12. The dual wave-particle nature of electrons describes how the electrons in atoms can behave as \_\_\_\_\_ and \_\_\_\_\_.

Section II - Electrons

13. What is an electron cloud?
14. Who proposed the uncertainty principle?
15. Who is credited with the idea that electrons are placed in the lowest energy level first?
16. What rule requires that each of the "p" orbitals (at a particular energy level) receive one electron before any of the orbitals can have two electrons?
16. What is the maximum number of electrons in any orbital?
17. The principal quantum number, n, indicates the \_\_\_\_\_.
18. The maximum number of electrons in an energy level can be determined by the equation \_\_\_\_\_  
 That means the maximum number of electrons in the 3rd energy level is \_\_\_\_\_.
19. The number of sublevels in any energy level can be determined by \_\_\_\_\_.

20. The number of orbitals in an energy level can be determined by the equation \_\_\_\_\_.  
So, the 3rd energy level has \_\_\_\_\_ orbitals. (\_\_\_\_\_ is/are "s" orbitals, \_\_\_\_\_ is/are "p" orbitals, and \_\_\_\_\_ is/are "d" orbitals)
21. List the four sublevels according to increasing energy.
22. The "s" sublevel is shaped like a \_\_\_\_\_ and has \_\_\_\_\_ orbitals.
23. A "p" sublevel is shaped like a \_\_\_\_\_ and has \_\_\_\_\_ orbitals.
24. The "d" sublevel has \_\_\_\_\_ orbitals and the "f" sublevel has \_\_\_\_\_ orbitals.

Section III - Electron configuration, noble gas configuration, valence electrons, orbital notations

25. What is the electron configuration for phosphorus?
26. How many total electrons are in a neutral atom of phosphorus?
27. Write the noble gas configuration for phosphorus.
28. What is the highest occupied energy level for phosphorus?
29. What is the atomic number of phosphorus?
30. Draw the orbital notation for phosphorus.
31. How many electrons are in the highest occupied energy level of phosphorus?
32. How many inner-shell electrons does phosphorus have?
33. Draw the electron dot diagram for phosphorus.