Chapter 2

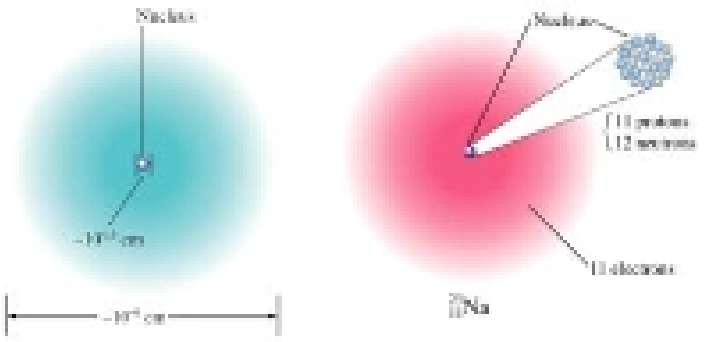
Read on your own:
- The Early History of Chemistry (2.1)
- Fundamental Chemical Laws (2.2)
- Dalton's Atomic Theory (2.3)
- Cannizzaro's Interpretation (2.4)
- Defining the Atom (2.5)

In Class:
- Modern View of Atomic Structure (2.6)
- Molecules and Ions (2.7)
- Electron Configuration (12.13)
- The Periodic Table (2.8)
- Nomenclature (2.9)

Main Concepts

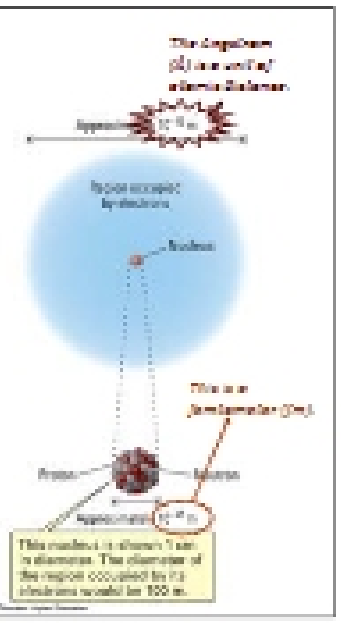
- Each element is made up of tiny particles called atoms; the atoms of each element are different from the atoms of other elements.
- The periodic table provides an organized way to group elements in a variety of ways.

The Atom

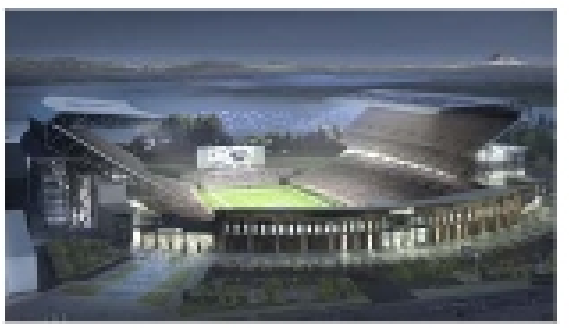


Atomic Structure

- Nucleus
  - Most of the mass (density!)
  - Protons (positive charge) and Neutrons (neutral)
- Large volume around nucleus
  - Mostly empty space
  - Electrons (negative charge)



Atomic Structure - Scale

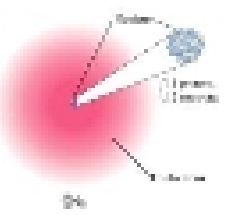


What roles do the different particles play?

Protons = chemical identity of the atom (which element is it?)

Electrons = ionic character of the atom (is it charged?)

Neutrons = isotopic character of the atom (is it stable?)



11

Na

Sodium

22.99

Atomic Structure Definitions

- **Atomic number (Z):** the number of protons in the nucleus of an atom
- **Mass number (A):** the sum of the numbers of protons and neutrons in the nucleus of an atom
- **Atomic Mass:** an average of the atomic masses of the most common isotopes

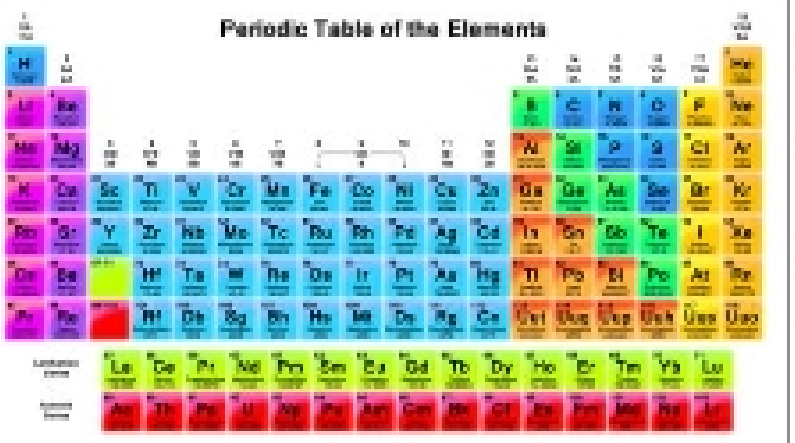
Nuclear Symbol: ${}^{A}_{Z}X$ ← Atomic symbol (X)

For example: ${}^{16}_{8}O$ or ${}^{16}O$

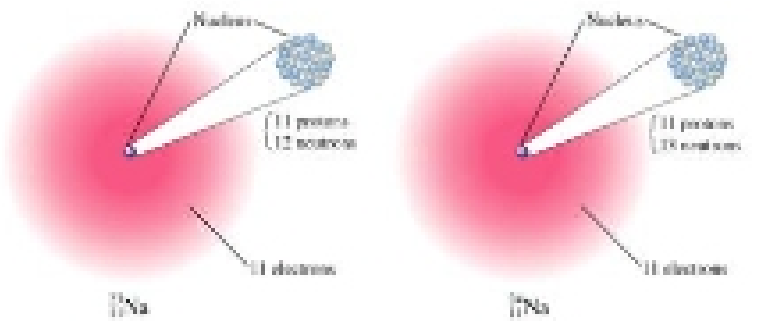
In the periodic table...

8
O
15.999

Atomic number (Z)
Atomic symbol (X)
Atomic Mass (related to A)



Isotopes of sodium



Isotopes and Atomic Mass

- Isotopes:
  - Atoms of the same element that differ in mass (e.g. ${}^{12}C$, ${}^{13}C$, ${}^{14}C$)
  - The same element
  - Have the same number of protons
  - Different number of neutrons
    - therefore they have different mass
- Not necessarily radioactive, nor are they necessarily harmful.
- A sample of an element will contain same percentage of all its isotopes.

Let's count some particles

	Symbol	# Protons	# Electrons	# Neutrons
Cobalt-60	${}^{60}Co$	27	27	60-27 = 33
Chlorine-37 anion	${}^{37}Cl^-$	17	18	37-17 = 20
Uranium-238	${}^{238}U$	92	92	238-92 = 146
Copper-63 cation	${}^{63}Cu^{2+}$	29	27	63-27 = 34
Copper-65 cation	${}^{65}Cu^{2+}$	29	27	65-27 = 36

Let's say you have two particles:
#1 has 10 protons, 11 neutrons and 10 electrons
#2 has 9 protons, 11 neutrons and 10 electrons

a. They are isotopes of the same element
b. They are different elements
c. They are different ions of the same element
d. #1 is neutral, #2 is an ion

What does an atom weigh?

Table 2.2

The Mass and Charge of the Electron, Proton, and Neutron

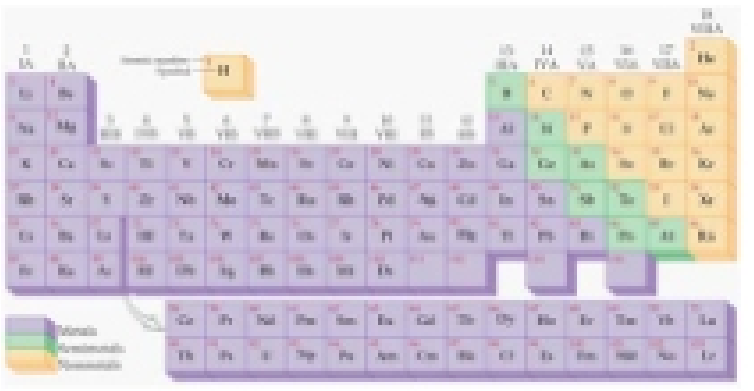
Particle	Mass	Charge*
Electron	9.11×10^{-31} kg	1−
Proton	1.67×10^{-27} kg	1+
Neutron	1.67×10^{-27} kg	None

*The magnitude of the charge of the electron and the proton is 1.60×10^{-19} C.

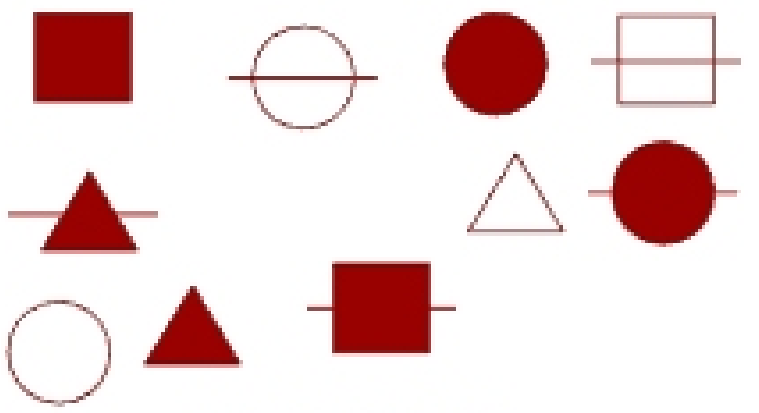
Modern Atomic Theory

- All matter is composed of atoms.
  - Atoms are composed of smaller particles (electrons, protons, and neutrons)
  - Smallest unit that retains the unique identity of the element.
- Chemical reactions do not change elements (sorry, alchemists).
  - Nuclear reactions can change elements
- Atoms of each element have the same number of protons
  - Isotopes of an element have different numbers of neutrons
    - Different mass, same chemical properties (mostly)
- Compounds are formed by the chemical combination of two or more elements

Periodic Table

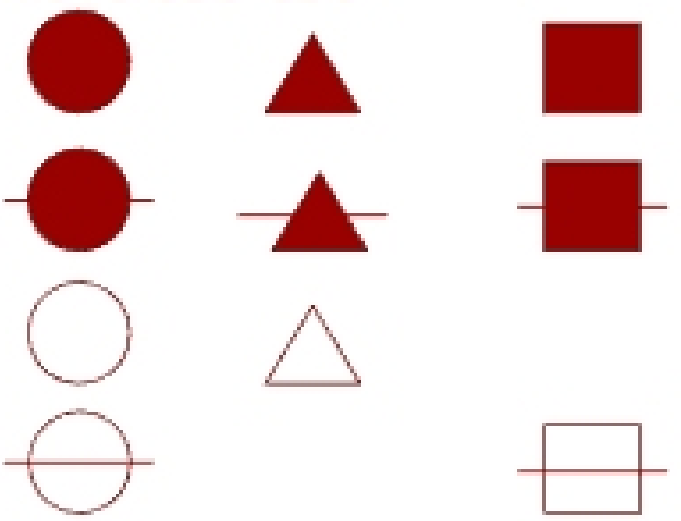


The Periodic Table

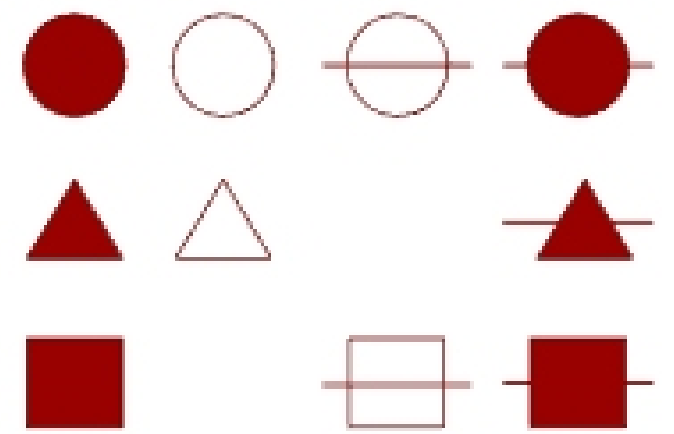


How can we organize these?

The Periodic Table



The Periodic Table



Can we predict what is missing?