How Periodic Table is Arranged

- Properties of elements are periodic functions of their ATOMIC NUMBERS.

There are 7 Periods (rows) in the Periodic Table

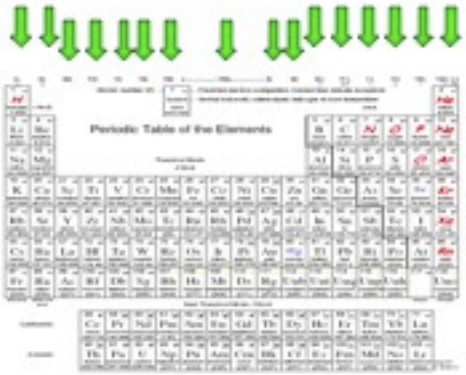
Periods/Rows

1
2
3
4
5
6
7

First period has 2 elements

16 Groups/Families in the Periodic Table

Elements in groups have similar chemical properties



Group 1A has 7 elements

Periodic Table Explains Chemical Reactivity

The next slides show the similar chemical reactivity for elements in Group 1A through Group 8A

Group 1A: Alkali Metals

H, Li, Na, K, Rb, Cs

- Metals (malleable, ductile, conduct heat & electricity)
- Reactive, exist in nature as compounds
- Form alkaline solutions with water
- Tend to form +1 ions
- Hydrogen, placed in Group 1, is not a metal, exists naturally as a diatomic gas, H_2, and tends to form +1 ions

Group 2A: Alkaline Earth Metals

Be, Mg, Ca, Sr, Ba, Ra

- Metals
- Reactive, exist in nature as compounds
- All but Be form alkaline solutions with water
- Tend to form +2 ions

Group 3A: B, Al, Ga, In, Tl

- B is a metalloid
- Al, Ga, In, Tl are metals
- B chemistry tends to be different because it is a metalloid
- Tend to form +3 ions
- Group 3A forms similar compounds BCl_3, $AlCl_3$

Group 4A: C, Si, Ge, Sn, Pb

- C is a nonmetal (often +4 or – 4 ion)
- Si and Ge are metalloids (+/- 4 ions)
- Sn and Pb are metals (often +4 ions)
- More variation in elemental properties than other groups
- Form analogous compounds – CO_2, SiO_2, GeO_2, SnO_2, PbO_2
- Carbon allotropes (graphite, buckminsterfullerene, diamond)

Group 5A: N, P, As, Sb, Bi

- N and P are nonmetals (often -3 ions)
- As and Sb are metalloids (-3/+5 ions)
- Bi is a metal (often +5 ions)
- Nitrogen occurs naturally as a diatomic molecule N_2
- Phosphorous glows in the dark if it is in air and has red and white allotropes
- Form analogous compounds – N_2O_5, P_2O_5, As_2O_5

Group 6A: O, S, Se, Te, Po

- O, S and Se are nonmetals (often -2 ions)
- Te is a metalloid
- Po is a metal
- Oxygen occurs naturally as a diatomic molecule O_2 and has an allotrope, Ozone - O_3
- S, Se, and Te are known as chalcogens because of presence in most Cu ores
- Polonium is radioactive.
- Form similar oxides (SO_2, SeO_2, TeO_2) and sodium compounds (Na_2O, Na_2S, Na_2Se, Na_2Te)

Group 7A: Halogens

- F, Cl, Br, I and At are nonmetals
- Tend to form -1 ions
- Fluorine, Chlorine, Bromine and Iodine occur naturally as diatomic molecules
- Halogens are reactive
  - combine violently with alkali metals.
  - React with other metals and most nonmetals
- At room temperature, F_2 and Cl_2 are gases, Br_2 is a liquid, and I_2 is a solid.

Group 8A: Noble Gases
He, Ne, Ar, Kr, Xe, Rn

- He, Ne, Ar, Kr, Xe, and Rn are nonmetals
- Tend not to form ions
- Least reactive elements
- All are gases
- None are abundant
- Known as noble, inert or rare gases

Diatomic Molecules

- Remember HONClBrIF (Honclbrif)
- Represents H_2, O_2, N_2, Cl_2, Br_2, I_2, F_2
- Iodine is a solid, bromine is a liquid and the rest are gases at room temperature
- When they form compounds, they are no longer diatomic (NaCl)

Transition Elements

Lanthanides and actinides

ATOMIC COMPOSITION

- Protons
  - +1 electrical charge
  - mass = 1.672623×10^{-24} g
  - relative mass = 1.007 atomic mass units (u)
- Electrons
  - -1 electrical charge
  - relative mass = 0.0005 u
- Neutrons
  - no electrical charge
  - mass = 1.009 u

ATOMIC COMPOSITION

- The atom is mostly empty space
- Protons and neutrons are located in the dense nucleus
- The number of electrons is equal to the number of protons.
- Electrons occupy space around the nucleus.

Atomic Number, Z

All atoms of the same element have the same number of protons in the nucleus, Z

Atomic weight on periodic table is an average for all isotopes

Atomic Mass

- This tells us the mass of one atom of an element relative to one atom of another element.
- Standard = carbon (1 u = 1/12th of the mass of 1 atom of carbon with 6 protons and 6 neutrons. This C atom's mass is 12.000 u.

1 u = 1.661×10^{-24}g. Calculate g using 6.022×10^{23}

Mass Number, A

- **Mass Number (A)** - Not on Periodic Table
- **A = # protons + # neutrons**
- **Boron atoms (Z=5) can have A = 5 p + 5 n = 10 u**

$^{10}_{5}B$

- **C atom with 6 protons and 6 neutrons is the mass standard (Z=6 and A=12)**
- **= 12 atomic mass units (u)**

$^{12}_{6}C$

Isotopes of carbon and boron

Isotopes

- **Atoms of the same element (same Z) but different mass number (A).**
- **Boron-10 has 5 p and 5 n: $^{10}_{5}B$**
- **Boron-11 has 5 p and 6 n: $^{11}_{5}B$**

Hydrogen Isotopes

$^{1}_{1}H$ 1 proton and 0 neutrons, protium

$^{2}_{1}H$ 1 proton and 1 neutron, deuterium

$^{3}_{1}H$ 1 proton and 2 neutrons, tritium

radioactive

Isotopes & Atomic Mass

- Because of the existence of isotopes, the mass of a collection of atoms has an average value.
- ^{6}Li = 7.5% abundant and ^{7}Li = 92.5%
  - Atomic mass of Li = _____
- ^{28}Si = 92.23%, ^{29}Si = 4.67%, ^{30}Si = 3.10%
  - Atomic mass of Si = _____

Calculate % Abundance

- Calculate the percent abundance of each isotope given that copper has 2 isotopes ^{63}Cu with mass 62.9298 u and ^{65}Cu with mass 64.9278 u

Calculate % Abundance

- Calculate the percent abundance of each isotope given that copper has 2 isotopes ^{63}Cu with mass 62.9298 u and ^{65}Cu with mass 64.9278 u
- Need atomic mass of Cu = 63.546 u (Periodic Table).
- The percent abundances of each isotope times the atomic masses must equal the atomic mass for copper
- Note that the percentages of both isotopes must total 100% or 1.
- So, if the fraction of ^{63}Cu is X, the fraction of ^{65}Cu must be 1-X
- Set up relationship and solve for X, the fraction of ^{63}Cu

Calculate % Abundance

- Calculate the percent abundance of each isotope given that copper has 2 isotopes ^{63}Cu with mass 62.9298 u and ^{65}Cu with mass 64.9278 u

- 62.9298 u (X) + 64.9278 u (1-X) = 63.546 u
- X = fraction of ^{63}Cu = 0.6916
- 1-X = fraction of ^{65}Cu = 0.3084
- % ^{63}Cu = 0.6916 * 100% = 69.16%
- % ^{65}Cu = 0.3084 * 100% = 30.84%

Summary

- Determine atomic weight from isotope abundance.
- Calculate isotope abundance from atomic weight.