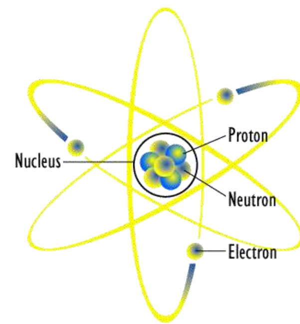
Chemistry

Name:__________________
Period: ____

Study of the Atom
Packet 6



Day	**In Class Work**
1	Radioactive Decay
2	½ Life
3	Lab
4	Electromagnetic Spectrum
5	Electron Configuration
6	Electron Configuration
7	Self Test/ Review
8	Packet Test

Outcomes

- **Student will state the symbol, charge and mass of alpha or beta particles.**
- **Student will explain nuclear decay.**
- **Student will solve half life problems.**
- **When given the letter of a sublevel the student will state the number of orbitals in the sublevel and the number of electrons in the sublevel.**
- **Student will write the electron configuration of a given element.**
- **Student will state the name of an s,p,d orbital, locate the nucleus and the meaning of the diagram.**

Most nuclear reactions involve changes in the number of protons and/or neutrons in the nucleus of an atom. These changes are called *transmutations* because an atom of one element is changed into an atom of a different element. During these changes, nuclear particles may be absorbed and/or emitted along with a release of energy.

There are four types of nuclear reactions:

1) *natural radioactive decay*: transmutations occur by *natural radioactivity* (the ability of a nucleus to emit a nuclear particle and energy without external stimulation);
2) *artificial transmutation*: transmutations occur by nuclear disintegration caused by external stimulation as a scientist bombards a nucleus with a particle (the addition of another nuclear particle makes the nucleus unstable);
3) *fission*: certain nuclei having a large mass are bombarded with special particles that cause the nuclei to split into two nuclei each having a smaller mass;
4) *fusion*: nuclei of light elements are combined to form heavier nuclei.

Nuclear reactions are written using symbols in the $^{m}_{a}X$ notation. The symbols for the major nuclear particles involved in nuclear reactions are given below.

Alpha particle	$^{4}_{2}He$ (an alpha particle is a helium nucleus)
Proton	$^{1}_{1}H$ (the most common hydrogen nucleus is a proton)
Neutron	$^{1}_{0}n$
Electron	$^{0}_{-1}e$ or $^{0}_{-1}\beta$ (also called a beta particle)
Positron	$^{0}_{1}e$ or $^{0}_{1}\beta$
Gamma ray	$^{0}_{0}\gamma$

The table below contains information about nuclear reactions involving the emission of radiation.

Type of Reaction	Radiation (Particle)	NUCLEAR CHANGES: Effect on the Atomic Number	NUCLEAR CHANGES: Effect on the Atomic Mass
Alpha emission (α)	$^{4}_{2}He$	decrease by 2	decrease by 4
Beta emission (β)	$^{0}_{-1}e$ or $^{0}_{-1}\beta$	increase by 1	no change
Positron emission (β^{+})	$^{0}_{1}e$ or $^{0}_{1}\beta$	decrease by 1	no change
Gamma emission	$^{0}_{0}\gamma$	no change	no change
Electron capture (EC)	$^{0}_{-1}e$ or $^{0}_{-1}\beta$	decrease by 1	no change

TABLE 21.2 Common Particles in Radioactive Decay and Nuclear Transformations

Particle	Symbol
Neutron	$^{1}_{0}n$
Proton	$^{1}_{1}H$ or $^{1}_{1}p$
Electron	$^{0}_{-1}e$
Alpha particle	$^{4}_{2}He$ or $^{4}_{2}\alpha$
Beta particle	$^{0}_{-1}e$ or $^{0}_{-1}\beta$
Positron	$^{0}_{1}e$

Alpha Decay α

Sample:

$^{238}{}_{92}U$ ➔ $^{4}{}_{2}He$ + ? ? = $^{234}{}_{90}$Th

1. $^{226}{}_{88}Ra$ ➔
2. $^{218}{}_{84}Po$ ➔
3. $^{222}{}_{86}Rn$ ➔
4. $^{221}{}_{87}Fr$ ➔
5. $^{227}{}_{91}Pa$ ➔

Beta Decayβ

Sample:

$^{14}{}_{6}C$ ➔ $^{0}{}_{-1}e$

1. $^{214}{}_{82}Pb$ ➔
2. $^{214}{}_{83}Bi$ ➔
3. $^{58}{}_{28}Ni$ ➔
4. $^{118}{}_{50}Sn$ ➔
5. $^{108}{}_{46}Pd$ ➔

Positron Emission

Sample:

$^{11}{}_{6}C$ ➔ $^{0}{}_{1}e$

1. $^{24}{}_{12}Mg$ ➔
2. $^{222}{}_{86}Rn$ ➔
3. $^{58}{}_{28}Ni$ ➔
4. $^{118}{}_{48}Cd$ ➔
5. $^{108}{}_{40}Zr$ ➔

h

Complete the following nuclear equations:

1) ______ → $^{0}{}_{-1}e$ + $^{14}{}_{7}N$

2) ________ + $^{4}{}_{2}He$ → $^{12}{}_{6}C$ + $^{1}{}_{0}n$

3) $^{239}{}_{93}Np$ → $^{239}{}_{94}Pu$ + _________

4) $^{4}{}_{2}He$ + _________ → $^{240}{}_{94}Pu$ + $^{1}{}_{0}n$ + $^{1}{}_{0}n$

5) $^{1}{}_{0}n$ + __________ → $^{236}{}_{92}U$

6) $^{13}{}_{7}N$ → _________ + $^{0}{}_{+1}e$

7) ______ + $^{1}{}_{1}H$ → $^{12}{}_{6}C$ + $^{4}{}_{2}He$

8) ______ + $^{1}{}_{0}n$ → $^{3}{}_{1}H$ + $^{4}{}_{2}He$

9) $^{226}{}_{88}Ra$ → _______ + $^{222}{}_{86}Rn$

10) $^{18}{}_{9}F$ → ________ + $^{0}{}_{-1}e$

No one can say for sure when a particular nucleus will decay but one can predict how many in a given sample will decay over time. Radioactive elements have a half-life. The half life of any given element is the time that is required for one half of the sample to decay. So if you have 10 grams of a radioactive element, after one half-life there will be 5 grams of the radioactive element left. After another half-life, there will be 2.5 g of the original element left, after another half-life, 1.25 g will be left. The equation for half-life calculations is as follows:

$$A_E = A_O * .5^{\frac{t}{t_{\frac{1}{2}}}}$$

- A_E is the amount of substance left
- A_0 is the original amount of substance
- t is the elasped time
- $t_{1/2}$ is the half-life of the substance

Other variations on the half-life equation are as follows:

$$t = \frac{\log \frac{A_E}{A_O}}{\log .5} * t_{\frac{1}{2}}$$

$$t_{\frac{1}{2}} = \frac{\log .5}{\log \frac{A_E}{A_O}} * t$$

An example problem is if you originally had 157 grams of carbon-14 and the half-life of carbon-14 is 5730 years, how much would there be after 2000 years?

$$A_E = 157 * .5^{\frac{2000}{5730}}$$

There would be 123 grams left.

Radioactive Half-Life show all work!
Try #1 - #5 **without** using the equation:

1. Tritium (H-3) is a radioactive isotope of hydrogen with a half-life of 12.3 years.
How long would it take for a 40.0 g sample to decay down to 1.25 g?
Ans: _______

2. Fe-61 has a half-life of 6.00 min. Of a 100.0 mg sample, how much will remain after 18.0 min?
Ans: _______

3. After 20.0 days, a 120 kg sample of Bi-210 decays down to just 7.5 kg. What is its half-life?
Ans: _______

4. What percent of a sample of a radioactive element whose halflife = 5.0 years will decay after 25 years?
Ans: _______

5. K-42 has a half-life of 12.0 hours. At present, a given ore sample contains 34.2 mg of K-42. How much did it contain yesterday at this same time?
Ans: _______

For the remaining 6 problems, use the half-life equations (above) to solve:
6. Tritium is hydrogen-3. Of a 24.0 mg sample, how much will remain after 9.25 years?
Ans: _______

7. How long will it take for a 80.0 g sample of cobalt-60 to decay down to 13.0 g?
Ans: _______

8. After 34.8 min, a 43.5 g sample of Fr-215 has decayed down to 10.0 g. Whatis its half-life?
Ans: _______

9. An ore sample is found to contain 3.45 g of K-40. How much did it contain 6.0 billion years ago?
Ans: _______

10. How long will it take for one mole of Na-22 to decay down to just one atom?
(hint- initial amount = 6.02_E^{23})
Ans: _______

Chemist began studying colored flames in the 18th century and soon used "flame tests" to distinguish between some elements. Different elements burn with different colored flames. Although some of the flames you will be seeing will appear similar in color, their light can be resolved (separated) with a prism into distinctly different bands of colors on the electromagnetic spectrum (ROYGBIV). These bands of colors are called **atomic line spectra**, and they are UNIQUE to each element.

Niels Bohr studied the line spectrum for hydrogen, and wondered what the specific line spectrum had to do with the structure of the atom. He postulated that an electron can have only specific energy values in an atom, which are called **energy levels**. Bohr believed that the energy levels for electrons were **quantized**, meaning that only certain, specific energy levels were possible.

To discover this idea concerning the atom let's observe a group of atoms before, during and after burning.

- Place a tin can lid on an iron ring and place out equally small amounts of the following solid elements:

lead, ______, iron, ______, tin, ______, copper,______, and magnesium, ______.

Record observations of elements before burning.

Element	Lead	Iron	Tin	Copper	Magnesium
Observation before burning					

Pick the Bunsen burner up and torch each element on the tin can lid.
(Do not look directly at the magnesium while it is burning!)

Element	Lead	Iron	Tin	Copper	Magnesium
Observation during burning					

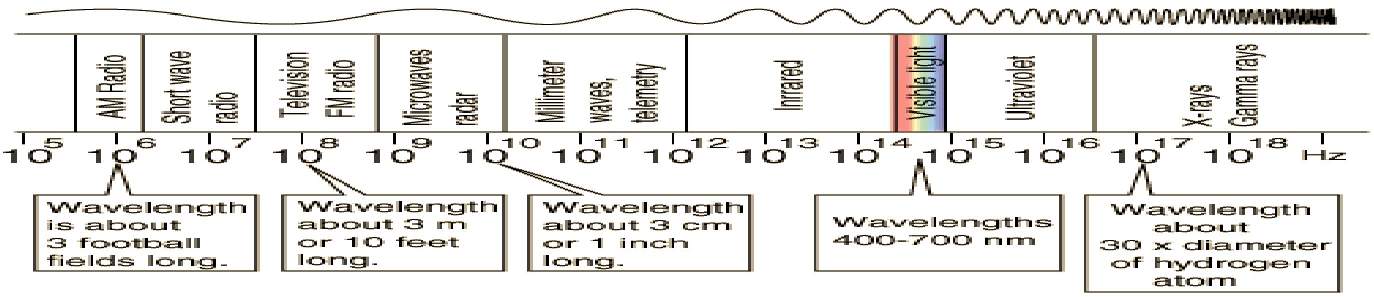
As the element burns, they combine with oxygen to form oxides of the elements. All the oxides to cool and record observations.

Element	Lead	Iron	Tin	Copper	Magnesium
Observation after burning					

Does the oxide of magnesium look the same as the oxide of lead? ____ Do all the oxides look like each other? ____ Therefore the atoms of the oxides must be _______________.

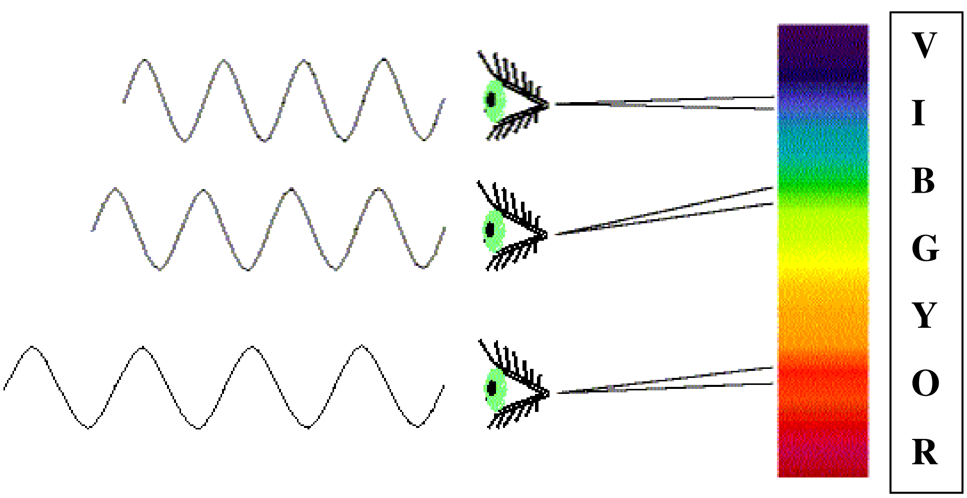
Disposal- All solids can be placed in the waste cans.

Electromagnetic Spectrum



color	λ(Å)	f (*10^{14} Hz)	Energy (*10^{-19} J)
violet	4.0-4.6 E $^{-7}$	7.5 → 6.5	5.0 → 4.3
indigo	4.6-4.75 E $^{-7}$	6.5 → 6.3	4.3 → 4.2
blue	4.75-4.9 E $^{-7}$	6.3 → 6.1	4.2 → 4.1
green	4.9-5.65 E $^{-7}$	6.1 → 5.3	4.1 → 3.5
yellow	5.65-5.75 E $^{-7}$	5.3 → 5.2	3.5 → 3.45
orange	5.75-6.0 E $^{-7}$	5.2 → 5.0	3.45 → 3.3
red	6.0-8.0 E $^{-7}$	5.0 → 3.7	3.3 → 2.5

Note the trends: Bluer light has *shorter* λ, *higher f*, and more energy.
Redder light has *longer* λ, *lower f*, and less energy.



Using a slinky to demonstrate the properties of a Transverse wave

A. Obtain a slinky from the lab table and stretch the slinky across the floor. One person needs to hold one stationary while the other person slowly moves the other end back and forth about 9 inches. Draw the shape of the slinky showing the number of transverse waves formed.

B. Now move the slinky back and forth with more energy. Redraw the shape of the slinky showing the number of waves that form.

C. Now use the most energy possible and redraw the shape of the slinky showing the number of waves formed.

The symbol λ, lambda, represents a wave length. From your drawings indicate which slinky created the longest wave length.

Longest λ ___________ Medium λ __________ Smallest λ __________

Energy is the ability to move an object through a distance and is measured in Joules (J). Energy is symbolized by a capital E. From your drawing indicate which slinky displayed the most energy.

Greatest Energy __________ Medium Energy __________ Least Energy__________

Therefore the

Longest λ has the __________ energy

Medium λ has the __________ energy

Smallest λ has the __________ energy

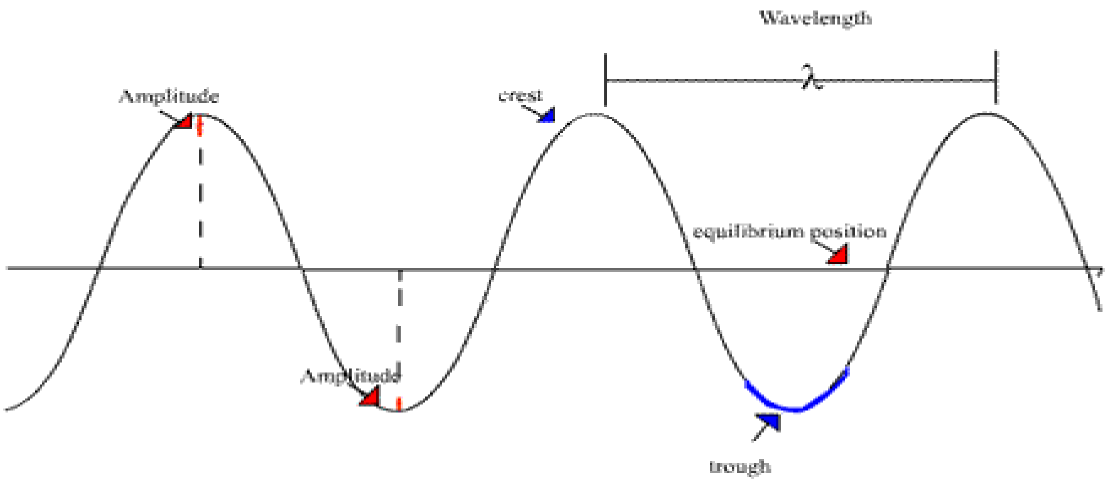
What type of relationship is there between energy and wavelength?

Electromagnetic Radiation and the Spectrum of Atomic Hydrogen

To make sense of the chemistry of the elements we need to understand the electronic structure of atoms. It is the atom's electronic structure which governs everything from molecular geometry to chemical reactivity. Electromagnetic radiation is the probe we use to obtain knowledge of electronic structure, so we begin by looking at some of its properties.

Light has a *dual nature* – it is both wave-like and particle-like. Thus light and all other forms of electromagnetic radiation obey two equations, one of which shows the inverse relation between wavelength □ and frequency □ (both properties of waves) and the other which relates the energy of light photons ("particles") to their frequency □:

Wave model $\lambda(\text{m}) \times \nu(\text{s}^{-1}) = c(\text{m/s})$



The constants and variables in these equations are

Speed of light = *c* = 3.00 x 10^8 m/s = 3.00 x 10^8 m s^{-1}

Planck's constant = *h* = 6.626 x 10^{-34} J s

Wavelength = λ = Greek lower case *lambda*

Frequency = υ = Greek lower case *nu*

Photon Energy = E_{photon}

Common units include

Wavelength λ : 1 nm = 10^{-9} m = 10 Å *Frequency* □: 1 s^{-1} = 1 Hz

$$\mathbf{E = \frac{h\,c}{\lambda}}$$

1. Calculate the energy for a wave whose length is 6.25_{E}^{-7}

2. Calculate the energy for a wave whose length is 8.15_{E}^{-7}

3. Calculate the energy for a wave whose length is 3.35_{E}^{-7}

4. Calculate the energy for a wave whose length is 2.25_{E}^{-7}

5. Calculate the energy for a wave whose length is 8.25_{E}^{-7}

Worksheet Questions

1. Draw a wave and label it, using the following terms: crest, trough, amplitude, and wavelength.

2. A cork floating on water moves up and down 10 times in 30 seconds. What is the frequency of the water wave?

3. A tuning fork produces a sound of musical note middle C. It moves back and forth 256 times each second. What is the frequency of the tuning fork?

4. What is the electromagnetic spectrum?

5. a. How are infrared waves different from red light waves?

b. How are ultraviolet waves different from violet light waves?

c. In what ways are infrared, red, ultra-violet, and violet light waves alike?

6. What is the wavelength in meters of a radio wave with a frequency of 540,000 sec^{-1}.

7. For each of the following wavelengths of visible light, determine the energy of the wave and what color of light is created.

a. 4.64 E^{-7}

b. 5.64 E^{-7}

c. 8.00 E^{-7}

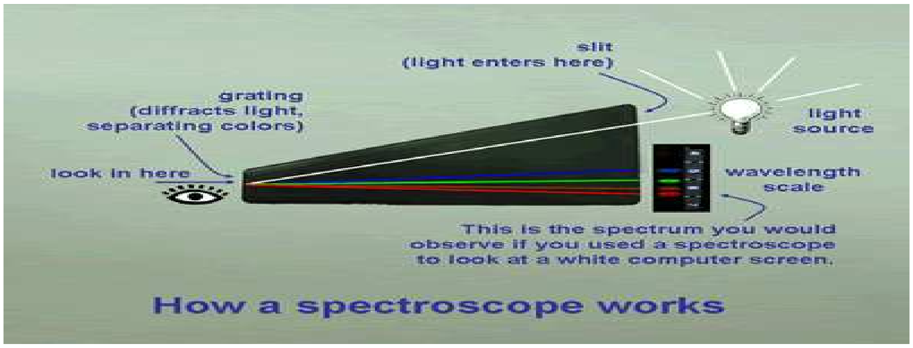
8. For each of the following energies of visible light, determine the wavelength and color of light.

a. 3.20 E^{-19}J

b. 2.50 E^{-19} J

c. 4.00 E^{-19} J

Any element subject to high voltage will emit light. In the laboratory three different tubes of gases will be subjected to 10,000 volts. These tubes of gas will glow like a neon sign. By viewing the light through a spectroscope the light is broken down into its component wavelengths.



At each station look through the spectroscope and determine the color and the wavelength of each line.

Hydrogen

Color	Wavelength	Energy of Wave

Which color of visible light has the shortest wavelength?

Which color of visible light has the longest wavelength?

What are the colors of visible light?

Helium

Color	Wavelength	Energy of Wave

Which color of visible light has the least energy?

Which color of visible light has the most energy?

Mercury

Color	Wavelength	Energy of Wave

Draw a light wave and label the wavelength, amplitude, crest, and frequency.

Atomic Structure

CALCULATION PRACTICE — 1

Formulas and Constants				
$c = \lambda\upsilon$	$\upsilon = \frac{c}{\lambda}$	$\lambda = \frac{c}{\upsilon}$	$E = h\upsilon$	$E = \frac{hc}{\lambda}$
$c = 2.998 \times 10^{8}$ m/s	$h = 6.626 \times 10^{-34}$ J·s			

1. List all electromagnetic radiations from low energy to high.

2. An FM radio station has a frequency of 88.9 MHz (1 MHz = 10^{6} Hz, or cycles per second). What is the wavelength of this radiation in meters?

3. The U.S. Navy has a system for communicating with submerged submarines. The system uses radio waves with a frequency of 76 s^{-1}. What is the wavelength of this radiation in meters? In miles?

4. Violet light has a wavelength of about 410 nm. What is its frequency? Calculate the energy of one photon of violet light. What is the energy of 1.0 mol of violet photons?

5. The energy of a mole of photons of red light from a laser is 175 kJ/mol. Calculate the energy of one photon of red light. What is the wavelength of red light in meters? In nm? Compare the energy of photons of violet light with those of red light. Which is more energetic and by what factor?

6. The most prominent line in the spectrum of neon is found at 865.438 nm. Other lines are found at 837.761 nm, 878.062 nm, 878.438 nm, and 1885.387 nm.
   (a) Which of these lines represents the most energetic light?
   (b) What is the frequency of the most prominent line? What is the energy of one photon of this wavelength?

Quantum Model of the Atom

A. The Nature of Electrons
1. The amount of energy an electron has determines its distance from the nucleus
2. Electrons can have only certain amounts of energy (quanta)
3. This means that electrons orbit at certain levels away from the nucleus

B. Energy Levels
1. There are maximum of 7 energy levels
2. The maximum number of electrons that can exist in an energy level is 2n^2 (where n is the number of the energy level)

C. Sublevels
1. Each energy level has a number of sublevels equal to the number of that energy level
2. There are only 4 sublevels due to the numbers of electrons they can hold
3. The sublevels are named **s, p, d, and f**
4. These names come from old spectroscopic terms (sharp, principal, diffuse, and fundamental)

D. Orbitals
1. Each sublevel can contain a certain number of electron orbitals
2. Each orbital can hold **two electrons**
3. Each orbital within a sublevel must receive one electron before any of them receive two electrons

Sublevel	# of Orbitals
s	1
p	3
d	5
f	7

Sublevels of the first four energy levels

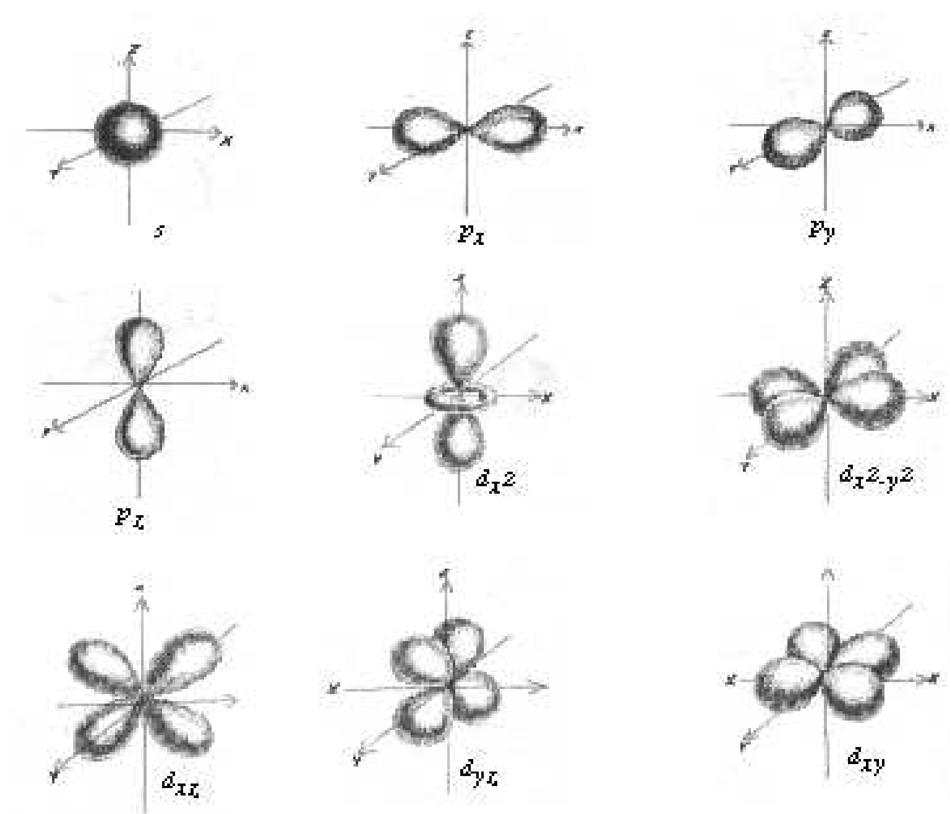
Principle energy level	Sublevel	Number of orbitals in sublevel	Total electrons occupying sublevel	Total Electrons
1	_____	_____	_____	_____
2	_____	_____	_____	
	_____	_____	_____	_____
3	_____	_____	_____	
	_____	_____	_____	
	_____	_____	_____	_____
4-7	_____	_____	_____	
	_____	_____	_____	
	_____	_____	_____	
	_____	_____	_____	_____

Referring to the chart on the last page answer the following questions:

1. How many orbitals are in the 2p sublevel? _____
2. How many orbitals are in the 4f sublevel? _____
3. How many orbitals are in the 3d sublevel? _____
4. How many orbitals are in the 4d sublevel? _____
5. The maximum number of electrons on the 2p sublevel is _____.
6. The maximum number of electrons on the 4f sublevel is _____.
7. The maximum number of electrons on the 4d sublevel is _____.
8. The maximum number of electrons on the 1s sublevel is _____.
9. The maximum number of electrons on the 5p sublevel is _____.
10. How many orbitals are in the 2s sublevel? _____.

In the Quantum Mechanical Model of the atom the electrons are moving around the positive nucleus but their exact path cannot accurately be determined. The German physicist Weiner Heisenberg expressed this idea in his **Heisenberg Uncertainty Principle:** It is impossible to determine accurately both the momentum and position of a particle simultaneously. When a scientist tries to determine the momentum of a particle, the position of the particle is altered. When a scientist tries to determine the position of a particle, the momentum is altered. The probability of finding an electron within an atom can be determined. The following are the shapes of s, p, and d orbitals.

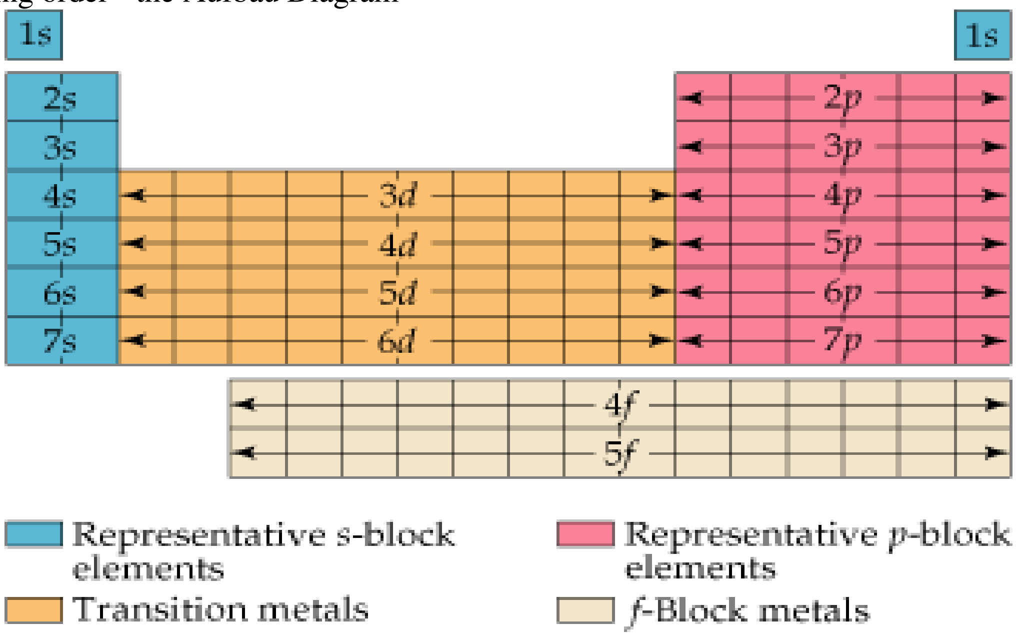
Directional characteristics of *s*, *p* and *d* orbitals



Locations of the nucleus______________________
Meaning of the diagrams ____

E. Electron Configuration

1. An electron configuration is a chemist's shorthand way of showing how many electrons an atom has in each of its sublevels
2. Filling order - the Aufbau Diagram



a. Start at the upper left
b. Fill the orbitals and sublevels as you move down the column
c. When you reach the bottom of a column, move to the top of the next column to the right and continue

Brief Instructions

An electron configuration is a method of indicating the arrangement of electrons about a nucleus. A typical electron configuration consists of numbers, letters, and superscripts with the following format:

1. A number indicates the energy level; 1,2,3,4,5,6,7. (The number is called the principal quantum number.).
2. A letter indicates the type of orbital; s, p, d, f.
3. A superscript indicates the number of electrons in the orbital.

Example: ls^2 means that there are two electrons in the 's' orbital of the first energy level. The element is helium.

To write an electron configuration:

1. Determine the total number of electrons to be represented.
2. Use the Aufbau process to fill the orbitals with electrons. The Aufbau process requires that electrons fill the lowest energy orbitals first. In another words, atoms are built from the ground upwards.
3. The sum of the superscripts should equal the total number of electrons.

Configuration Writing Practice

Write the number of electrons and then the electron configuration for each neutral atom.

Example: Mg- has 12 electron - $1s^2\ 2s^2\ 2p^6\ 3s^2$ (adding the subscript numbers = 12)

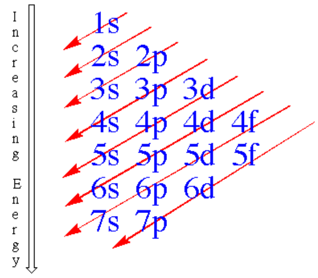
1. Na

2. Fe

3. Ne

4. K

5. 3



Electron Configurations

Write the complete ground state electron configurations for the following:

Atomic #	Element	Symbol	Electron Configuration
5			
8			
13			
24			
35			
40			
12			
1			
10			

Ion is an element with a positive (+) or negative (-) charge.

- A cation is positive because it loses electrons.
- An anion is negative because it gains electrons.

Identify the following as a cation or anion.

11. O^{2-}

12. Ca^{2+}

13. B^{3+}

14. Mg^{2+}

15. K_{+}

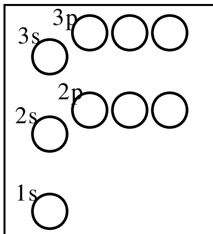
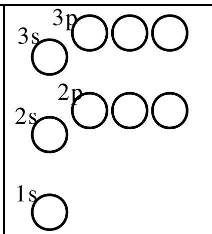
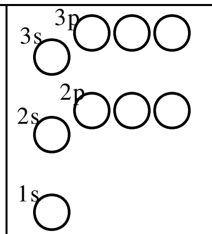
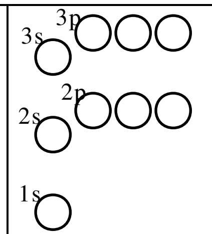
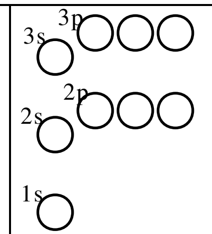
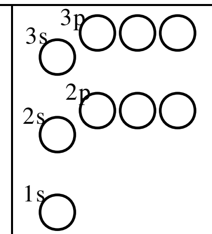
16. Al^{3+}

The elements in the far right column of the periodic table are called noble gases. They are noble because their energy level is completely filled with electrons. Other elements will lose or gain electrons to become like a noble gas.

Electron Configurations & Periodicity

WRITING ELECTRON CONFIGURATIONS

For each given element, fill in the orbital diagram and then write the electron configuration for the element.

1.	2.	3.	4.	5.	6.
					
Element: Ar # of e⁻'s: ___	Element: Mg # of e⁻'s: ___	Element: N # of e⁻'s: ___	Element: Li # of e⁻'s: ___	Element: P # of e⁻'s: ___	Element: Cl # of e⁻'s: ___

Write the electron configurations of each of these in **long form** and **short form**:

1. Ar
   Ar

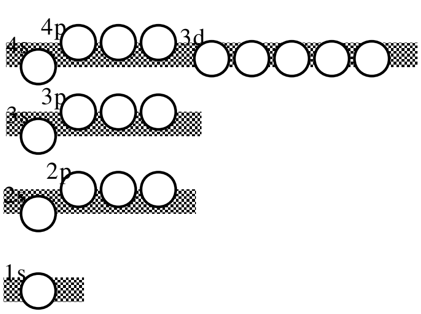
2. Mg
   Mg

3. N
   N

4. Li
   Li

5. P
   P

6. Cl
   Cl

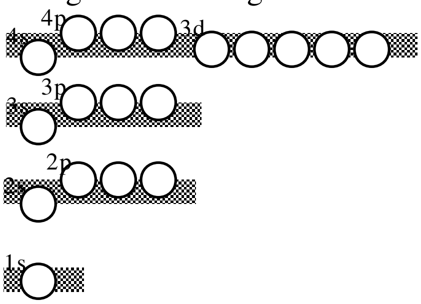


7. Fill in the orbital diagram for the element, Fe, and write the electron configuration of Fe in the long and short form.

   Fe

   Fe

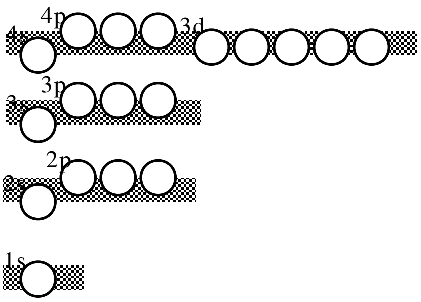
A few elements do not follow the "rules". There is some lowering of the energy of the atom by completely filling or half-filling the five d-orbitals.



8. Fill in the orbital diagram for the element, Cu, and write the electron configuration of Cu in the long and short form.

Cu

Cu



9. Fill in the orbital diagram for the element, Cr, and write the electron configuration of Cr in the long and short form.

Cr

Cr

Tell how many electrons need to lost or gained to become noble or stable,

17. N   18. Be

19. K   20. C

Write each of the following elements as an ion.

Lithium	Magnesium	Oxygen	Fluorine
Silicon	Chlorine	Potassium	Sulfur

21. If each orbital can hold a maximum of two electrons, how many electrons can each of the following hold?
a. 2s   b. 5p   c. 4f   d. 3d   e. 4d

22. What is the shape of an s orbital?

23. How many s orbitals can there be in an energy level?

24. How many electrons can occupy an s orbital?

25. What is the shape of a p orbital?

26. How many p orbitals can there be in an energy level?

27. Which is the lowest energy level that can have an s orbital?

28. Which is the lowest energy level that can have a p orbital?

29. Is it possible for two atoms to have exactly the same electron configuration?

31. How many d orbitals can there be in an energy level?

32. How many d electrons can there be in an energy level?

33. Which is the lowest energy level having d orbitals?

34. How many f electrons can there be in an energy level?

35. Which is the lowest energy level having f orbitals?

36. How many f orbitals can there be in an energy level?

37. How many energy levels are partially or fully occupied in a neutral atom of calcium?

38. Why do the fourth and fifth series of elements contain 18 elements, rather than 8 as do the second and third series?

39. Which sublevels of the 3rd energy level are filled (a) in the element argon (b) in the element krypton?

41. What is meant by the electron configuration of an atom?

42. For the following elements list the shorthand electron configuration

a. oxygen

b. cesium

e. scandium

f. nitrogen

g. chlorine

h. fluorine

i. boron

j. cadmium

44. For the following electron configurations choose the element they may represent

a. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^4$
b. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^5$
c. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^6$
d. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6\ 7s^1$
e. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^5$
f. $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^2$
g. [Kr] $5s^2\ 4d^{10}\ 5p^3$
h. [Kr] $5s^2\ 4d^{10}\ 5p^6$
i. [Ar] $4s^1$
j. [Xe] $6s^2\ 4f^{14}\ 5d^7$

B U I L D I N G T H E P E R I O D I C T A B L E

The following elements belong together in families as grouped below. The elements listed are not necessarily in order. The letters are not the symbols for the elements.

ZRD, SIFP, JXBE, LHT, QKA, WOV, YMC, GUN

The assignment is to arrange these elements in the proper periodic form, according to the information given below. Fill in the answers in the periodic table provided at the bottom of this page. Use your periodic table for assistance if necessary.

1. U has a total of six electrons.
   (Used as an example below – U is carbon, therefore G and N are either silicon or germanium.)
2. A is the second most common element in the atmosphere.
3. E is a noble gas.
4. S is an alkali metal.
5. O is a halogen.
6. O has an atomic number larger than V but smaller than W.
7. The charge on an L ion is 2+.
8. C has five electrons in its outer energy level.
9. The atomic mass of T is more than that of H but less than that of L.
10. M has an atomic number one less than that of A.
11. The electrons of atom N are distributed in three energy levels.
12. R has the largest atomic mass of its group.
13. F is a gas at room temperature.
14. Atom B contains 10 protons.
15. Q has an atomic mass less than that of K.
16. Y is more metallic than either M or C.
17. X has an atomic number one higher than F.
18. D has the smallest atomic mass in its group.
19. P is the most reactive element in its family.
20. J has the greatest density of the elements in its group as listed.
21. Atoms of I are larger than those of S.

I	II		III	IV	V	VI	VII	VIII
				U				
		the dotted lines provide a workspace for listing the families		***GUN***				

Self Test

A. Define and state the symbol for the following:

Wavelength-

Energy-

Speed of light-

B. Problems

Calculate the energy of a wave whose length is 4.5E^{-7}m.

Calculate the energy of a wave whose length is 6.2E^{-7}m.

C. State the relationship between color, wavelength, frequency, and energy.

D. Fill in the blanks with the appropriate response.

The s sublevel has ____ orbitals and ____ electrons
The p sublevel has ____ orbitals and ____ electrons
The d sublevel has ____ orbitals and ____ electrons
The f sublevel has ____ orbitals and ____ electrons
The maximum number of electrons in an orbital is ____.

E. Draw the electron path of the s, px, py, and pz orbitals

F. Write the electron configuration for the following atoms.

P____
Ni____
Cl____
C____
Mg____

	3			8				
8	9	6	1	4				
		2					4	
	1		2	9				3
4								2
3				6	4		9	
	5					3		
				7	9	8	1	5
				1			7