Welcome to AP Chem

For your bellwork complete the student survey
Have your summer packet ready to turn in

Syllabus Gallery Walk

https://apclassroom.collegeboard.org/7/home?apd=hfdpkld0zc&subunit=1&unit=1

Daily Videos will frequently be assigned as homework

Follow along and fill out your note sheet as you go

BELLWORK

Happy twin day

Hint: Law of Conservation of Mass

BELLWORK

Sig Figs

1. **All non-zero numbers ARE significant.** The number 33.2 has THREE significant figures because all of the digits present are non-zero.

2. **Zeros between two non-zero digits ARE significant.** 2051 has FOUR significant figures. The zero is between a 2 and a 5.

3. **Leading zeros are NOT significant.** They're nothing more than "place holders." The number 0.54 has only TWO significant figures. 0.0032 also has TWO significant figures. All of the zeros are leading.

4. **Trailing zeros to the right of the decimal ARE significant.** There are FOUR significant figures in 92.00.

92.00 is different from 92: a scientist who measures 92.00 milliliters knows his value to the nearest 1/100th milliliter; meanwhile his colleague who measured 92 milliliters only knows his value to the nearest 1 milliliter. It's important to understand that "zero" does not mean "nothing." Zero denotes actual information, just like any other number. You cannot tag on zeros that aren't certain to belong there.

5. **Trailing zeros in a whole number with the decimal shown ARE significant.** Placing a decimal at the end of a number is usually not done. By convention, however, this decimal indicates a significant zero. For example, "540." indicates that the trailing zero IS significant; there are THREE significant figures in this value.

6. **Trailing zeros in a whole number with no decimal shown are NOT significant.** Writing just "540" indicates that the zero is NOT significant, and there are only TWO significant figures in this value.

Sig fig test

https://chemquiz.net/sig/

ORGANIZATION

- You need a binder to keep up with all materials I give you
- NO EXTRA COPIES OF ANY ASSIGNMENT WILL BE GIVEN
- You need to keep up with all of your own labs

I do, we do, you do

Grab a whiteboard and dry erase marker

A student has a $1\ g$ sample of each of the following compounds: $NaCl$, KBr, and KCl. Which of the following lists the samples in order of increasing number of moles in the sample?

(A) $NaCl < KCl < KBr$

(B) $NaCl < KBr < KCl$

(C) $KCl < NaCl < KBr$

(D) $KBr < KCl < NaCl$

A student obtains a sample of a pure solid compound. In addition to Avogadro's number, which of the following must the student know in order to determine how many molecules are in the sample?

(A) Mass of the sample, volume of the sample

(B) Mass of the sample, density of the sample

(C) Molar mass of the compound, mass of the sample

(D) Molar mass of the compound, density of the sample

Which of the following numerical expressions gives the number of particles in 2.0 g of Ne?

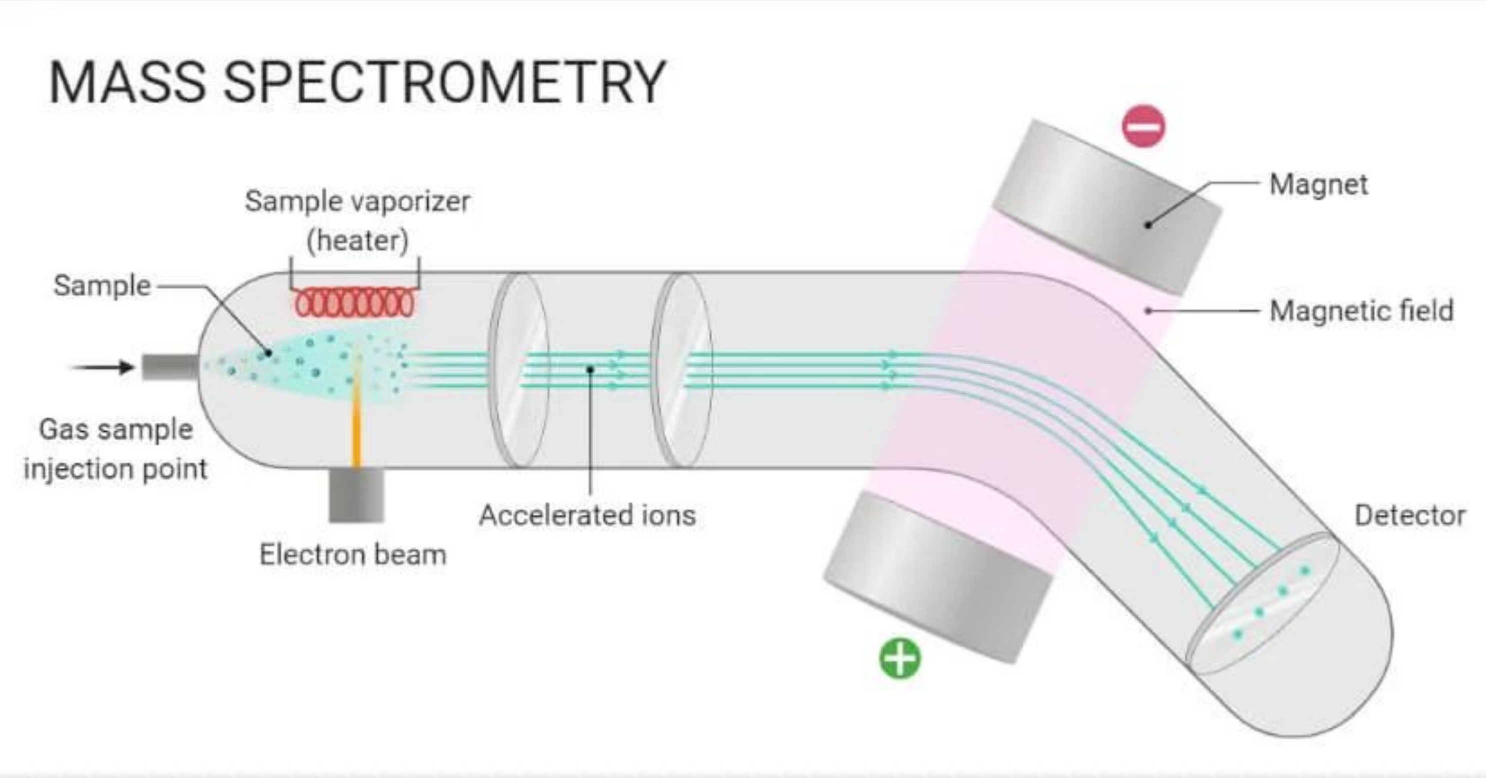
Ⓐ $$\frac{6.0 \times 10^{23} \text{ particles/mol}}{2.0 \text{ g}}$$

Ⓑ $$\frac{6.0 \times 10^{23} \text{ particles/mol}}{20.18 \text{ g/mol}}$$

Ⓒ $$\frac{2.0 \text{ g}}{20.18 \text{ g/mol}}(6.0 \times 10^{23} \text{ particles/mol})$$

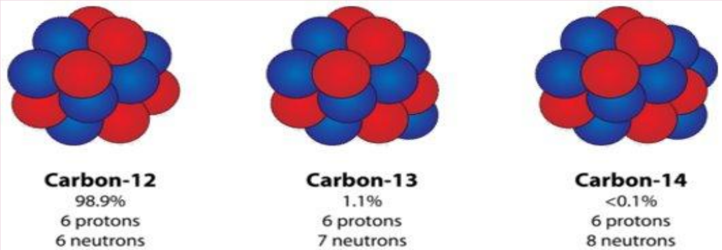
Ⓓ $$\frac{20.18 \text{ g/mol}}{2.0 \text{ g}}(6.0 \times 10^{23} \text{ particles/mol})$$

Mass spectroscopy



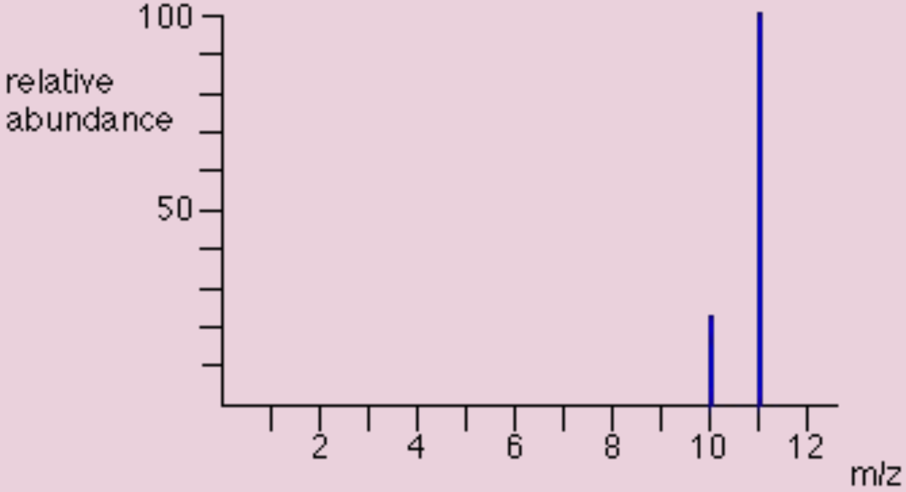
Mass spec applications

- Drug testing and development
    - Pharmaceutical and forensics
- Pesticide residue analysis
- Food and water contamination detection
- Carbon dating



Let’s practice

- How many isotopes are pictured?
- What would be an estimate of the average mass?
- What do you think this element might be?



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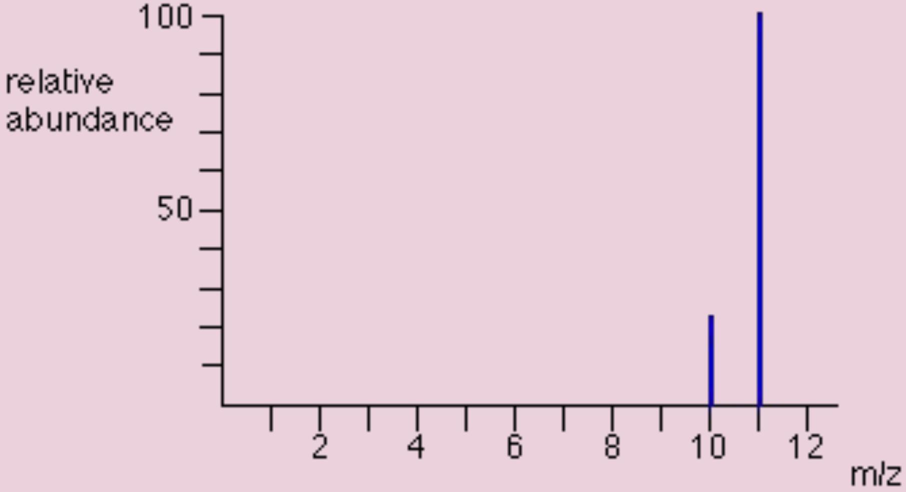


Average atomic mass*

The weighted average of the masses of all naturally occurring isotopes of an element*

We can calculate this instead of estimating with our mass spectrum

Calculating average atomic mass

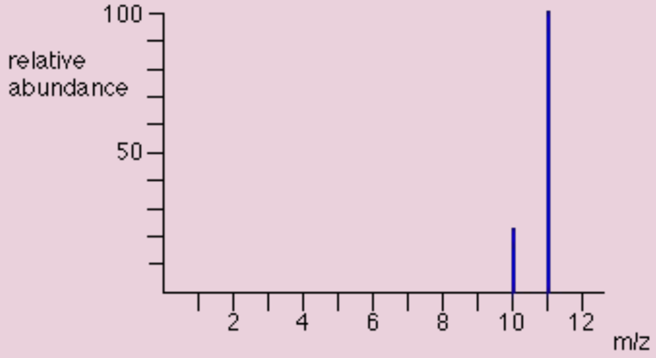
1. Take the mass of the isotope

2. Change its percent abundance to a decimal (divide by 100)

3. Multiply the mass by the abundance.

4. Repeat for each isotope then add them together.

5. Does this match our prediction? Does it make sense?



Isotope 10- 18.7%
Isotope 11- 81.3%

Videos

https://apclassroom.collegeboard.org/7/home?apd=kej52umthz

Mass spec of M&Mium

- You and a partner are charged with creating a mass spectrum for a new element M&Mium
- There are 3 isotopes of M&Mium (plain, mini, and caramel)
- Work with your partner to determine the following
    - Count for each isotope
    - Total mass for each isotope
    - Average mass for each isotope
    - Percent abundance for each isotope

<u>DO NOT EAT THE M&Ms</u>

From each student I need

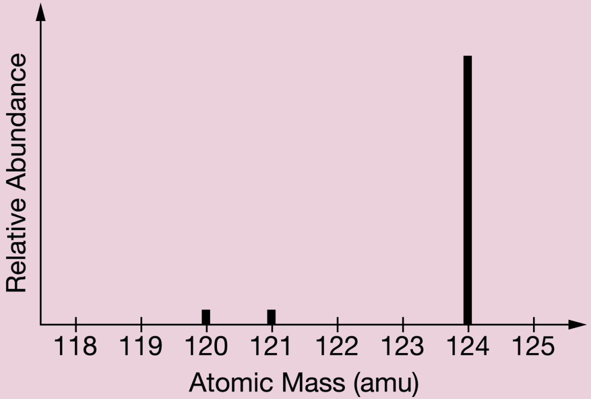
- Procedure
- Data table
- Calculation showing average atomic mass
- Calculation showing number of each isotope in a 837 gram sample
- Mass spec graph
  - To scale
  - With labels including title and axis labels

Bellwork

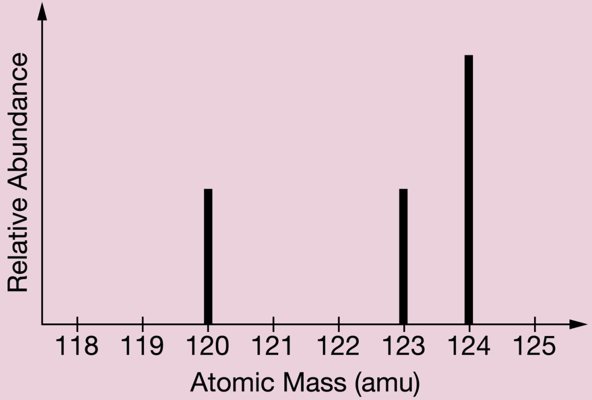
I do, we do, you do

Which one of the following could be the mass spec for Sb

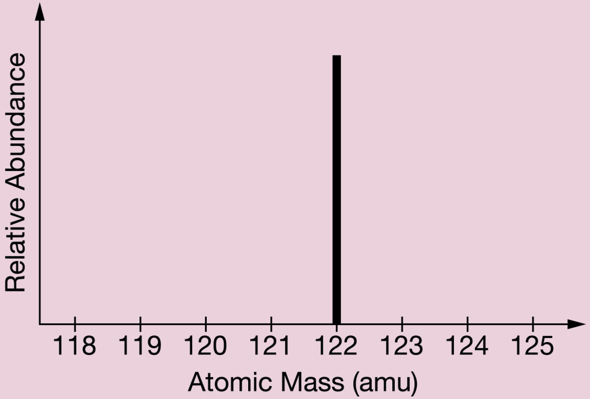
A



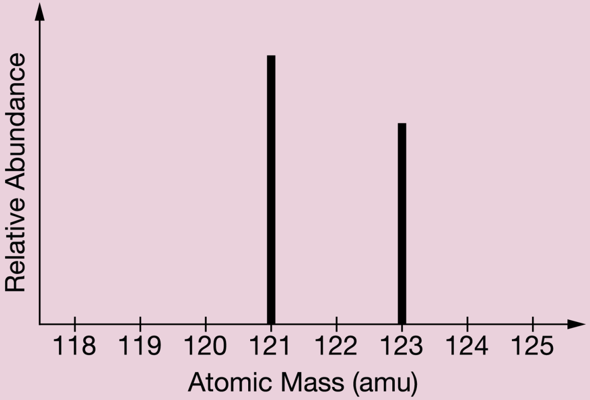
B



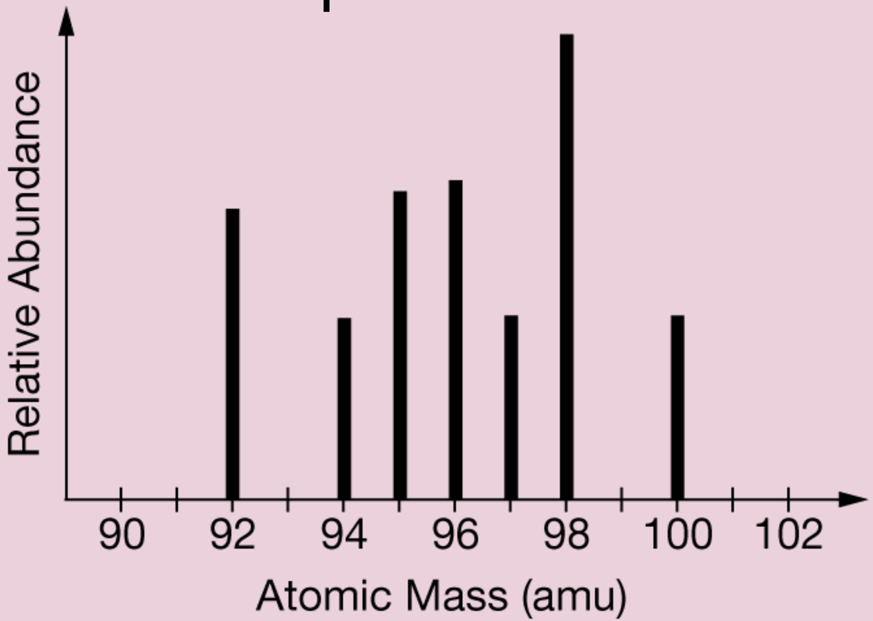
C



D



Which of the following elements could be represented on the mass spec?



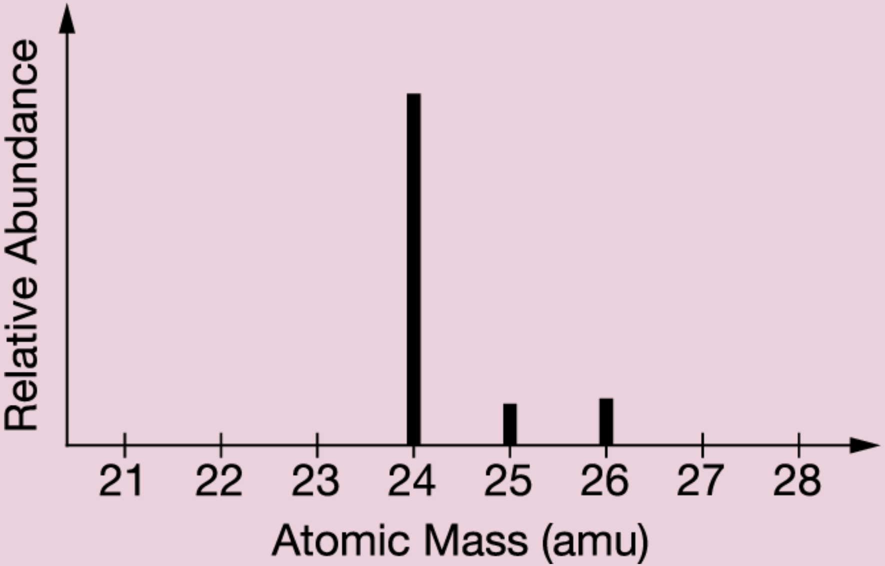
A) Nb

B) Mo

C) U

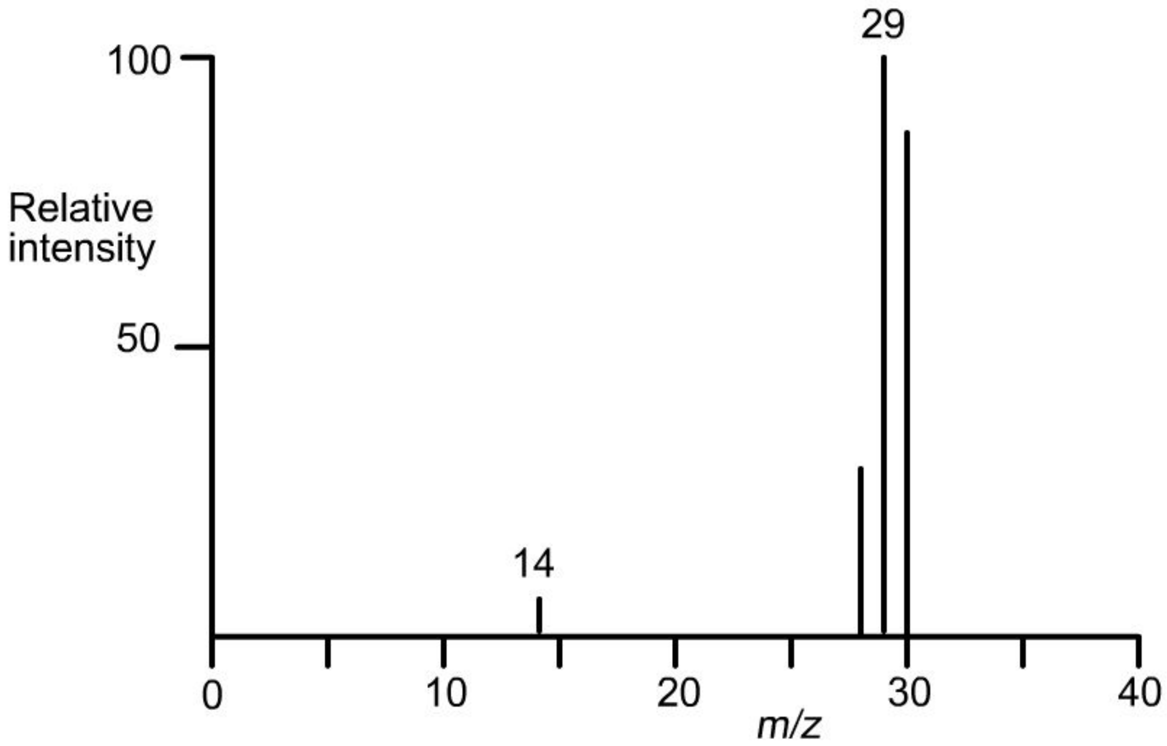
D) Cf

The mass spectrum of a sample of a pure element is shown above. Based on the data, the peak at 26amu represents an isotope of which of the following elements?



A. Al with 13 neutrons
B. Mg with 14 neutrons
C. Fe with 26 neutrons
D. Ti with 26 neutrons

Intensity



In the mass spectrum shown above, which peak represents the molecular ion?

- m/z = 30
- m/z = 14
- m/z = 29
- m/z = 28

Homework (due Monday)

- **On number 9 change relative abundance to percent abundance**

1.3 Elemental Composition of a Pure Substance

TOPIC 1.3: ELEMENTAL COMPOSITION OF A PURE SUBSTANCE

Enduring Understanding	
SPQ-2	Chemical formulas identify substances by their unique combination of atoms
Learning Objective	
SPQ-2A	Explain the quantitative relationship between the elemental composition by mass and the empirical formula of a pure substance

PUre Substances

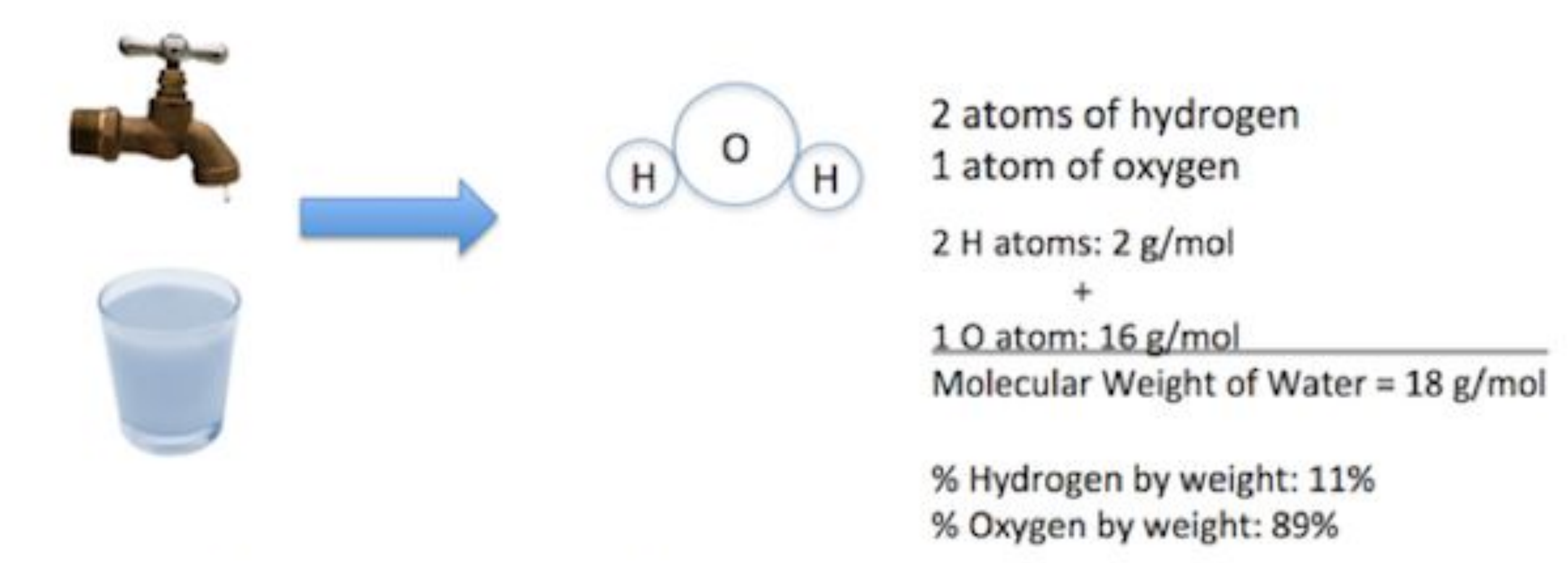
A **pure substance** is one with constant composition; a pure substance can either be an element or a compound.

When dealing with compounds you can assume it follows the **law of definite proportion**, which states compounds with the same elements in the same proportion are the SAME compound.

Following the law of definite proportion, you can find the **percent composition** which is the percent by mass of each element that makes up a compound.

Law of Definite Proportions

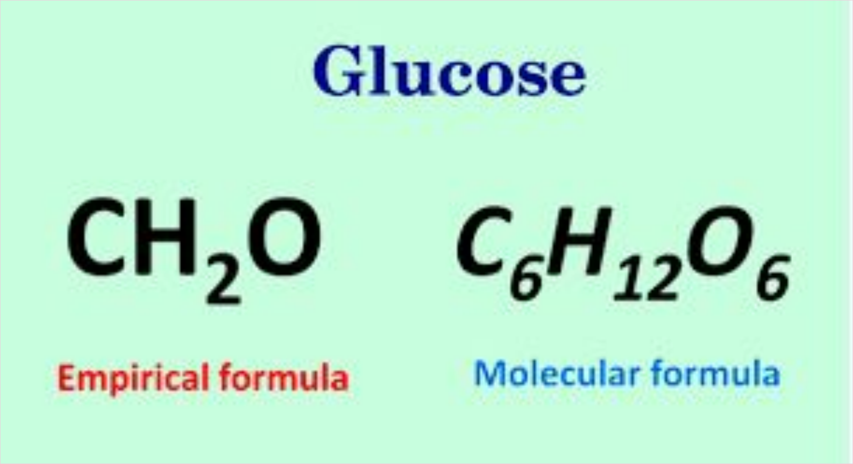
To calculate the percent composition, you divide the mass of each element in a compound by the total molar mass of the substance.



Law of Definite Proportions: % by Weight of Hydrogen and Oxygen in Water

Empirical and Molecular Formulas

In compounds, the **empirical formula** represents the simplest ratio of one element to another in a compound. The **molecular formula** represents the *actual formula* for the substance.



To determine the empirical formula

Determine the *empirical formula* for the compound **when given percent of each element**:

1. Assume you are given a 100g sample so you can change percent to grams
2. For each element take grams / molar mass to get moles of each element
3. Divide each mole value by the lowest of the values
4. If you are within 0.1 of a whole number round to the whole number, if you are not you must multiply by a factor that gives you whole numbers for all.
5. The values you found are the subscripts for each element

Example:

Find the empirical formula of a compound of 69.94% iron and 30.06% oxygen.

To Determine the Molecular Formula

Determine *molecular formula* (**can only determine if given molar mass of substance**)

1. Find mass of empirical formula
2. Molar mass/ empirical formula mass to find factor
3. Multiply all subscripts in the empirical formula by the value

Example:

A piece of iron ore is found to contain a compound containing 72.3% iron and 27.7% oxygen with a molecular mass of 231.6 g/mol. What is the molecular formula of the compound?

Together

A certain sugar used in treating patients with low blood sugar has the following chemical composition: 40 percent carbon, 6.7 percent hydrogen, and 53.3 percent oxygen. What is the empirical formula?

The molar mass of the compound is 180 grams/mole. What is the molecular formula of this compound?

You Do, We REview

A compound is found to contain 56.5% carbon, 7.11% hydrogen, and 36.4% phosphorus. Find the empirical formula.

If the compound has a molar mass of 170.14 g/mol, what is its molecular formula?

Two different ionic compounds each contain only copper and chlorine. Both compounds are powders, one white and one brown. An elemental analysis is performed on each powder. Which of the following questions about the compounds is most likely to be answered by the results of the analysis?

A. What is the density of each pure compound?

B. What is the formula unit of each compound?

C. What is the chemical reactivity of each compound?

D. Which of the two compounds is more soluble in water?

A student has two samples of $NaCl$, each one from a different source. Assume that the only potential contaminant in each sample is KCl. The student runs an experiment to determine the percent by mass of chlorine in each sample. From the results of this experiment alone, which of the following questions is most likely to be answered?

A. Which sample has the higher purity?

B. Which sample has the higher density?

C. What is the source of the contaminants present in each of the samples?

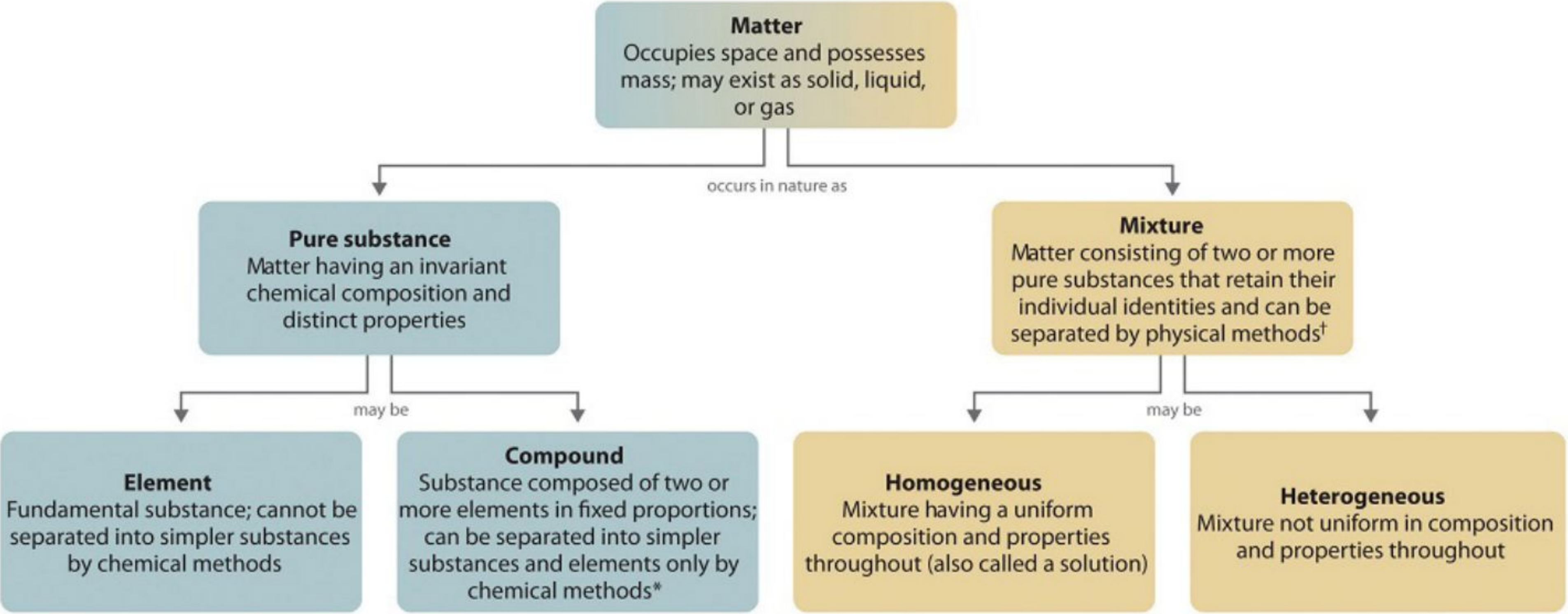
D. Which sample came from a salt mine, and which sample came from the ocean?

A student has samples of two pure compounds, $XClO_3$ and $ZClO_3$ which contain unknown alkali metals X and Z. The student measures the mass of each sample and then strongly heats the samples to drive off all the oxygen, leaving solid residues of XCl and ZCl. The student measures the mass of the solid residue from each sample. Which of the following questions can be answered from the results of the experiment?

A. Which has the greater molar mass, X or Z?
B. Which has the higher boiling point X or Z?
C. Which has the higher melting point XCl or ZCl?
D. Which has the greater density, XCl or ZCl?

TOPIC 1.4: COMPOSITION OF MIXTURES

Enduring Understanding	
SPQ-2	Chemical Formulas identify substances by their unique combination of atoms
Learning Objective	
SPQ-2B	Explain the quantitative relationship between the elemental composition by mass and the composition of substances in a mixture.



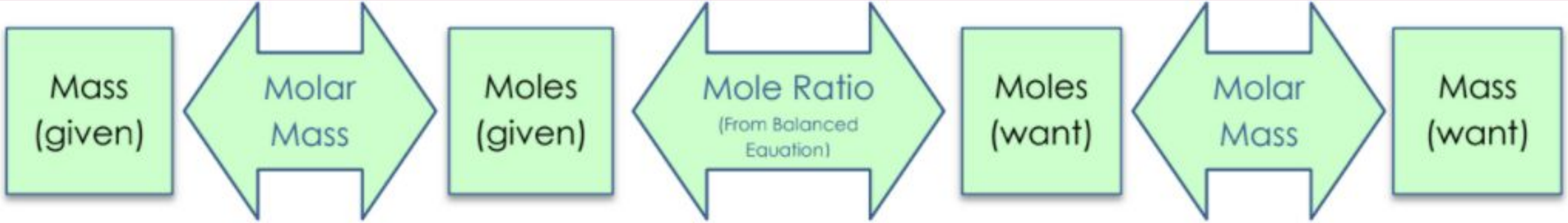
** Chemical methods of separation include electrolysis.*

† Physical methods of separation include filtration, distillation, and crystallization.

Mixtures

When two or more pure substances (elements and compounds) are combined they form a mixture. In mixtures the composition can vary. The mixture can be analyzed in order to determine the mass composition of each substance in that mixture.

You can use stoichiometry (mole ratios) to convert the masses of the products from the analysis to find the amounts of reactants that were in the original mixture.



Mass Percentage

The mass percentage of a substance in the mixture can be calculated:

$$\frac{\text{Mass of Substance}}{\text{Total Mass of Mixture}} \times 100 = \text{Mass Percentage}$$

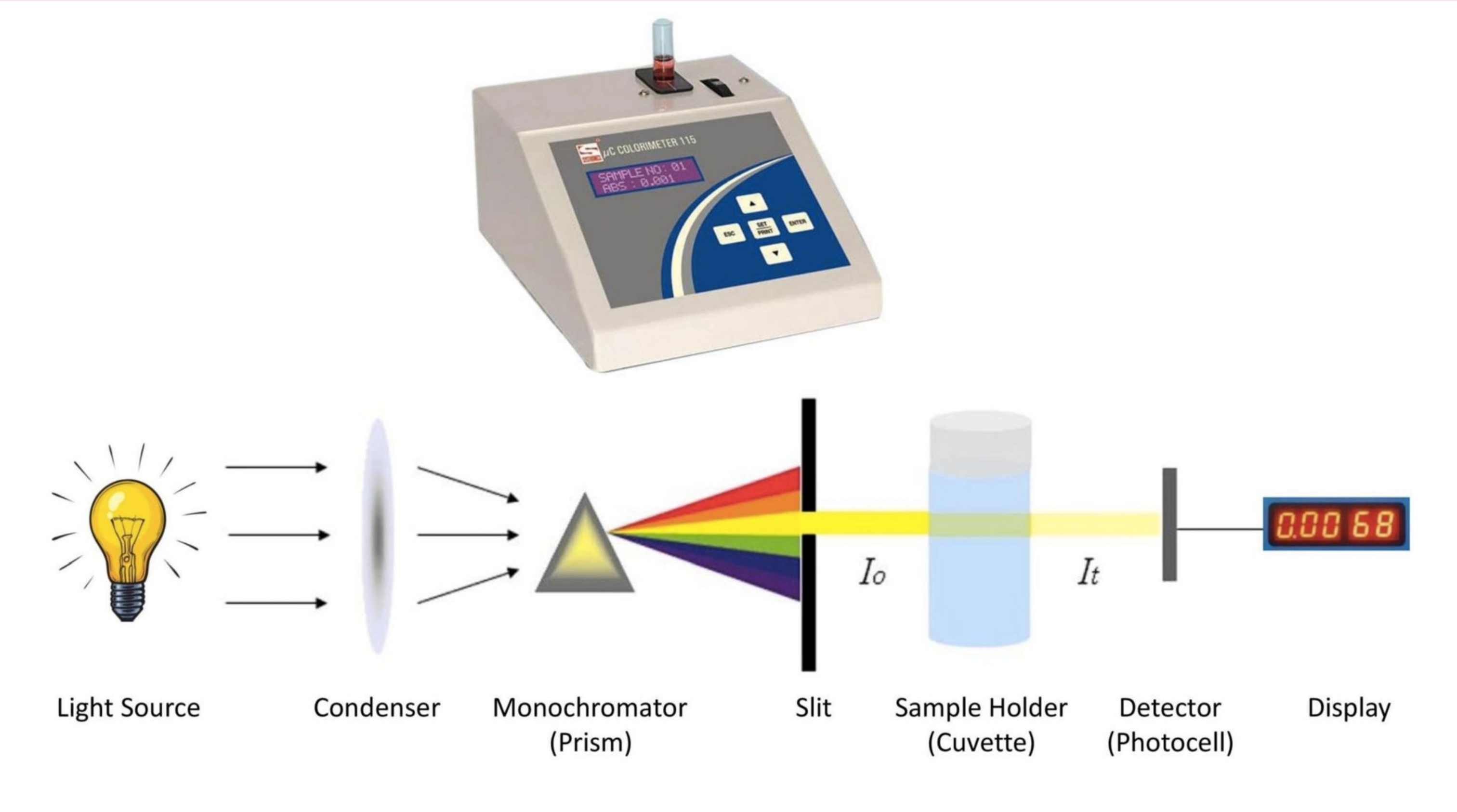
Elemental Analysis

Elemental Analysis to determine the composition of a mixture can be qualitative (identify the different elements present) or quantitative (identify the amounts of elements present.)

Elemental analysis is a part of analytical chemistry.

Example: Combustion Analysis - All of the carbon in a sample is converted into carbon dioxide, all of the hydrogen is converted into water, all of the nitrogen into nitrogen monoxide or nitrogen dioxide…

Colorimetry- Blue Dye Lab



Beer's Law

Light absorption is directly proportional to path length and the concentration of the solution.

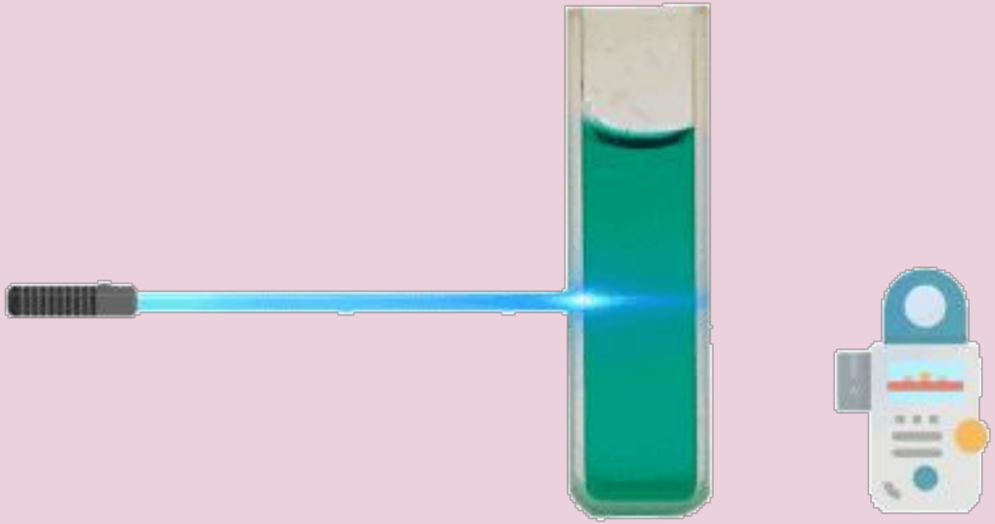
$$A = \varepsilon \ell c$$

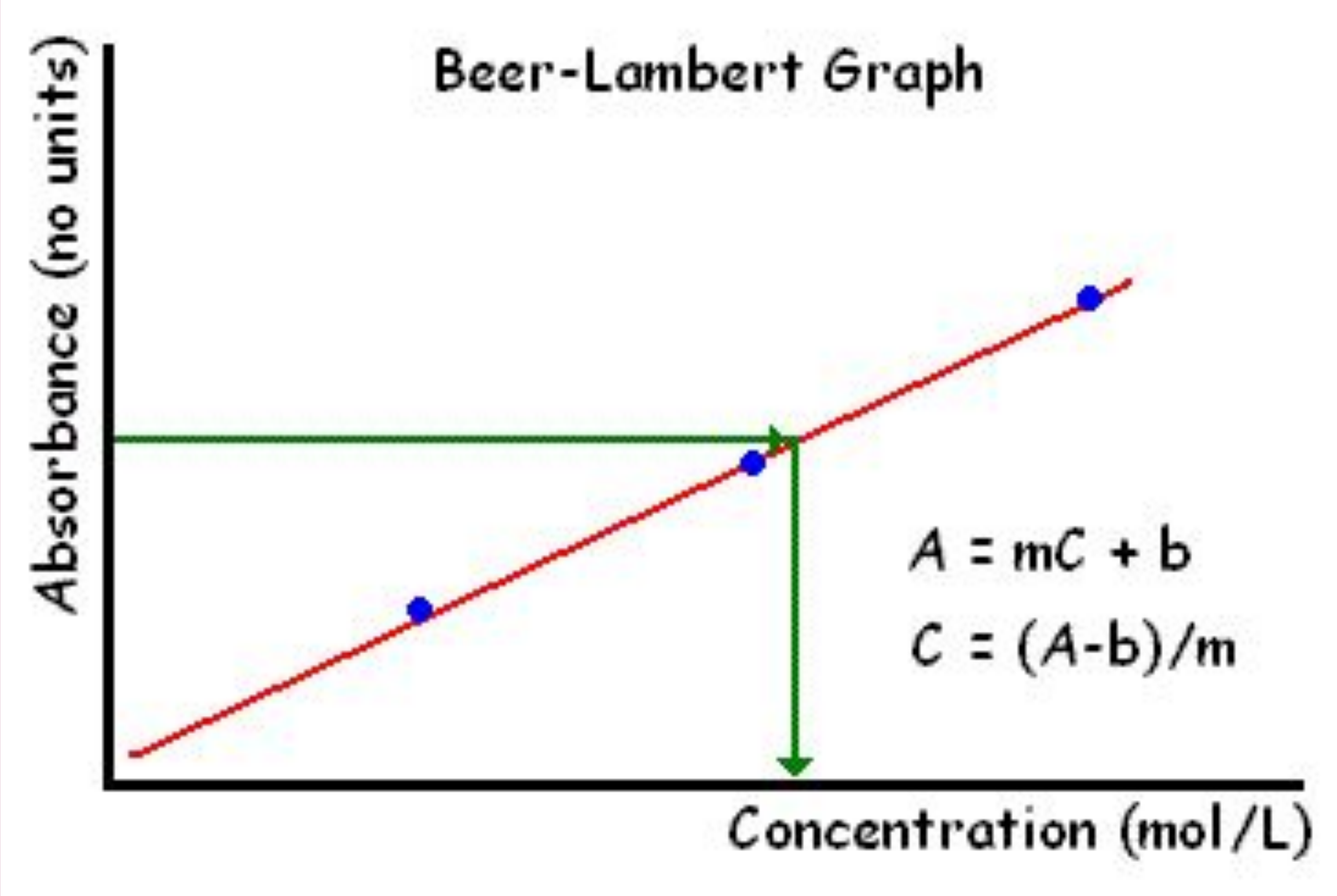
absorbance

molar absorptivity

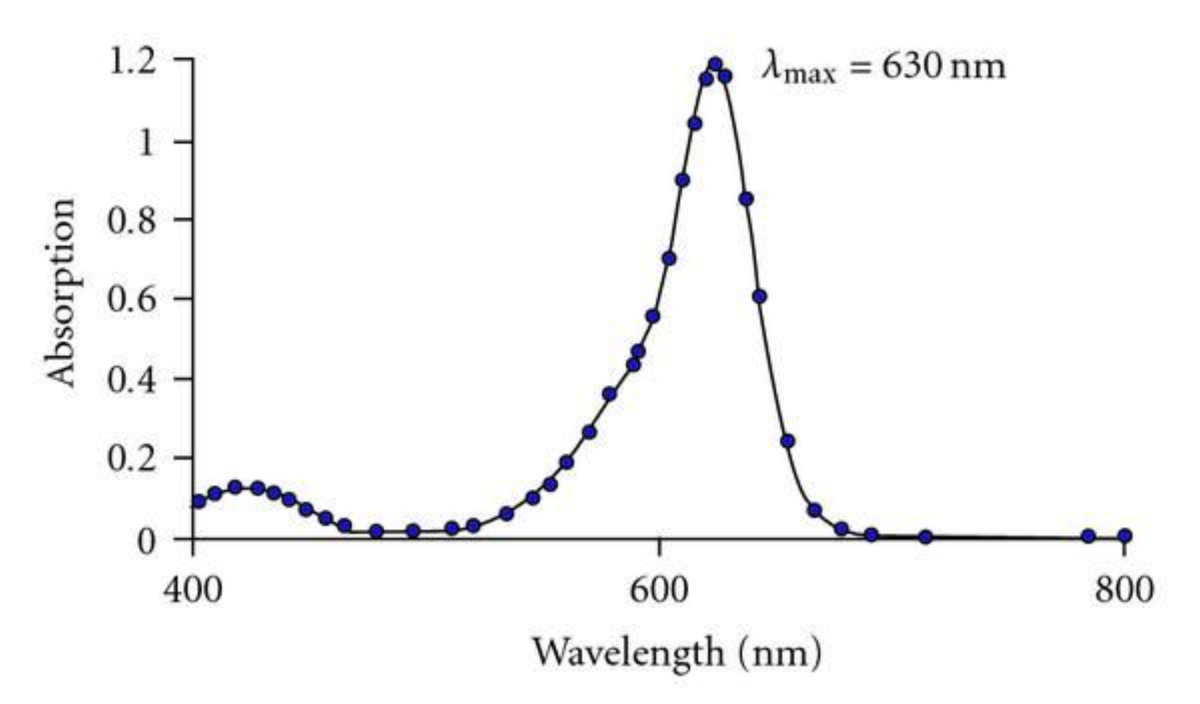
path length

concentration




Beer-Lambert Graph
Absorbance (no units)
A = mC + b
C = (A-b)/m
Concentration (mol/L)

Colorimeter needs to have wavelength set to 635 nm



You will Create a Beer Lambert Graph

- You must create 4 dilution solutions and obtain absorbances
- Obtain the absorbance of an unknown solution (Gatorade)
- Make a graph including a line of best fit
- Use the graph to determine the concentration of the unknown
- I must receive a copy of the graph

This will be due on Monday, August 21st

Together

Aluminum metal reacts with the air and forms a thin, corrosion resistant coating of aluminum oxide, Al_2O_3, according to the following unbalanced equation.

$Al\ (s) + O_2\ (g) \rightarrow Al_2O_3\ (s)$

A sample of a mixture of aluminum and aluminum oxide weighing 120.91 grams were analyzed and found to contain 120.32 grams of aluminum.

a) Balance the equation provided.

b) What mass of oxygen was in the sample?

c) What mass of aluminum oxide was in the mixture?

d) What is the mass percent of aluminum oxide in the aluminum and aluminum oxide mixture?

You do, We Review

The main component of egg shells is the compound calcium carbonate, $CaCO_3$. If you react egg shells with acetic acid, HCH_3COO, from vinegar the following reaction will take place.

$$\mathbf{CaCO_{3\,(s)} + 2\,HCH_3COO_{(aq)} \rightarrow H_2O_{\,(l)} + CO_{2\,(g)} + Ca(CH_3COO)_{2\,(aq)}}$$

If 4.421 grams of carbon dioxide, CO_2, was produced from 10.57 grams of egg shells, what percentage of the mass of the egg shells was calcium carbonate?

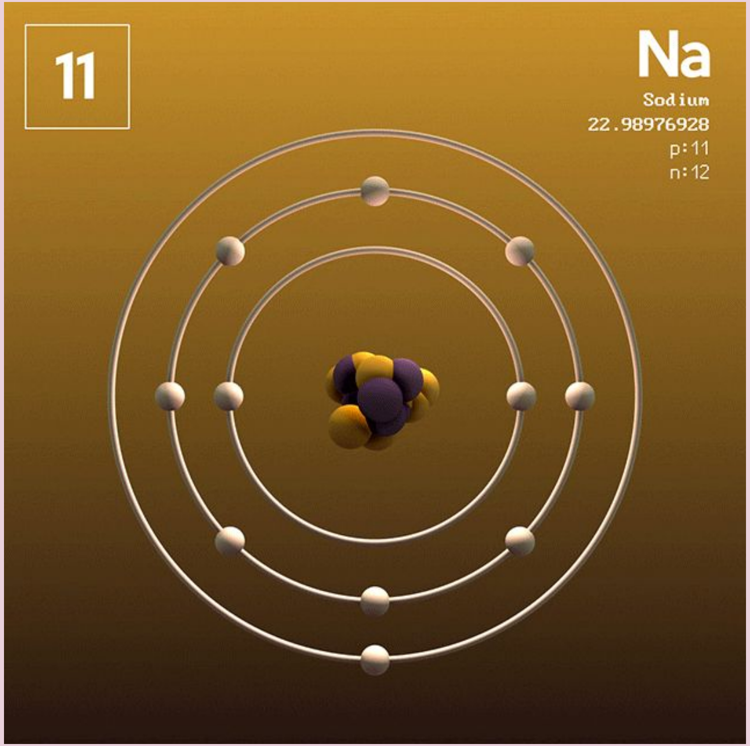
TOPIC 1.5: ATOMIC STRUCTURE & ELECTRON CONFIGURATION

Enduring Understanding	
SAP-1	Atoms and molecules can be identified by their electron distribution and energy.
Learning Objective	
SAP-1A	Represent the electron configuration of an element or ions of an element using the Aufbau principle.

Atoms

Atoms are made up from **protons** (positive), **neutrons** (neutral) and **electrons** (negative). The nucleus contains the protons and neutrons, while the electrons move around the nucleus.

The majority of the mass of the atom comes from the protons and neutrons, while most of the volume of an atom comes from the electrons.

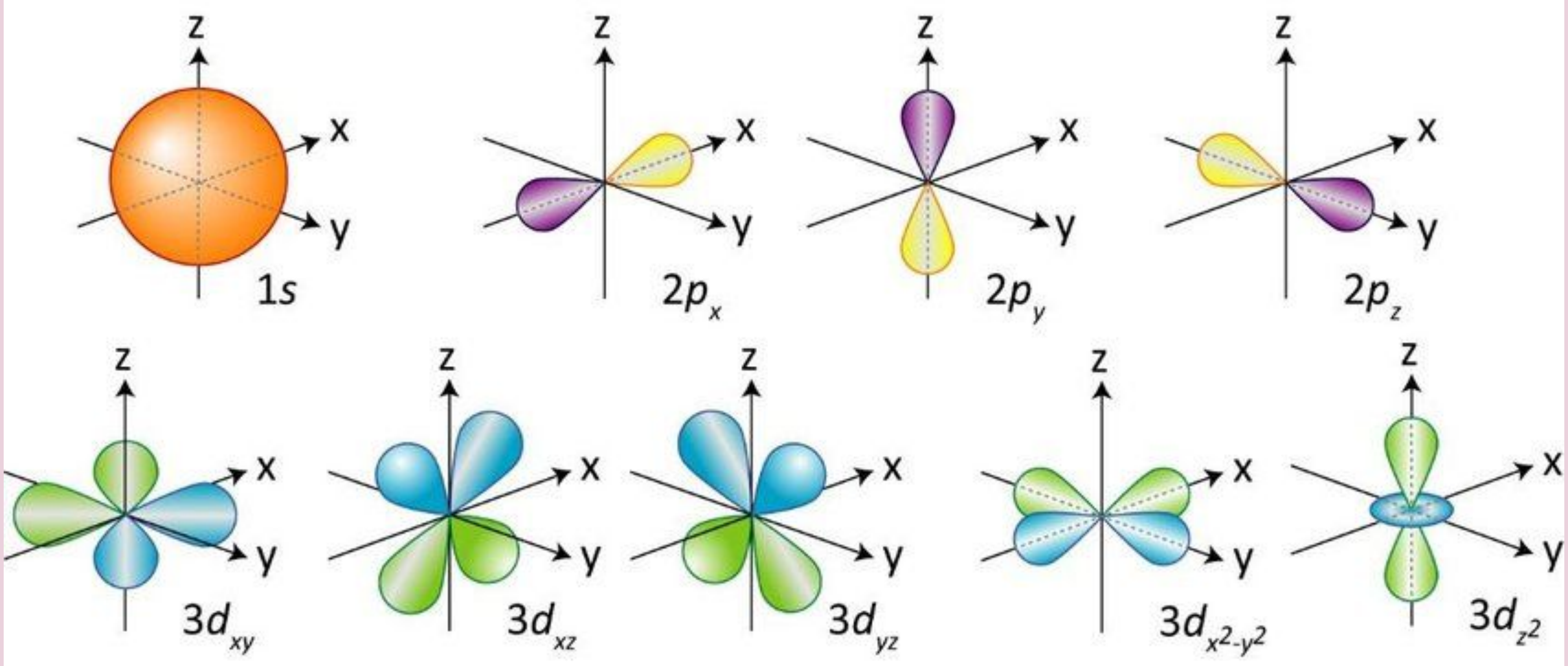


Think Back to Bohr Models

- How many electrons could fit on the first energy level?
- How many electrons can fit on the second level?

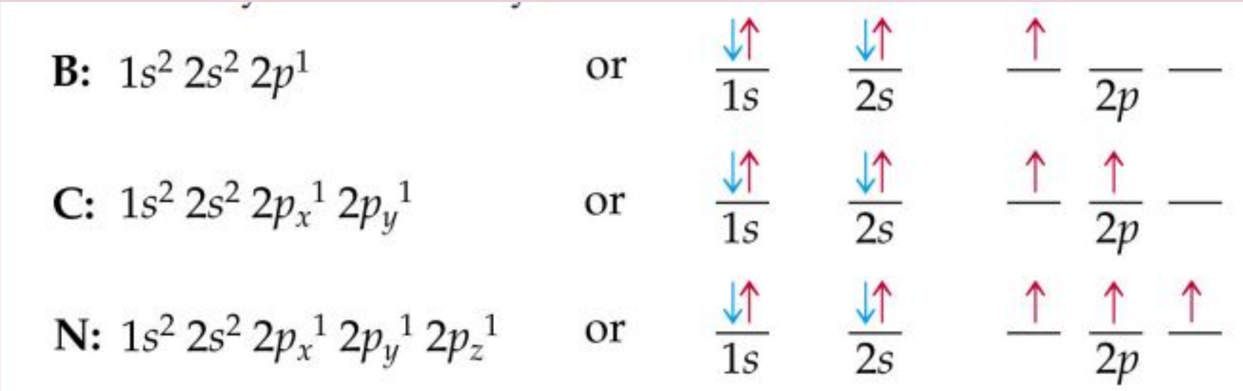
Orbitals

- Within each energy level there are orbitals



Electron Configuration

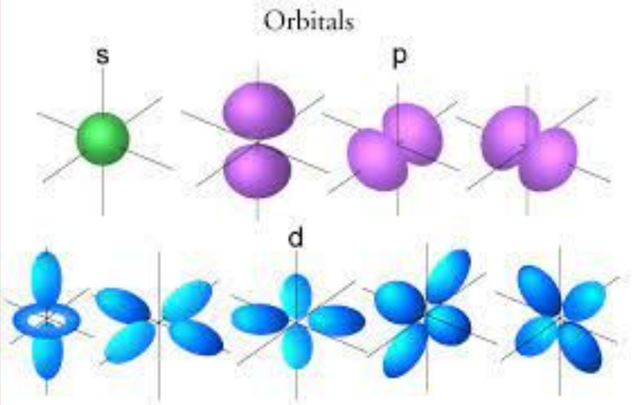
Electron Configurations are a way of describing the arrangement of electrons within an atom.



The inner electrons are called **core electrons**.

The outer electrons are called **valence electrons**.

Energy Levels

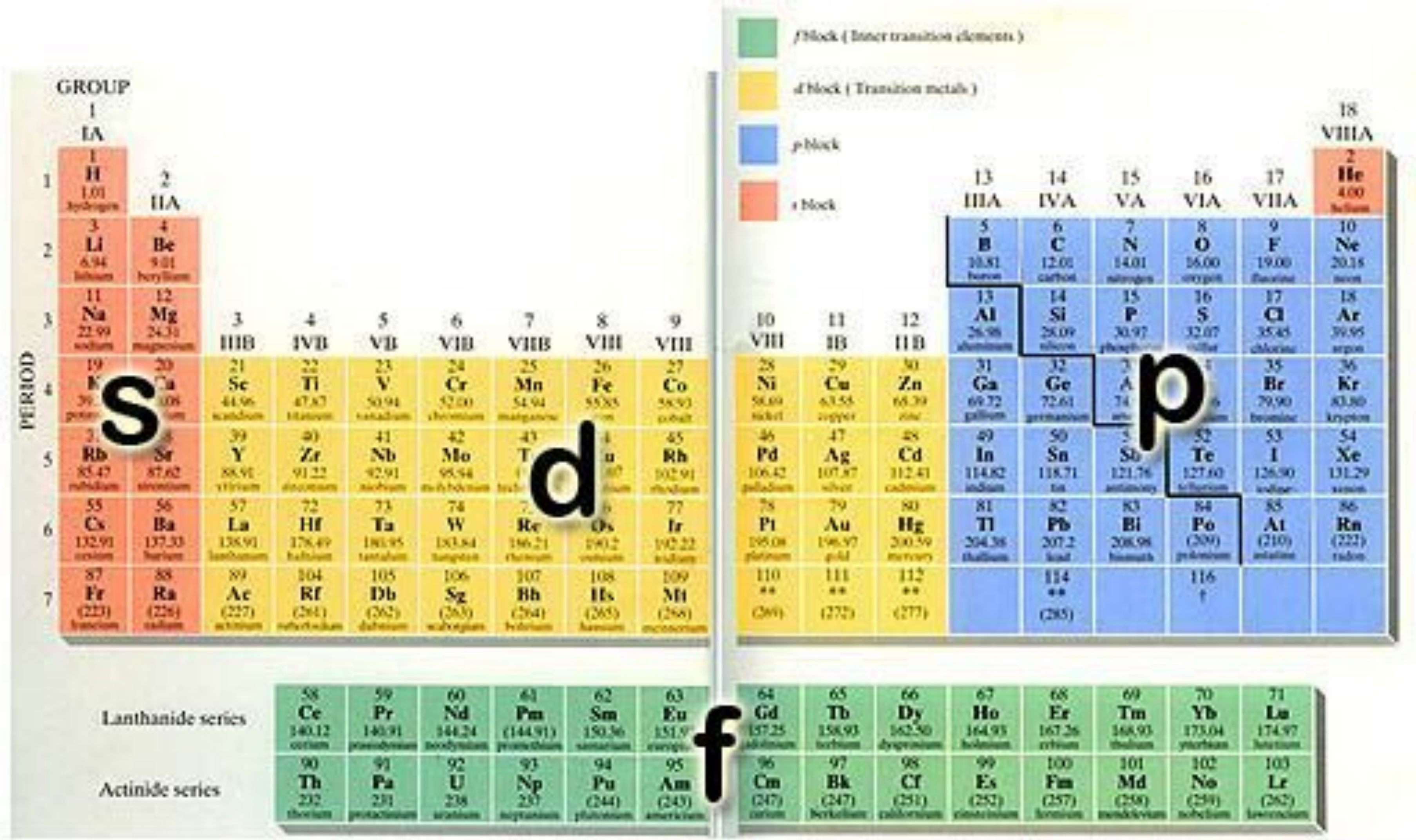


Energy Level	Possible Shapes (orbitals)	Number of Electrons
1	s	2
2	s p	8
3	s p d	18

The first shell is small and only has room for the 1s orbital.

The second shell is larger and there is room for a 2s orbital and a set of 3 2p orbitals which are dumb-bell shape.

The third shell is even larger and there is room for a 3s orbital, a set of 3p orbitals and a set of 5 3d orbitals which are double dumb-bell shape.

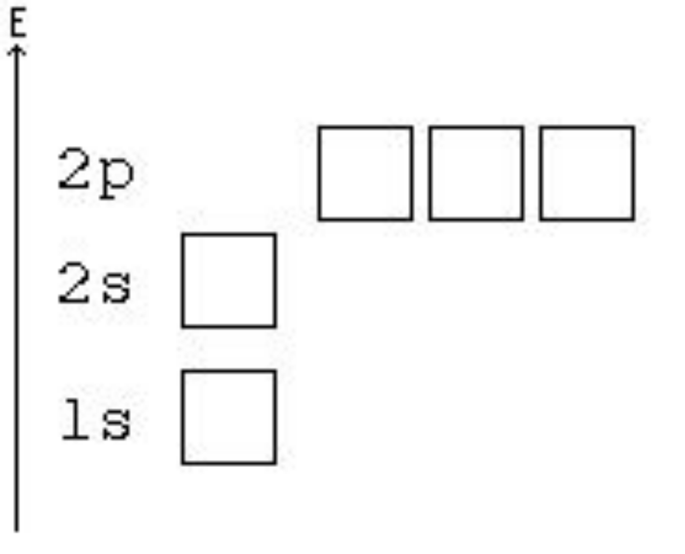

f block (Inner transition elements)
d block (Transition metals)
p block
s block
GROUP
PERIOD
s
d
p
f
Lanthanide series
Actinide series

RULES FOR ELECTRON CONFIGURATIONS:

1. **Aufbau principle:** electrons are added to the lowest subshells first and build up.

2. **Hund's Rule:** each subshell should have one electron before any are doubled up.

3. **Pauli Exclusion Principle:** no two electrons can have the same set of 4 quantum numbers.



Writing Electron Configuration

(Shell#)(orbital name)$^{\text{\# of e-}}$

Fluorine Example: $1s^2\ 2s^2\ 2p^5$

Writing Electron Configurations is more convenient than filling diagrams.

Follows Aufbau Principle

Hund's Rule and Pauli Exclusion are not represented.

Writing Electron Configurations

Determine how many electrons are in the atom. Iron has 26 electrons.

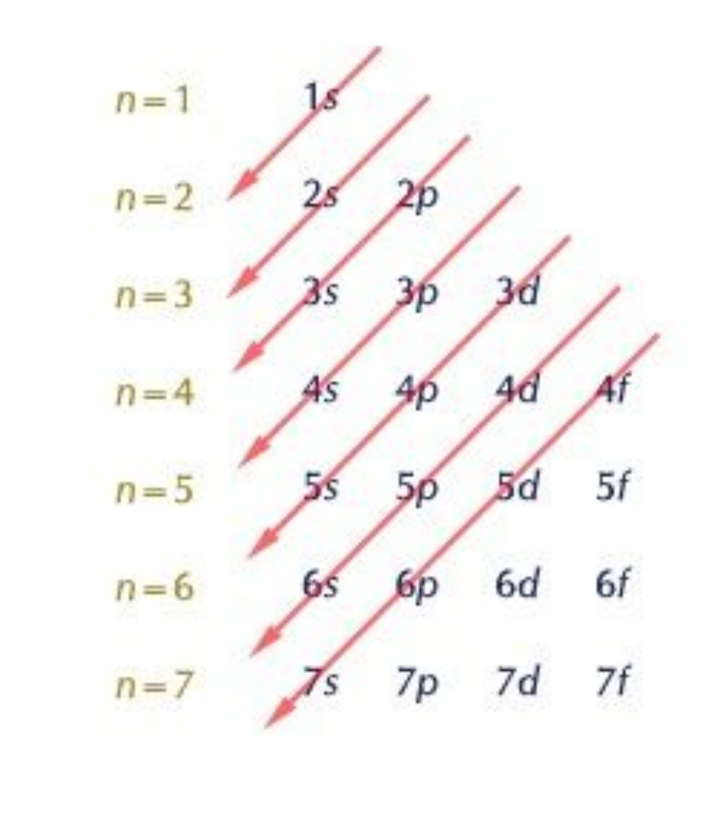
Arrange the energy sublevels according to increasing energy:

1s 2s 2p 3s 3p 4s 3d … (explained on next slide)

Fill each sublevel with electrons until you have used all the electrons in the atom:

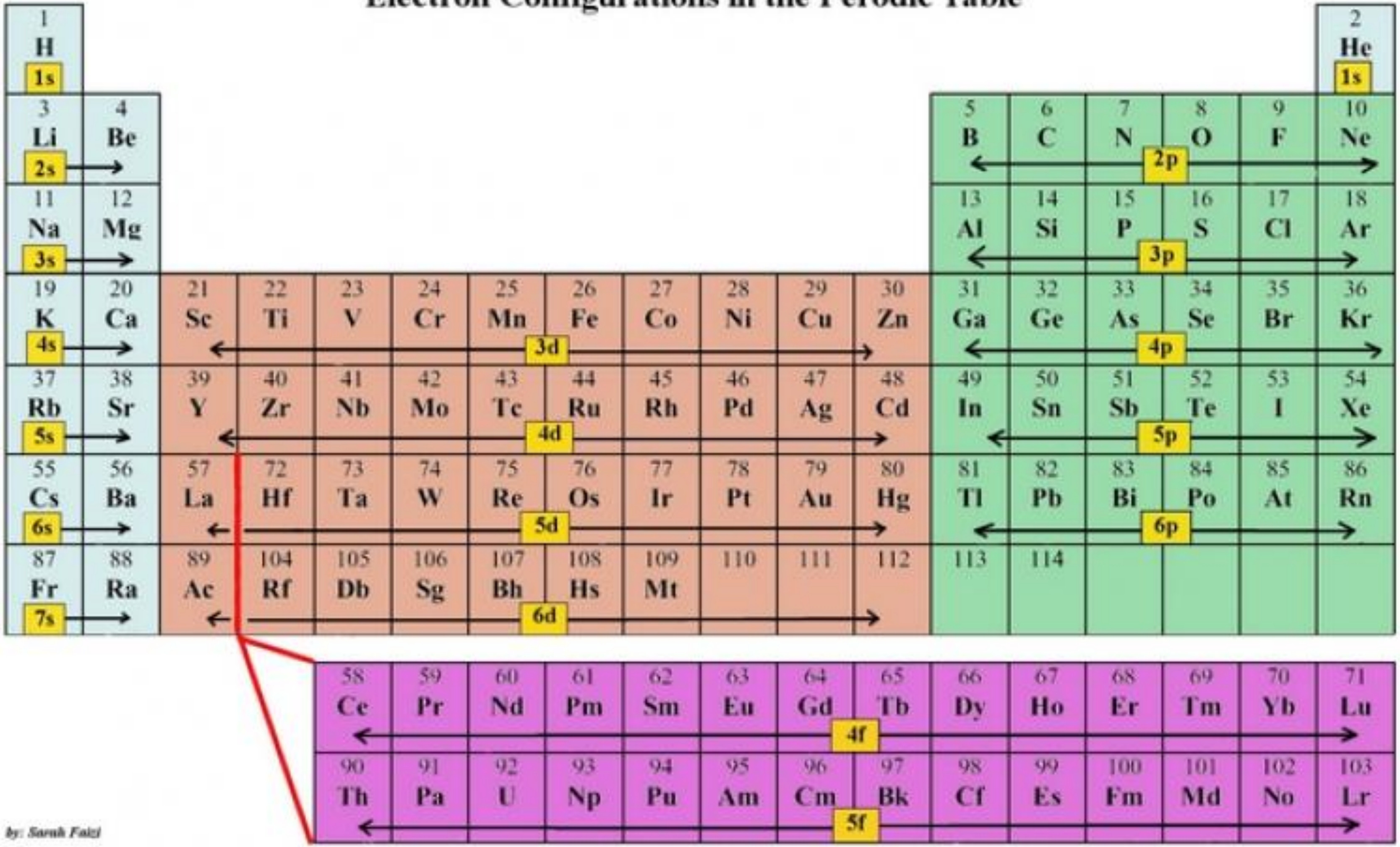
Fe: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$

Sublevel Increasing Energy



Bellwork

Electron Configurations in the Perodic Table



by: Sarah Faizi

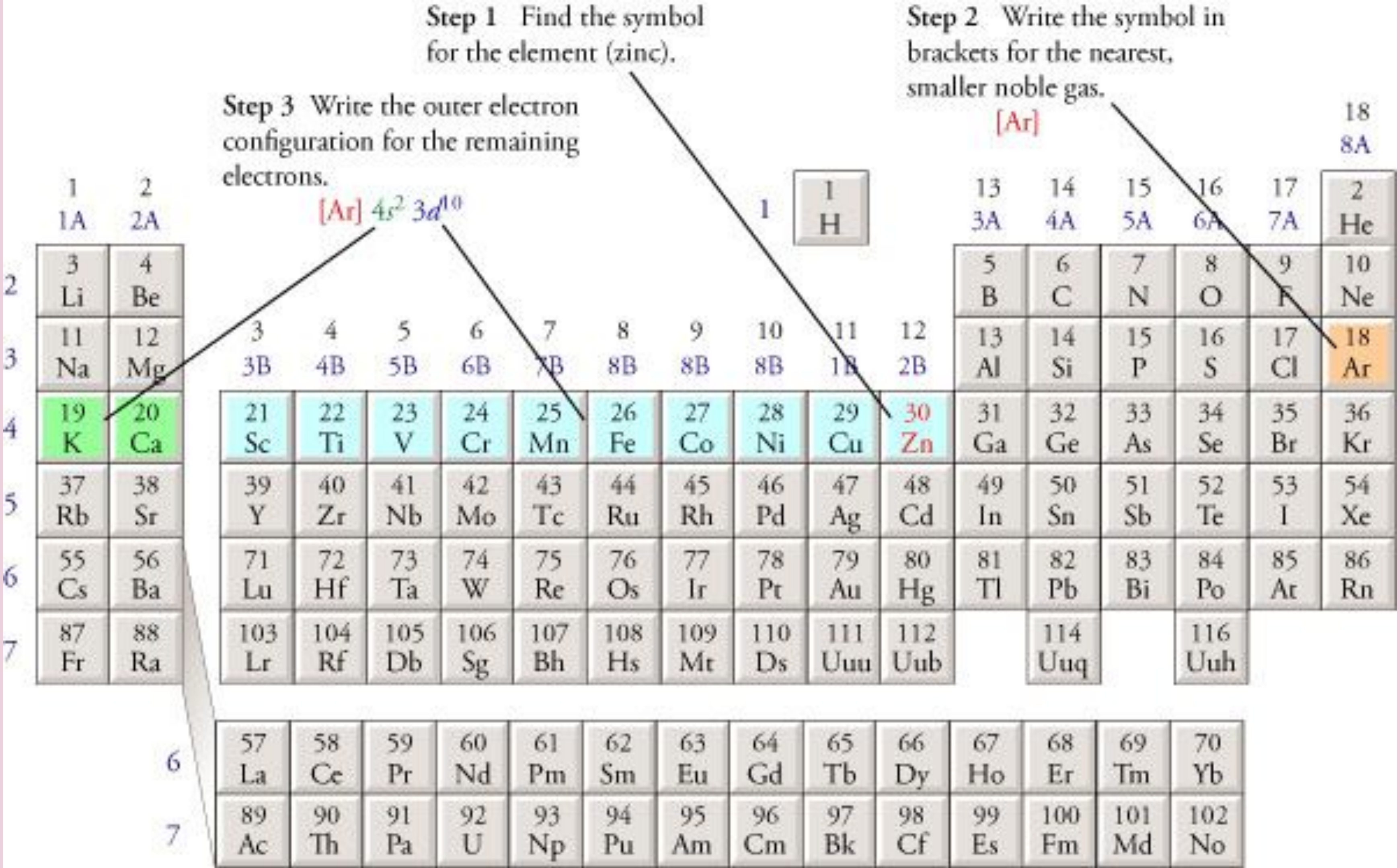
Noble Gas Abbreviation/Shorthand Electron Configuration

An abbreviated form of electron configurations was developed using the final column of the periodic table, the noble gases.

Example: Scandium

Instead of Sc: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$

We can abbreviate as $[Ar]4s^2 3d^1$



Step 1 Find the symbol for the element (zinc).
Step 2 Write the symbol in brackets for the nearest, smaller noble gas.
[Ar]
Step 3 Write the outer electron configuration for the remaining electrons.
[Ar] 4s2 3d10

Electromagnetic Forces

Chemistry is governed by the forces that exist between charged particles.

The strength of these electromagnetic forces are determined by two factors:

- **the amount of charge** (q1 and q2)
  - $F \propto q1 \times q2$
- **the distance between charges** (r)
  - $F \propto 1 / r^2$

★ Coulomb's Law ★

$$F = k\frac{q_1 q_2}{r^2}$$

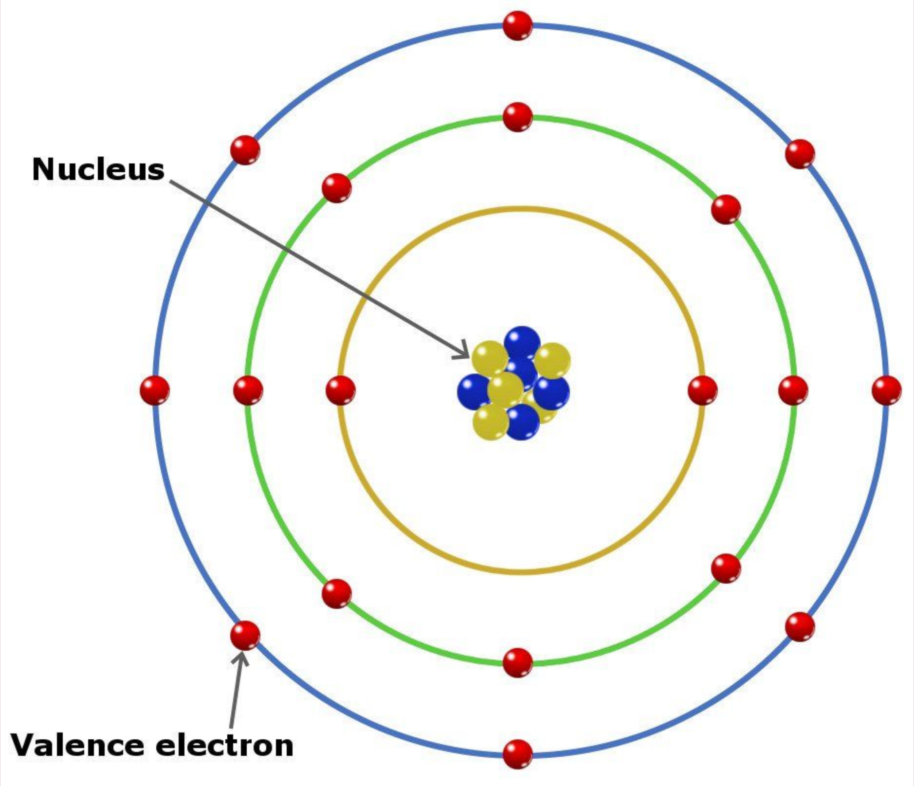
The force between charged particles is proportional to the product of the two charges and the force is inversely proportional to the squared radius between them.

The force will decrease the further away the particles are.

Higher charges and smaller distances between the charges result in a greater force of attraction. **This explains why it takes more energy to remove electrons that are closest to the nucleus.**

Shielding

In addition to the distance, the electrons that are on the valence shell experience less of the nuclear pull because the electrons that are in the core of the atom **shield** the attraction of the nucleus from the valence electrons.



Example 1

Write the ground state electron configuration for Arsenic.

Example 2

Write the electron configuration for Calcium ion, Ca^{2+}.

TOPIC 1.6: PHOTOELECTRON SPECTROSCOPY

Enduring Understanding	
SAP-1	Atoms and molecules can be identified by their electron distribution and energy.
Learning Objective	
SAP-1B	Explain the relationship between the photoelectron spectrum of an atom or ion and: a. The electron configuration of the species. b. The interactions between the electrons and the nucleus.

PES

Photoelectron spectroscopy (PES) is an experimental technique that measures the relative energies of electrons in atoms or molecules.

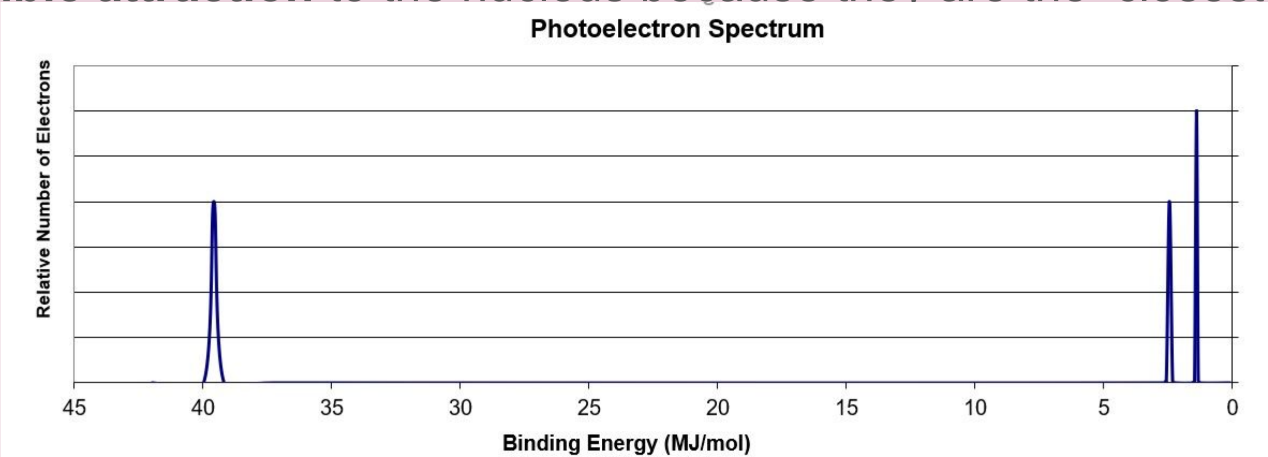
It works by ejecting electrons from the materials using high energy electromagnetic radiation (like UV or x-rays) and then measuring the kinetic energy of those electrons. This process can be described as photoionization.

PES Graphs

PES graphs show the **relative number of electrons** and their corresponding **binding energy**.

The **binding energy** can be described as the amount of energy needed to remove an electron from an atom.

The electrons with the highest binding energy are the ones that have the greatest **coulombic attraction** to the nucleus because they are the closest to the nucleus.



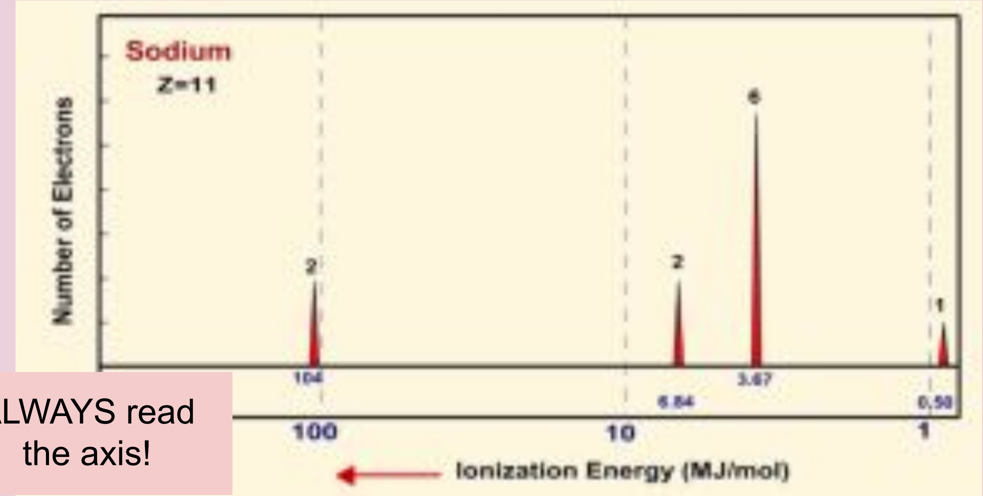
PES Graphs

A PES graph directly correspond to the electron configuration.

X axis sometimes decreases, sometimes increases

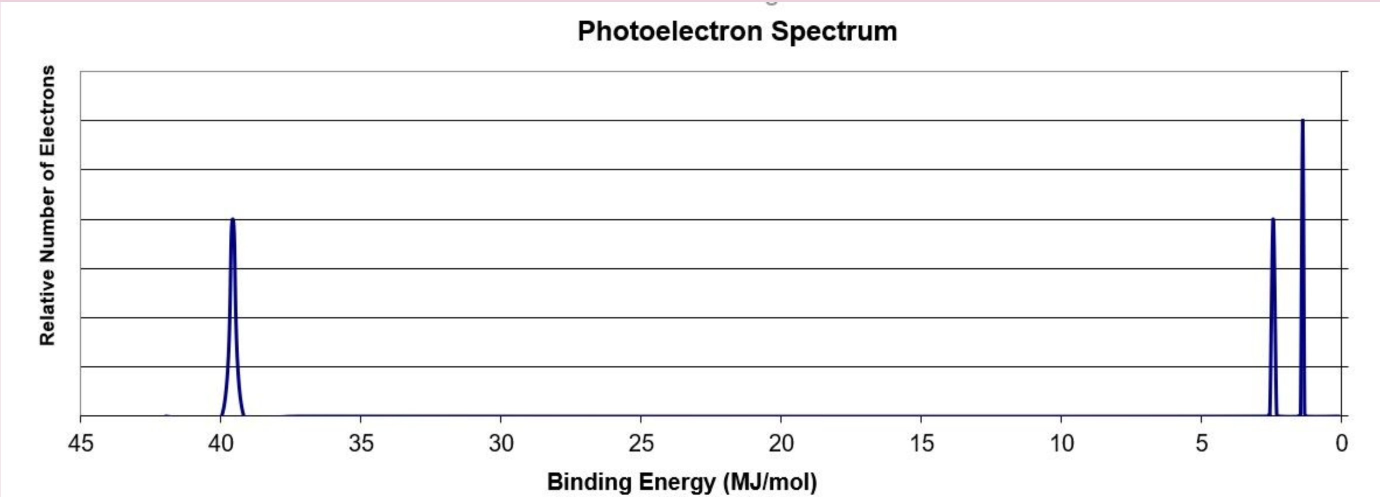
Peaks are often not labeled with # of electrons

We can find the 1s orbital and know that there are 2e there



ALWAYS read the axis!

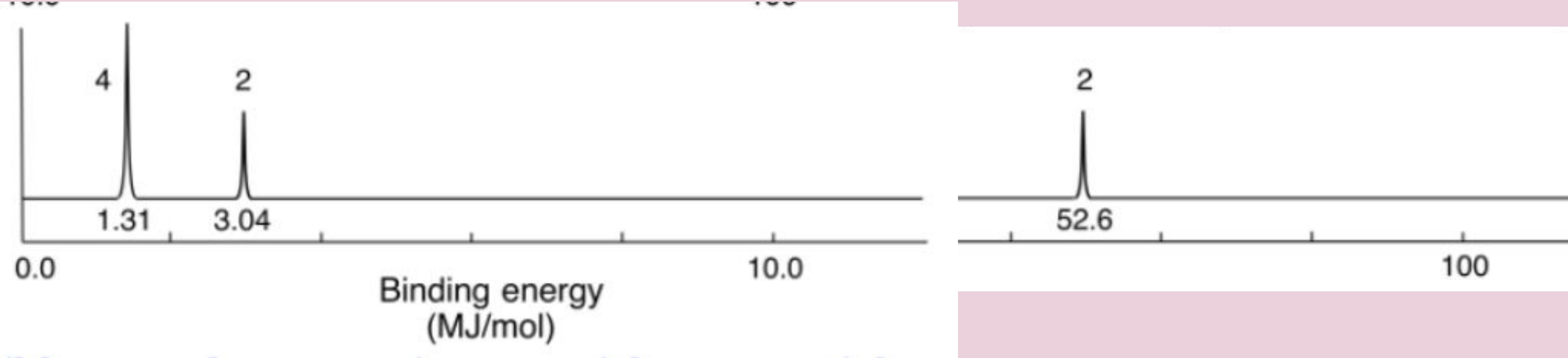
Unlabeled PES Graph



- Where is the highest binding energy, left or right?
- Which peak represents the 1s orbital?
- How many electrons are in the 1s orbital?
- What is the electron configuration? What element?

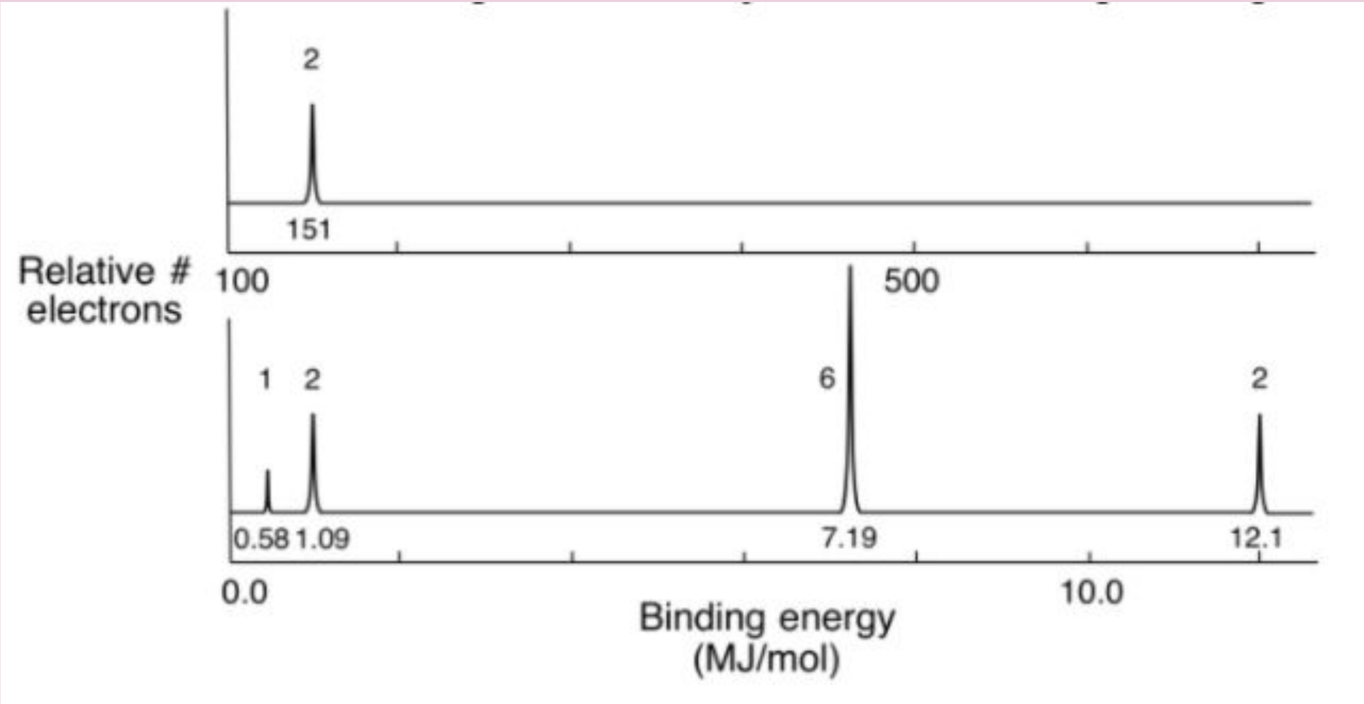
Together

Which element is represented by the PES below?



You Do, We Review

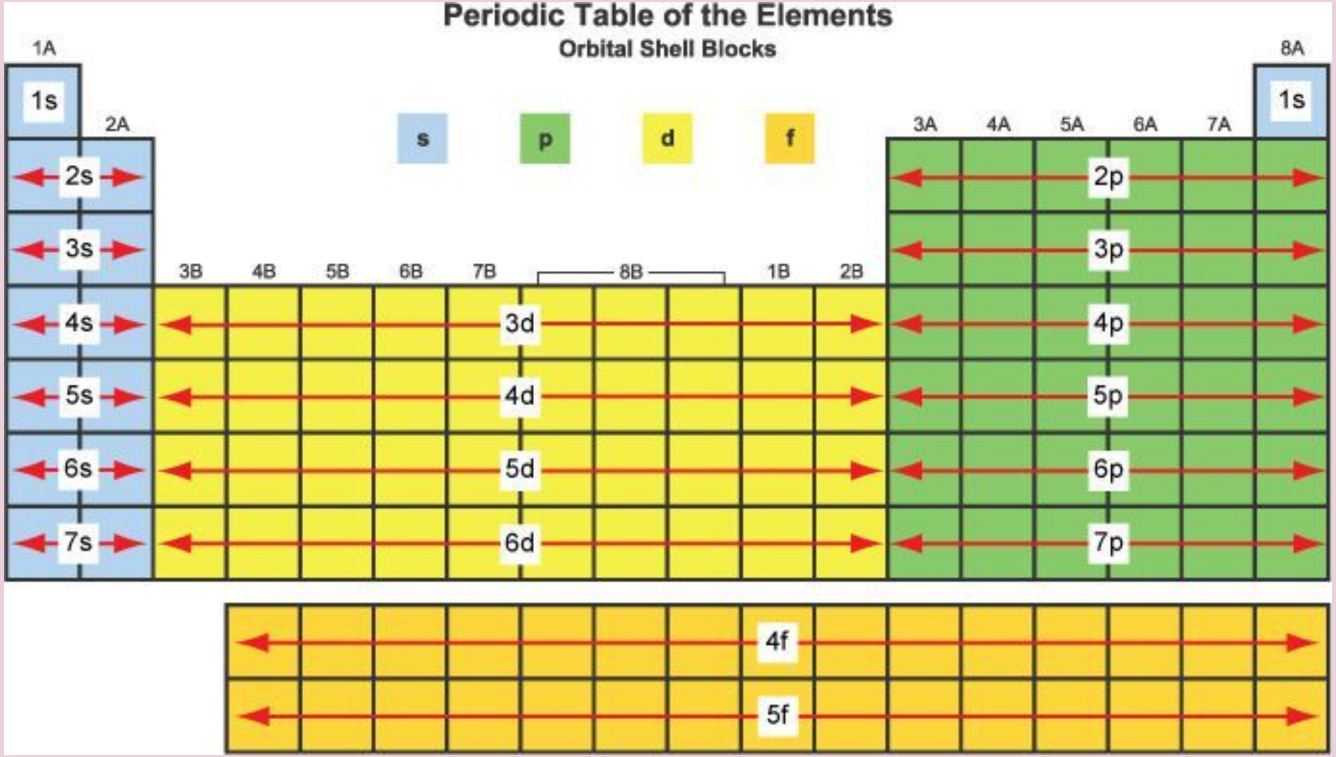
Which element is represented by the PES absorption spectra shown?



TOPIC 1.7: PERIODIC TRENDS

Enduring Understanding	
SAP-2	The periodic table shows patterns in electronic structure and trends in atomic properties.
Learning Objective	
SAP-2A	Explain the relationship between trends in atomic properties of elements and electronic structure and periodicity.

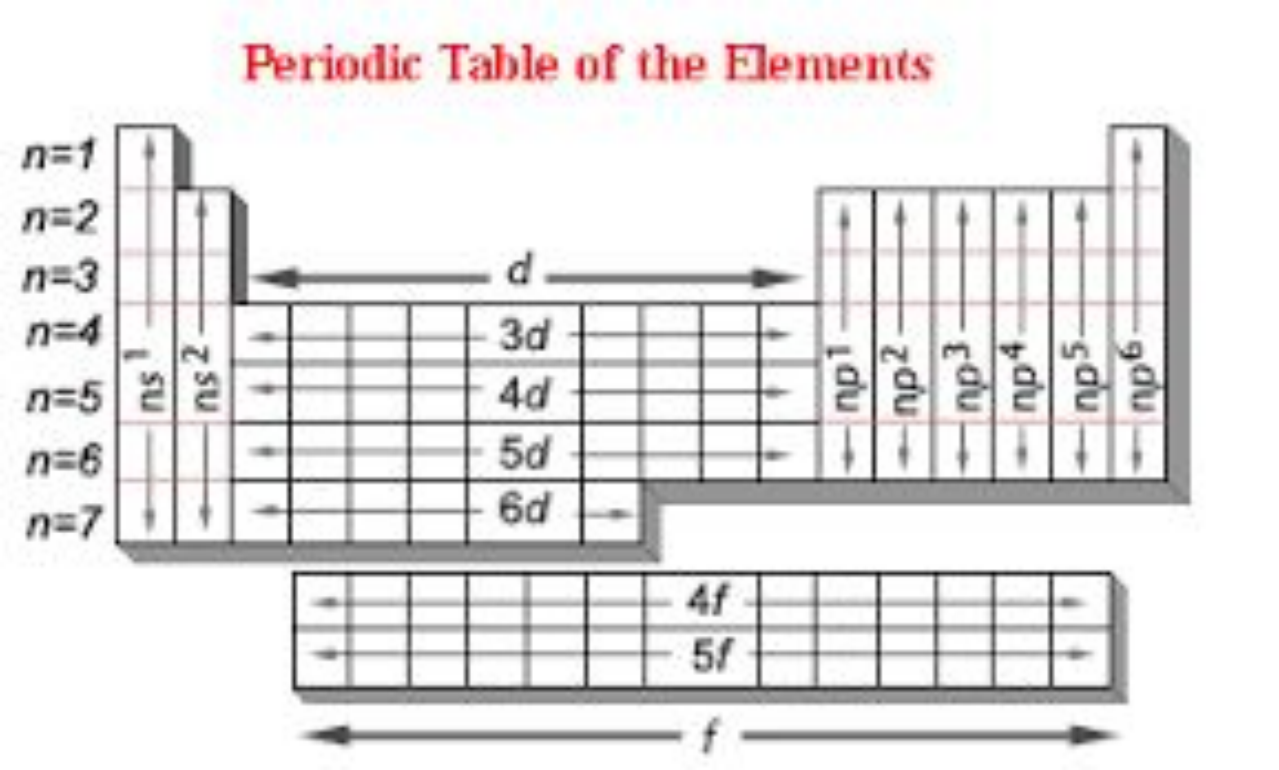
The Periodic Table



The periodic table is arranged in order from lowest atomic number to highest. The blocks of the periodic table correspond to the s/p/d/f groups for the electron configuration.

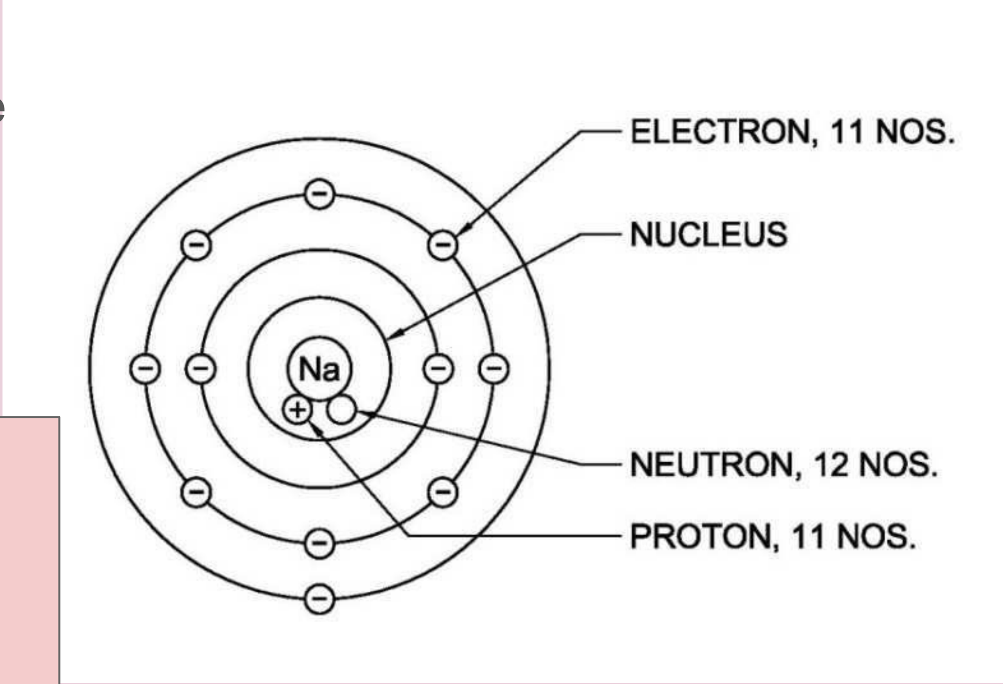
Chemical Properties

Elements that have the same valence electron configuration tend to have similar chemical properties.



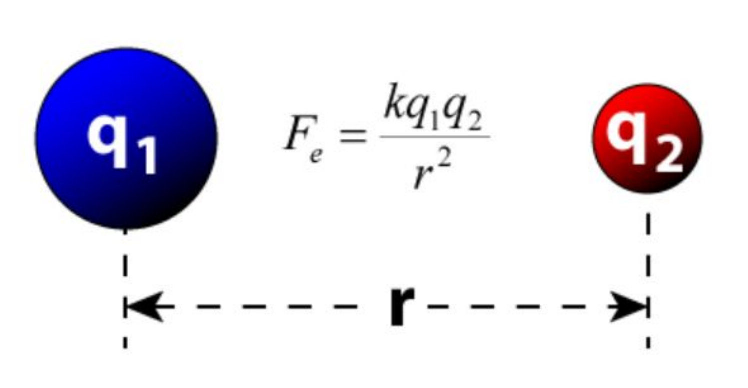
Periodic Trends

Periodic trends can be explained by the **arrangement of the electrons** and the **number of protons** in the atoms.



IMPORTANT: Stating a trend is not EXPLAINING a trend. Explanations of trends should never be in terms of the location of the periodic table.

Coulombic Attraction



- Explains most periodic trends.
- Negative electrons in the electron cloud and positive protons in the nucleus are attracted to each other.
- The larger the charge, the more attractive forces between the particles.
- The further away the particles are from each other, the weaker the attractive forces.

Effective Nuclear Charge

The **effective nuclear charge** is the net positive charge experienced by valence electrons.

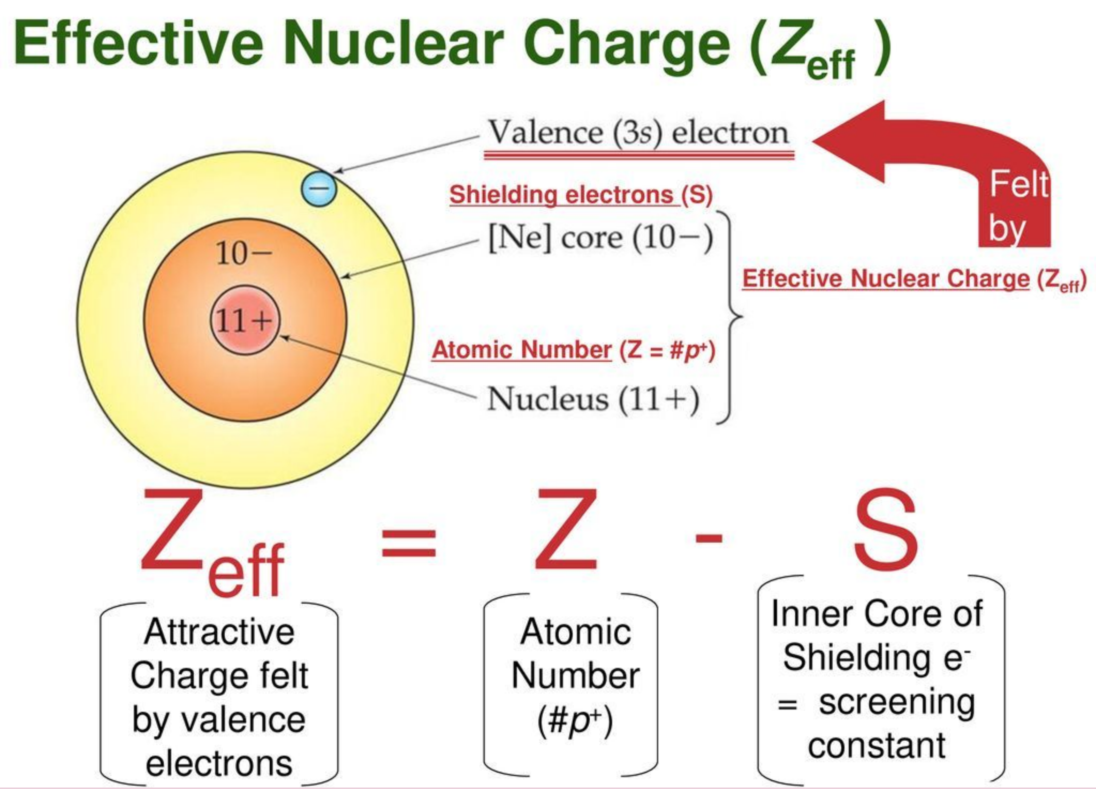
It can be *approximated* by the equation:

$$\mathbf{Z_{eff} = Z - S}$$

Z = atomic number

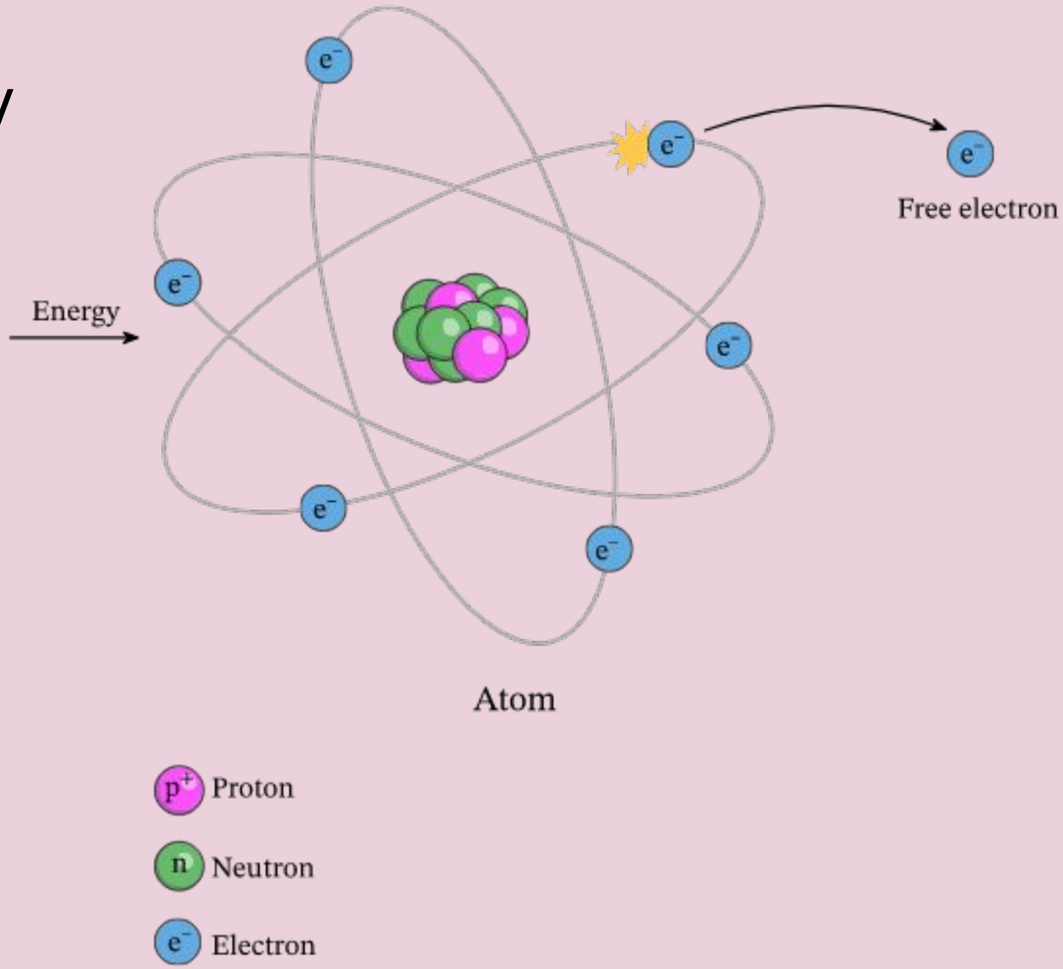
S = number of shielding electrons

Effective Nuclear Charge



First Ionization energy

The energy required to remove the outermost (highest energy) electron from a ground state, neutral atom in its gaseous form.



First Ionization Energy

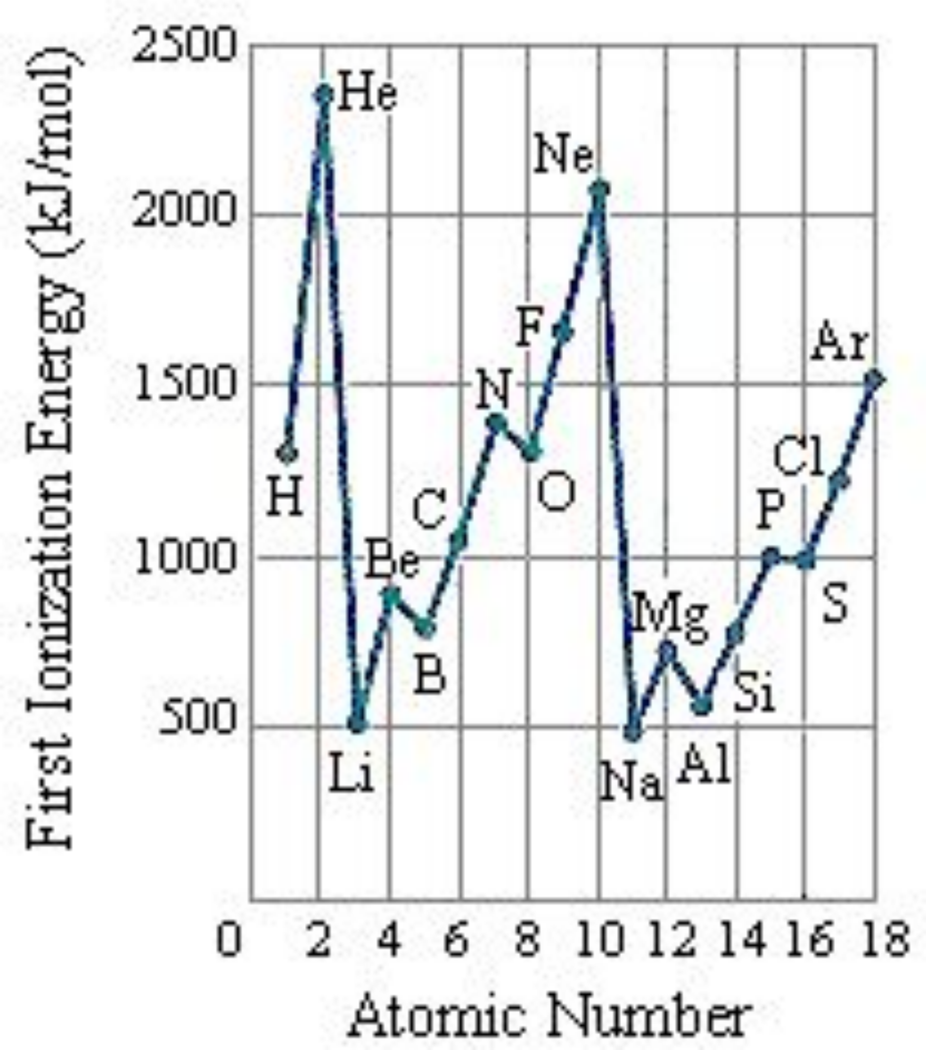
- Decreases as you move down a group.
  - Electrons are further from the nucleus and therefore have a lower Coulombic attraction. This results in the outer electrons being easier to remove (less energy required).
- Increases as you move across a period on the periodic table, from left to right.
  - Increase the number of protons as the number of shielding electrons remains the same.
  - Atomic radius decreases.
  - Both factors result in greater Coulombic attraction, which means it requires more energy to remove the first electron.

Think About it:

Look at the graph. Oxygen does not follow the trend.

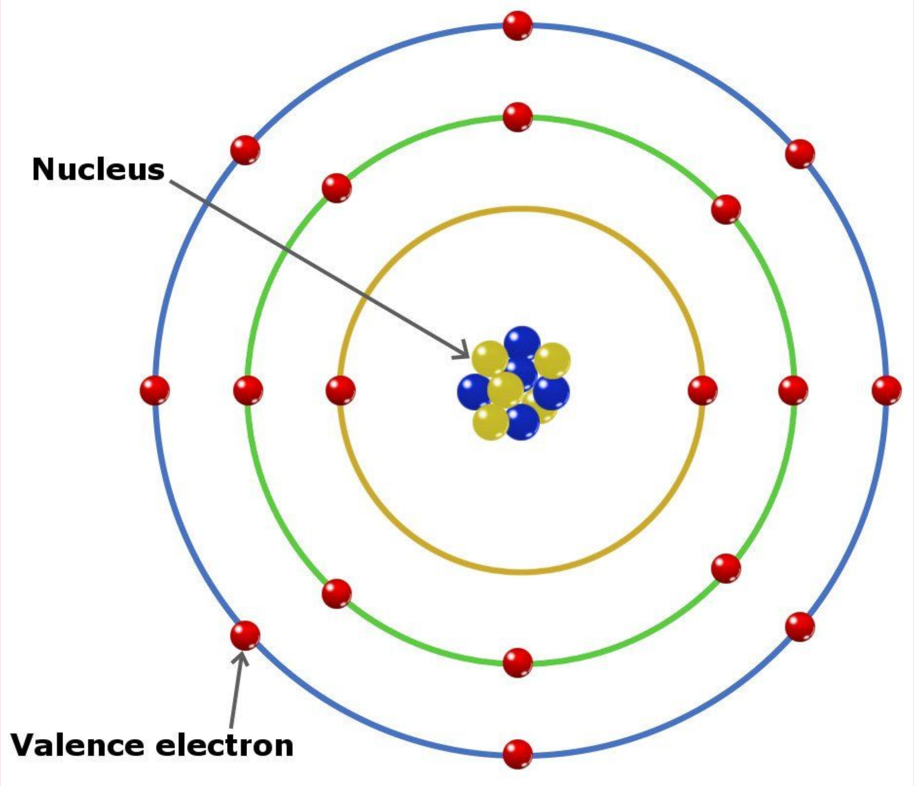
Why do you think Oxygen has a lower first ionization energy than Nitrogen?

What about Be and B?



Shielding

In addition to the distance, the electrons that are on the valence shell experience less of the nuclear pull because the electrons that are in the core of the atom **shield** the attraction of the nucleus from the valence electrons.



Second, third, fourth, ETC. Ionization Energies

The energy to remove a second electron from the atom is the second ionization energy.

The energy to remove a third electron is the third ionization energy and so on.

By examining the successive ionization energies for an element we can determine how many valence electrons there are in that element.

When all of the valence electrons have been removed, you will see a large jump in the ionization energy values.

Magnesium

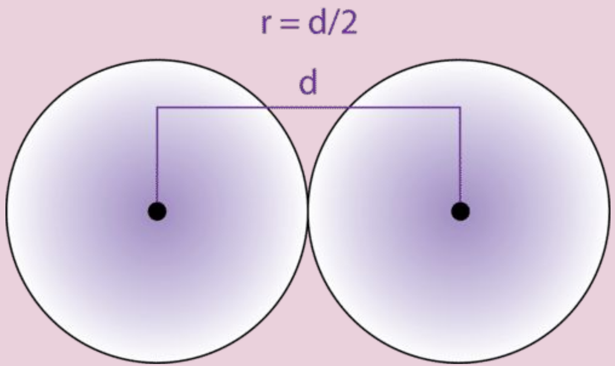
- Write the electron configuration for magnesium.
- How many valence electrons does Mg have?
- We see the large jump for the 3rd ionization energy!
- Why is there another large jump for the 11th ionization energy?

Ionization Energies (kJ/mol)

1st	737.75
2nd	1450.68
3rd	7732.68
4th	10542.51
5th	13636
6th	18020
7th	21711
8th	25658
9th	31646
10th	35457
11th	169988
12th	189368 (calculated)

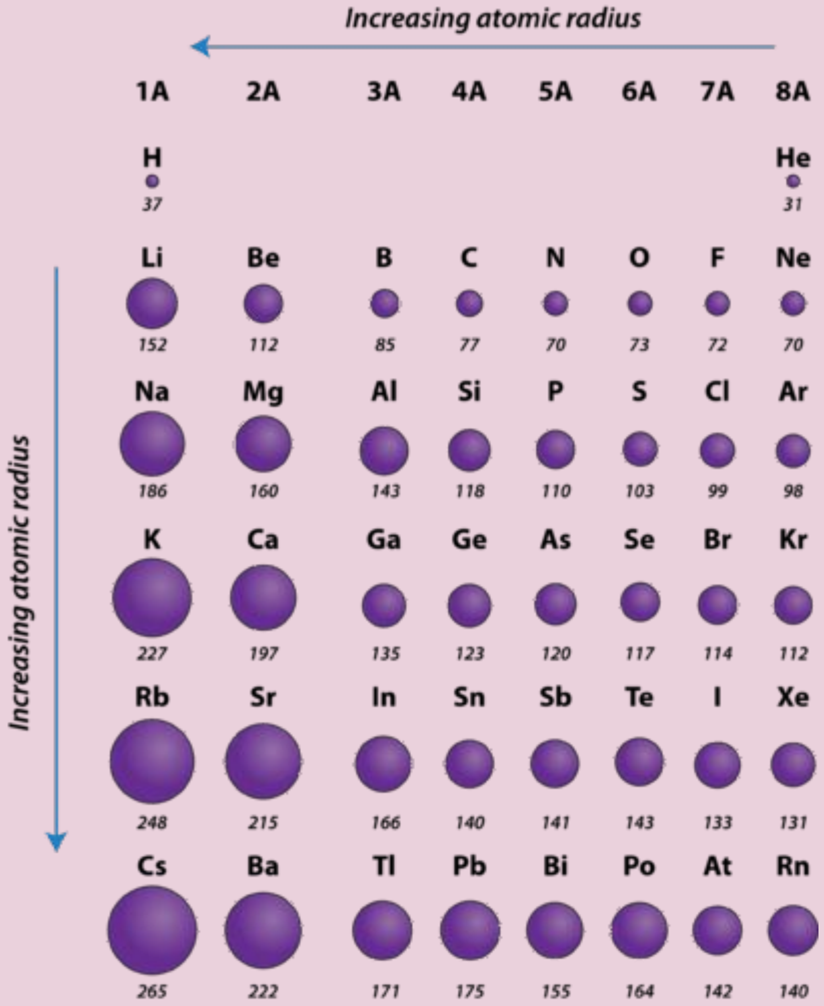
Atomic Radius

- The atomic radius of a chemical element is a measure of the size of its atoms, the mean or typical distance from the center of the nucleus to the boundary of the surrounding cloud of electrons.
- Measured by one-half the distance between the nuclei of identical atoms that are bonded together.



Atomic Radius

- Atomic Radii **increases as you move down a group** as there are more electron shells.
- Atomic Radii **decreases as you move across a period from left to right**. Electrons are being added to the same energy level and protons are being added to the nucleus. Increasing the number of protons gives a **higher effective nuclear charge.**



Ionic Radius

- **Cations are always smaller than the parent atom.**
  - They have lost their valence shell.
  - Additionally there are fewer electron-electron repulsions.
- **Anions are always larger than the parent atom.**
  - Electrons are added to the same valence shell however, there are greater electron-electron repulsions so the ion increases in size.

Electron Affinity

- The energy change that occurs when an electron is added to a gaseous atom or ion:

$$E_{(g)} + e^{-} \rightarrow E^{-}_{(g)} \qquad \text{energy change}=EA$$

- In general, the electron affinity **increases from left to right** on the periodic table. Electrons are filling the valence shell and effective nuclear charge (therefore coulombic attraction) is increasing.
- In group 1, electron affinity **decreases down a group**. This is sort of true for other groups. The distance from the nucleus to the valence shell increases, decreasing the coulombic attraction.

Exceptions

Period 2 has LOW electron affinities - small atoms, not a lot of space. F’s EA is lower than Cl’s.

Group 15 has LOWER electron affinities than expected.

≥0 kJ/mol — −348.6 kJ/mol

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	H −72.8																	e ≥0
2	Li −59.6	Be ≥0											B −27.0	C −121.8	N ≥0	O −141.0	F −328.2	Ne ≥0
3	Na −52.9	Mg ≥0											Al −41.8	Si −134.1	P −72.0	S −200.4	Cl −348.6	Ar ≥0
4	K −48.4	Ca −2.4	Sc −18	Ti −8	V −51	Cr −65.2	Mn ≥0	Fe −15	Co −64.0	Ni −111.7	Cu −119.2	Zn ≥0	Ga −40	Ge −118.9	As −78	Se −195.0	Br −324.5	Kr ≥0
5	Rb −46.9	Sr −5.0	Y −30	Zr −41	Nb −86	Mo −72.1	Tc −60	Ru −101.0	Rh −110.3	Pd −54.2	Ag −125.9	Cd ≥0	In −39	Sn −107.3	Sb −101.1	Te −190.2	I −295.2	Xe ≥0
6	Cs −45.5	Ba −14.0	La −45	Hf ≥0	Ta −31	W −79	Re −20	Os −104.0	Ir −150.9	Pt −205.0	Au −222.7	Hg ≥0	Tl −37	Pb −35	Bi −90.9	Po −180	At −270	Rn ≥0

Electronegativity

A measure of the ability of an atom (or group of atoms) to attract shared electrons **in a bond.**

Electronegativity **decreases as you move down a group** as there is a greater distance from the nucleus.

Electronegativity **increases as you move across a period** because the atomic radius is decreasing while the effective nuclear charge is increasing.

Fluorine is the most electronegative element.

Electronegativity and Bond Type

Example	Difference in electronegativity	Type of Bond
H – H	None	Covalent
H – Br	Small	Polar Covalent
NaCl	Large	Ionic

Together

1. For each of the following pairs of elements choose the at with:
   a. Higher first ionization energy

      Li F

   b. Larger atomic radius

      Na O

   c. Higher electronegativity

      Li F

You Do, We Review

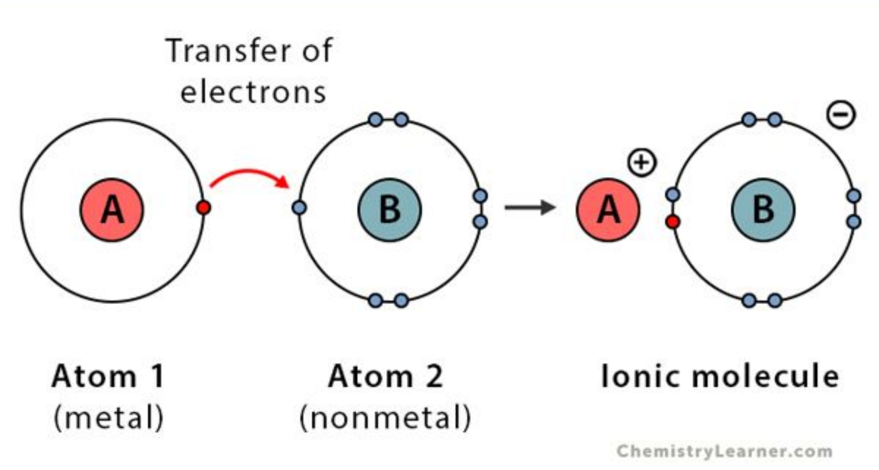
2. Rank the following from smallest to largest atomic/ionic radius.
   a. Na, Na^+, Na^-
   b. C, N, O
   c. Cl, Ar, K
   d. Be, Mg, Ca

TOPIC 1.8: VALENCE ELECTRONS & IONIC COMPOUNDS

Enduring Understanding	
SAP-2	The periodic table shows patterns in electronic structure and trends in atomic properties.
Learning Objective	
SAP-2B	Explain the relationship between trends in the reactivity of elements and periodicity.

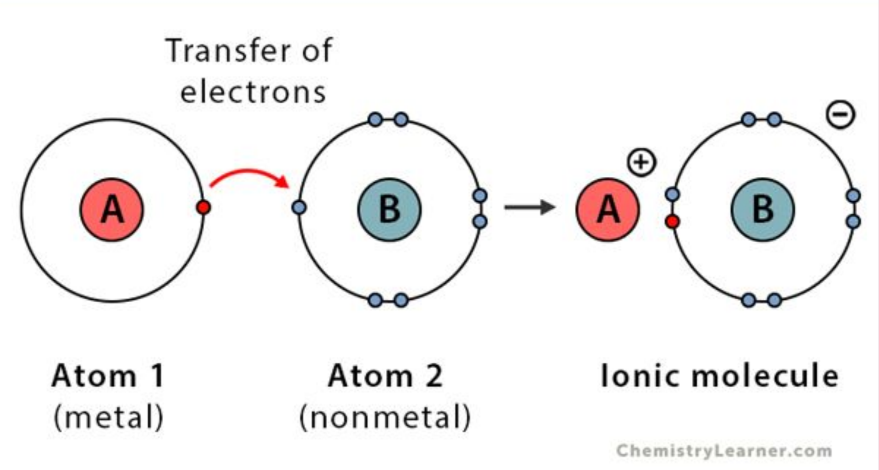
Ionic Bonds

An ionic bond always involves the transfer of electrons from the least electronegative species to the most electronegative. Traditionally, ionic compounds are described as being between a metal and a nonmetal.



Ionic Bonds

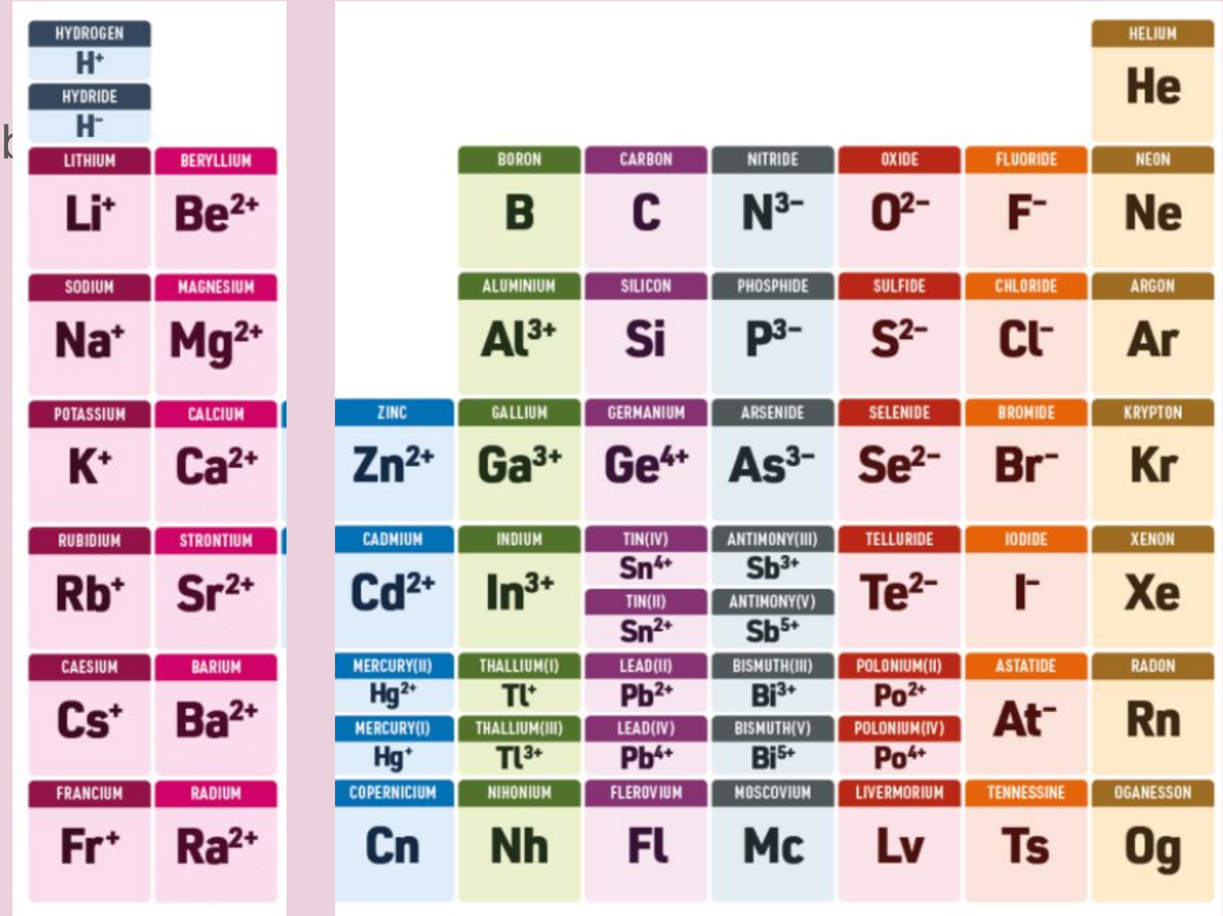
- Based on electron configuration, elements will either lose or gain electrons in order to have a complete s^2p^6 outer valence shell.
- This loss or gain of electrons leads to the formation of cations or anions.
- Ionic compounds are held together by an electrostatic force (Coulombic attraction).



Periodic Table

Group 1 2 12 13 14 15 16 17 18

We can use the periodic tab
to predict how many
electrons will be gained or
lost by each atom.



Periodic Table

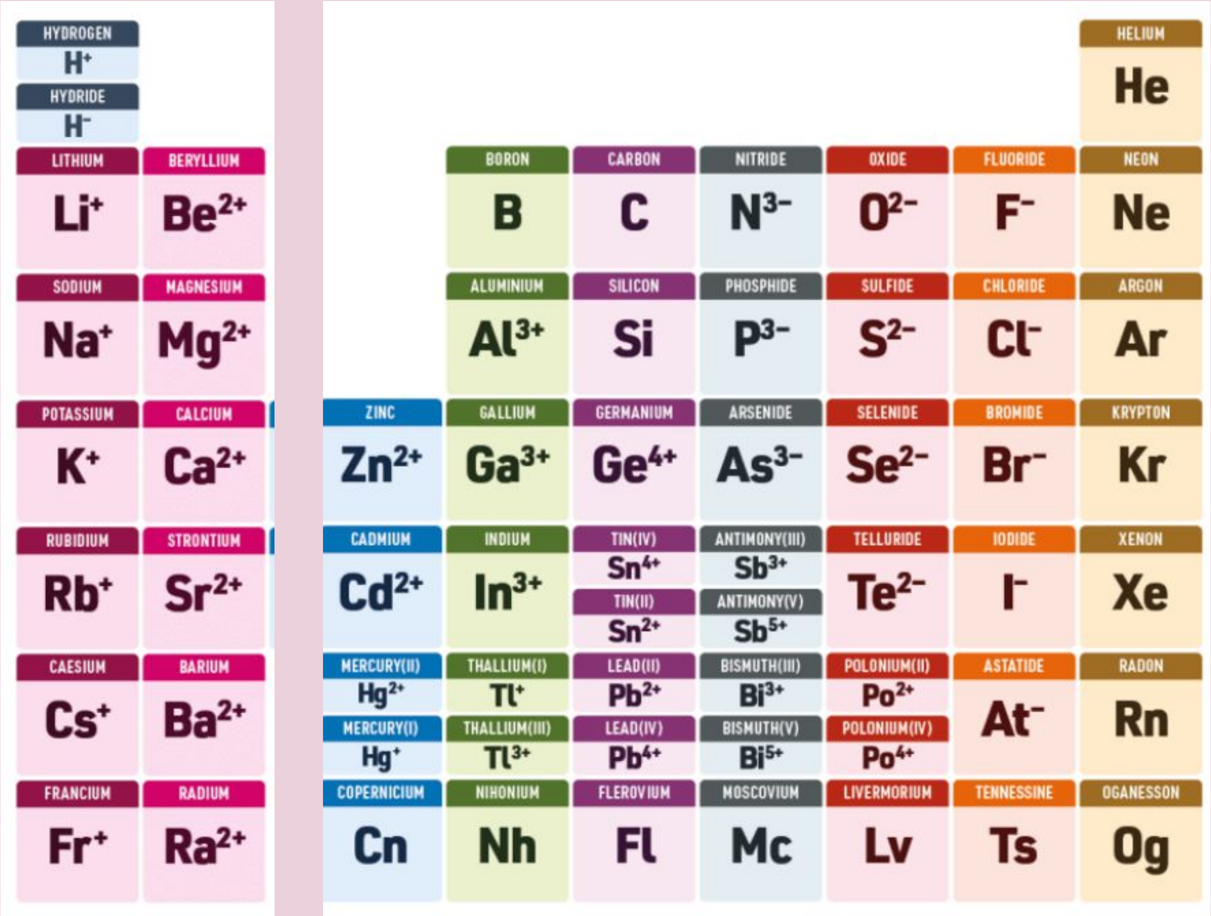
Group 1 2 12 13 14 15 16 17 18

Nonmetals only want to gain enough electrons to fill their octet.

Metals only want to give away enough electrons to have a pseudo-noble gas configuration.

The only 3 transition metal charges you are required to memorize:

Ag^{+} , Cd^{2+} , Zn^{2+}



Ionic Compounds

When ionic compounds form, the number of electrons lost by the metal must equal the number of electrons gained by the non-metal.

Example: Sodium and phosphorus form an ionic compound. What is the molecular formula?

Together

1. Calcium reacts with a certain element to form a compound with the general formula CaX_2. What would be the most likely formula for a compound formed between sodium and element X?
   a. NaX_2
   b. Na_2X
   c. Na_3X_2
   d. NaX

You Do, We Review

2. Element 117 was recently discovered and is named Tennessine. Assuming that periodic trends are followed, write the noble gas electron configuration and predict the formula when it forms an ionic compound with Mg.