Chemistry 6A Fall 2007

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Monday

9/17/07

Chem. 6A This week:

<u>Lab:</u> Experiment **2** *(You will need goggles!!)*

<u>Lecture:</u> Chapter 2

No goggles, no lab!
No open toed shoes allowed!
No pre-lab, no lab!
No excuses!

It's time to play…

Name that Element!

Cs	cesium
Hg	Mercury
Zn	zinc
As	Arsenic

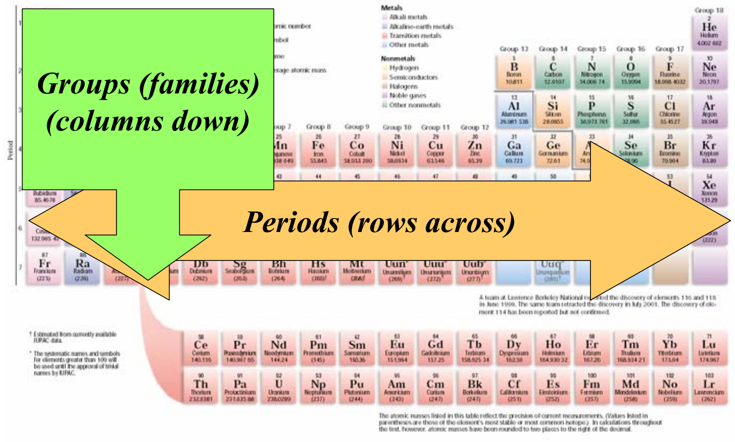
It's time to play…

Name that compound!

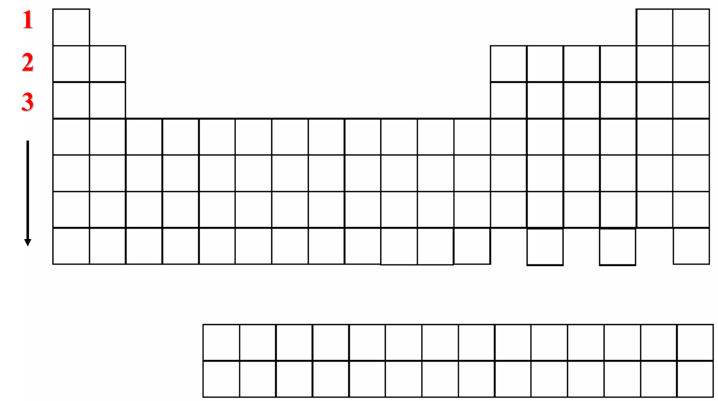
$MgCl_2$	magnesium chloride
$CuSO_4$	copper (II) sulfate
calcium acetate	$Ca(C_2H_3O_2)_2$
hydrogen hydroxide	HOH

or water… H_2O

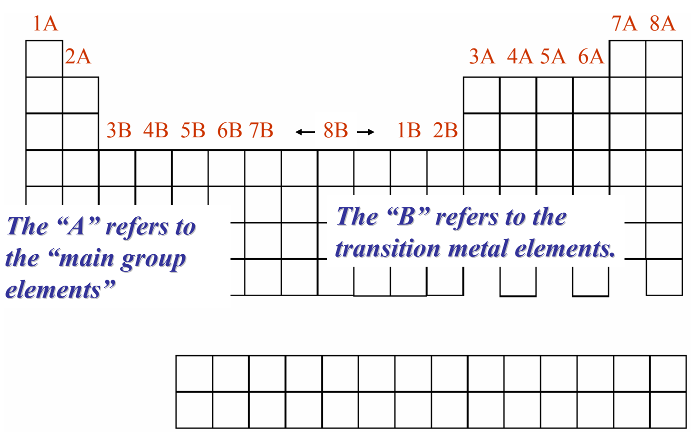
The modern periodic table is defined by:

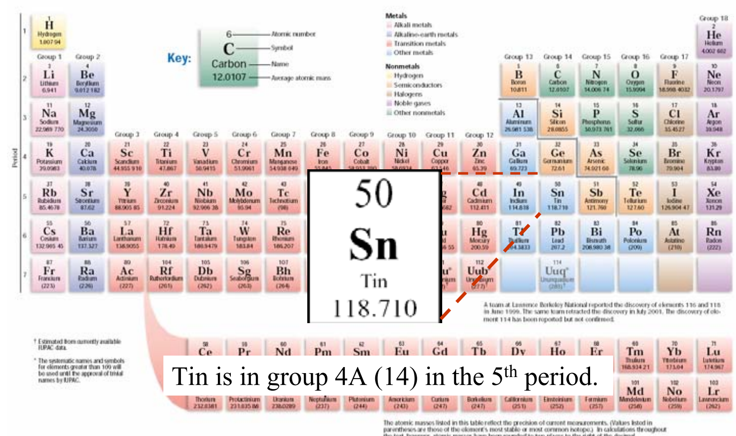


The Periods are labeled:



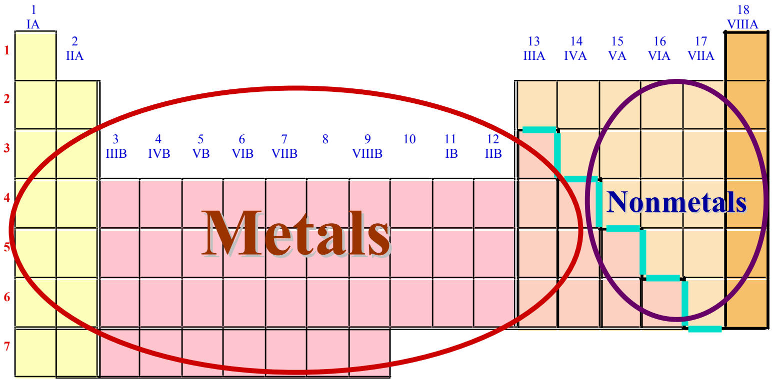
The Groups are labeled:



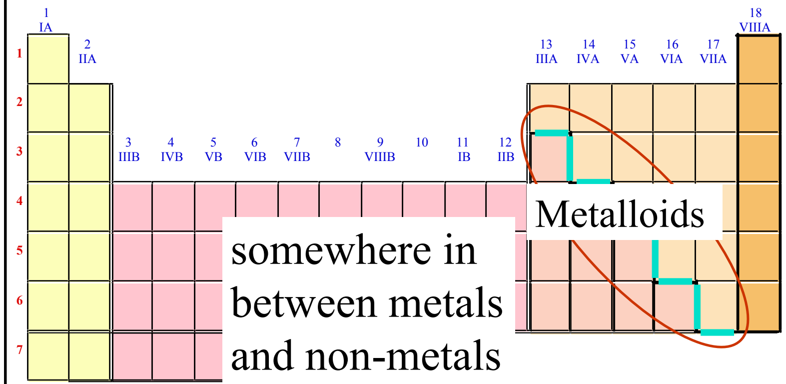


Tin is in group 4A (14) in the 5th period.

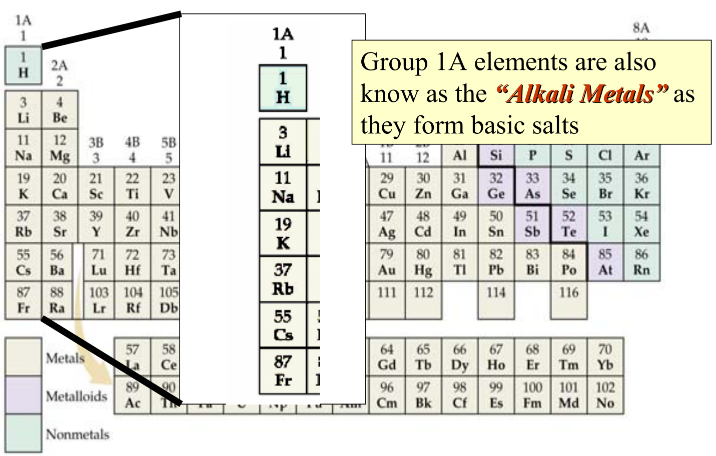
Periodic Table: Metallic arrangement



Periodic Table: Metallic arrangement



Today's Periodic table



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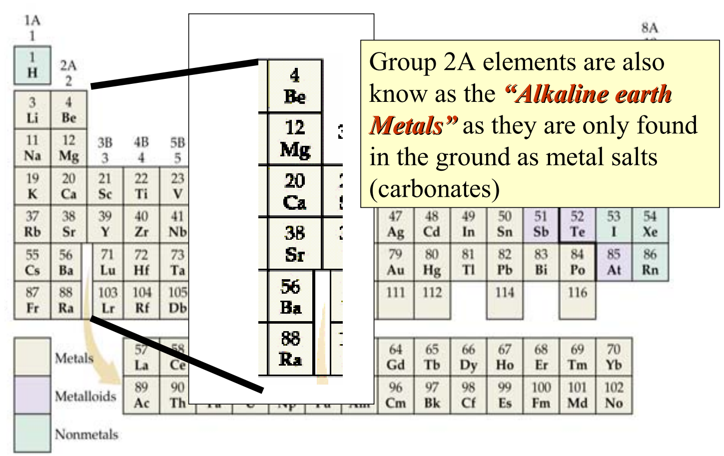
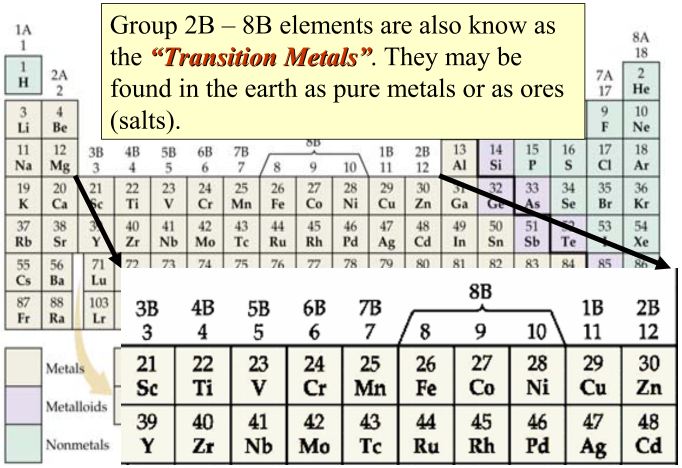


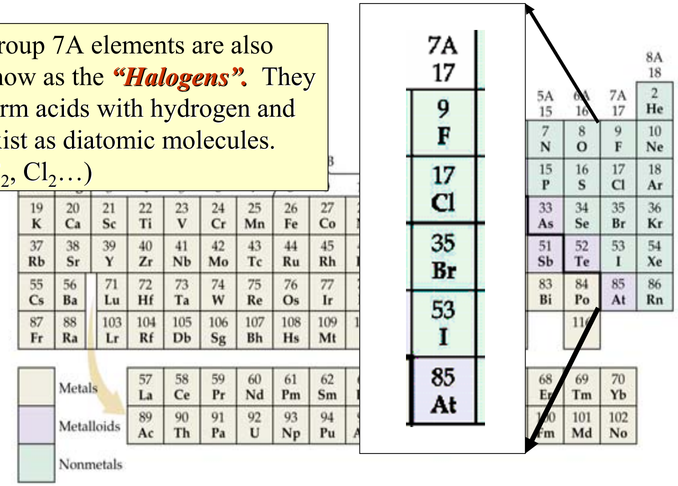
Today's Periodic table

Group 2B – 8B elements are also know as the ***"Transition Metals"***. They may be found in the earth as pure metals or as ores (salts).



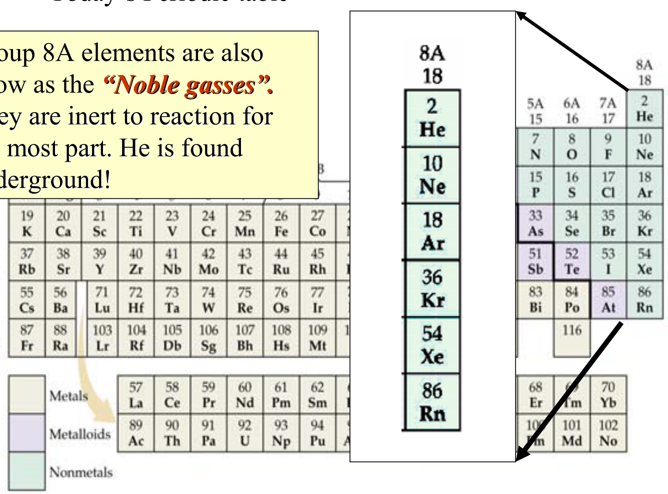
Today's Periodic table

Group 7A elements are also know as the ***"Halogens"***. They form acids with hydrogen and exist as diatomic molecules. (F_2, Cl_2…)



Today's Periodic table

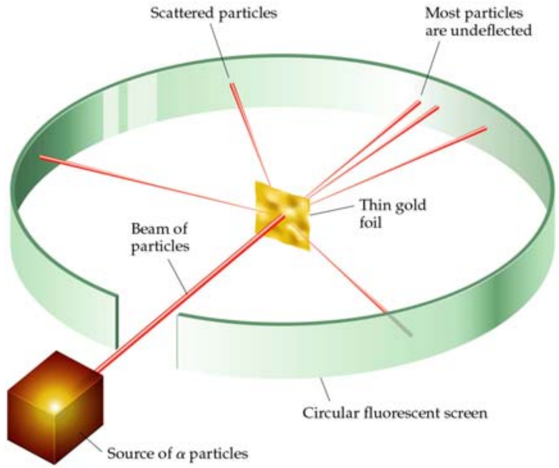
Group 8A elements are also know as the ***"Noble gasses"***. They are inert to reaction for the most part. He is found underground!



The discovery of modern atomic structure:

Experiments!

Rutherford's Scattering Experiment: 1911



Rutherford's Experiment: Explained

•Most of the α-particles passed through the gold foil.

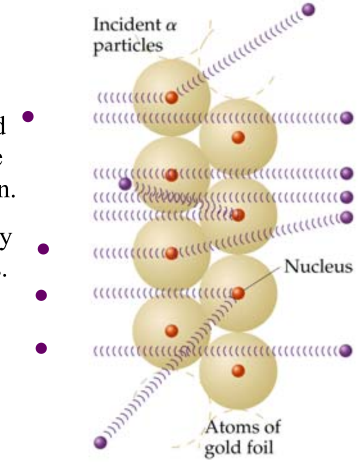
•Some α-particles were deflected slightly as they came close to the nucleus by the + charge repulsion.

•Some were deflect backwards by direct collisions with the nucleus.

Conclusion:

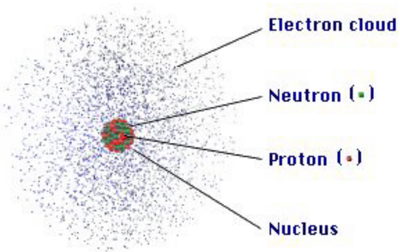
•Atoms are mostly space.

•The nucleus caries most of the mass with a positive charge.



The Composition of an Atom:

The atom is mostly empty space



•protons and neutrons in the nucleus.

•the number of electrons is equal to the number of protons.

•electrons in space around the nucleus.

Further experiments lead to the discovery and characterization of the electron, proton and neutron.

Electron: -1 charge

J.J. Thompson cathode ray tube (1897)
electrons were negatively charged

R. Millkan Oil drop experiment (1909)
charge on the electron

Proton: +1 charge

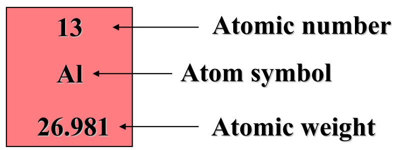
E. Rutherford (1918)
hydrogen nucleus termed a "proton"

Neutron: no charge

J. Chadwick (1932)
neutral particle with the mass of a proton

Atomic Number, Z

An element's identity is defined by the number of protons in the nucleus: Z

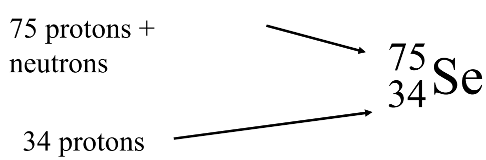


Isotopes, Atomic Numbers, and Mass Numbers

- Atomic number (Z) = number of protons in the nucleus.
- Mass number (A) = total number of nucleons in the nucleus (i.e., protons and neutrons).
- One nucleon has a mass of 1 amu
  (*Atomic Mass Unit*) a.k.a "*Dalton*"
- Isotopes have the same Z but different A.
- The elements are arranged by Z on the periodic table.

By convention, for element X, we write $^{A}_{Z}X$

The isotope $^{75}_{34}Se$ is used medically for diagnosis of pancreatic disorders. How many protons, neutrons, and electrons does an atom of $^{75}_{34}Se$ have?



protons = 34 electrons = 34

neutrons = 75-34 = 41

Atomic Masses and the Periodic Table:

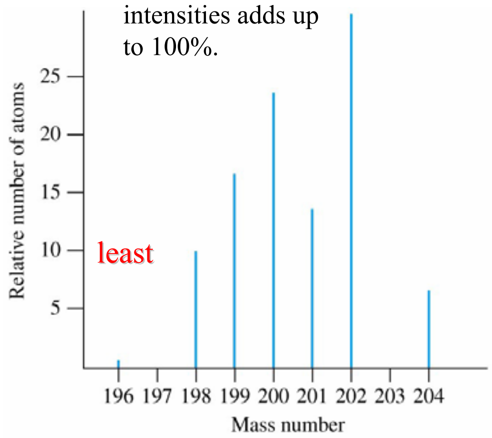
In nature, an element is found to contain a mixture of all of the naturally occurring isotopes.

These isotopes occur in proportions represented by their ***natural abundances***.

As macroscopic beings, we measure matter on a "bulk" scale (many atoms).

The *fraction or abundance* of each of the individual isotopes statistically weights the average atomic mass of an element.

The sum of the intensities adds up to 100%.



The relative abundance of each isotope is indicated by the height of the line corresponding to a particular mass.

Example:

Chlorine has two isotopes:

Cl-35 & Cl- 37 *shorthand notation*

$^{35}_{17}\mathrm{Cl}$ $^{37}_{17}\mathrm{Cl}$

Each isotope occurs in nature with a specific mass and corresponding fraction or "***Percent Abundance***".

	$^{35}_{17}\mathrm{Cl}$		$^{37}_{17}\mathrm{Cl}$
75.53 %	34.96885 u	24.47 %	36.96590 u

1 u = 1 amu

The ***average weighted*** atomic mass is determined by the following mathematical expression:

Average mass of a Cl atom — *mass of a Cl-35 atom* — *fraction that are Cl-35* — *mass of a Cl-37 atom* — *fraction that are Cl-37*

m Cl (u) = m Cl-35 × abundance of Cl-35 + m Cl-37 × abundance of Cl-37

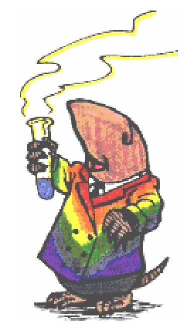
$$= 34.96885\text{u} \times 0.7553 + 36.96590 \times 0.2447 = 35.45\ \text{u}$$

(4 sig. fig)

This is the value that is reported on the periodic table.

Note that: 0.7553 + 0.2447 = 1.0000 (100%)

Avogadro's Number and the Mole



The concept of a mole is defined so that we may equate the amount of matter (mass) to the number of particles (mole).

The Standard is based upon the C-12 isotope.

The atomic mass of ^{12}C is defined as exactly 12 u.

The atomic mass of ^{12}C is 1.99265×10^{-23} g.

1 amu = (the mass of one ^{12}C atom ÷12) = 1.66054×10^{-24}g
= 1.66054×10^{-27} kg

Avagagro's Number

Since one mole of ^{12}C has a mass of 12g (exactly), 12g of ^{12}C contains 6.022142 x 10^{23} ^{12}C-atoms.

But carbon exists as 3 isotopes: C-12, C-13 &C-14

The average atomic mass of carbon is 12.011 u.

From this we conclude that 12.011g of carbon contains 6.022142 x 10^{23} C-atoms

Is this a valid assumption?

Yes, since N_A is so large, the statistics hold.

Molar Masses

Since we can equate mass (*how much matter*) with moles (*how many particles*) we now have a ***conversion factor*** that relates the two.

mols × molar mass (g/mol) = grams

The Molar Mass of a substance is the amount of matter that contains one-mole or 6.022 × 10^{23} particles.

aka: Avogadro's number (N_A)

The atomic masses on the Periodic Table also represent the molar masses of each element in grams per mole (g/mol)

So if you have 12.011g of carbon…

you have 6.022×10^{23} carbon atoms!

So if you have 39.95g of argon…

you have 6.022×10^{23} argon atoms!

if you have a mole of dollar bills… you are Bill Gates…

you have 6.022×10^{23} bucks!

and if you have 6.022×10^{23} avocados…

you have… ***a "guacamole"***