

Chapter 2

Chemical Foundations; Elements, Atoms, and Ions

Introduction to the Modern Nuclear Atom, 12S 3,2

Power Point

Atomic Structure:

PowerPoint, Atomic Theory

Invisible with any light microscope and not an indivisible sphere. Contains sub-atomic particles.

J.J. Thompson (the negatively charged electron) neutral atom (positively charged protons) in "plum Pudding – Model".

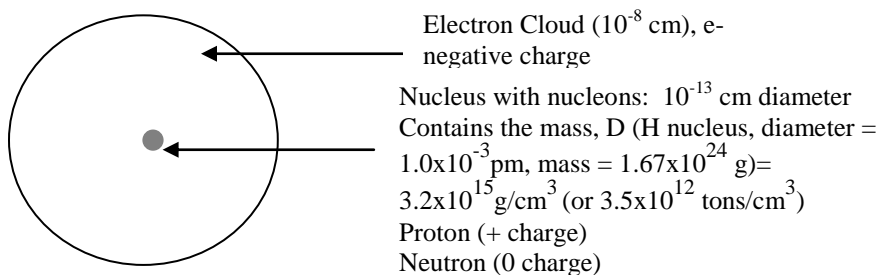
Rutherford's Gold Foil Experiment showing that the atom has a dense, positive nuclear core but mostly empty space with the electrons occupying the empty space region.

Modern Nuclear Atom:

If nucleus was size of grape, closest electron would be 1 mile from nucleus.

Mostly (99.999999%) empty space

Diagram:



Summary Table

Particle	Location	charge	mass
Electron	Outer cloud	Negative	1/1836 of proton ~ 0
Proton	Nucleus	Positive	1 (amu)
neutron	nucleus	Neutral	1 (amu)

Isotopes (atomic number and mass number) and atomic notation:

Electrons (e-):

Accounts for bulk of volume of atom.

Number and arrangement determines chemical properties.

Neutral free atoms have the same number of electrons as protons.

Q: all sodium atoms have 11 protons, how many electrons will each Na atom have?

Protons (Z), atomic number:

All atoms of same element have the same number of protons.

Found in nucleus and contributes to mass of atom

Determine the number of protons in an atom of Cr?

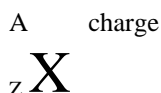
What is atomic number of Ca?

Z=15, name element and atomic number.

Mass Number (A):

Sum of protons and neutrons (nucleons) in an atom.

Notation:



Sample problems in table form.

Isotopes: Nuclides of same element (same Z, atomic number, number of protons), but a different number of neutrons. Results in a different mass number. Isotopes of an element have the same chemical properties.

Isotopes will generally undergo the same chemical reactions, have the same chemical characteristics and physical characteristics. Isotopes will have differing nuclear qualities. Some isotopes of an element may be radioactive and others may be non-radioactive.

Isotope Mass:

An atomic mass unit is defined as 1/12 the weight of the carbon-12 isotope. The old symbol was amu, while the most correct symbol is u (a lower case letter u). The ChemTeam will use amu.

By the way, carbon-12 is defined as weighing exactly 12 amu. This is the starting point for how much an atom weighs. For example, if you weigh 1/2 as much as C-12, you weigh 6. If you weigh twice as much, you weigh 24.



Isotope mass is the mass of the nucleus of a specific isotope of an element. It is an experimentally determined piece of information. When all the isotope masses of an element are averaged by taking into consideration their percentages of abundance, then the average will represent the atomic weight of the element

Atomic Mass Unit Standard (amu) C-12

Example Chlorine			Example Silicon		
atomic mass	exact weight	percent abundance	atomic mass	exact weight	percent abundance
35	34.968852	75.77	28	27.976927	92.23
37	36.965903	24.23	29	28.976495	4.67
			30	29.973770	3.10

The 6 isotopes of CALCIUM: Calculate the average isotopic mass of Ca.

Ca-40	96.94%
Ca-42	0.647%
Ca-43	0.135%
Ca-44	2.086%
Ca-46	0.004%
Ca-48	0.187%

Homework

Page 77 #6, 9, 11, 12, 17, 18, 23, 24, 28, 30, 33, 41, 47, 51, 53-57, 59, 114

2.4 Atomic Mass

2.5 Introduction to the Periodic Table

Periodic Table:

Dimitri Mendeleev: Russian Scientist who arranged elements according to similarities.

Periods

Family Groups (vertical columns); similar chemical properties

Group 1: Alkali metals (*CD; Glencoe, Activity of alkali metals*)

Group 2: Alkaline Earth metals

Group 7: Halogens

Group 8: Noble gases (noble, refers to inert)

Transition metals

Metalloid

Main Group Elements

Transition Metals

Inner Transition Metals (Lanthanides,

Actinides)

Staircase Line: separates metals from non-metals. (more metals)

Metalloids / Semi-metals: B, Si, Ge, As, Sb, Te

Elements:

Noble metals; Au, Ag, Pt

Diatomics: H₂, N₂, O₂, F₂, Cl₂, Br₂, I₂ (indicate state of matter)

States of matter: At RT (25°C) only 2 liquids: bromine and mercury (Cs and Ba melt ~30°C)

Allotropes: different structural form of the same element. Ex., S, C

Ions:

Loss or gain of 1 or more electrons (never protons, why?) from an atom. A charged particle.

Cation; positive ion formed by the loss of electron(s)

Ex. Na → Na⁺ + e⁻

Anion; negative ion formed by the gain of electron(s)

Ex. Cl + e⁻ → Cl⁻

Nomenclature; chlorine → *chloride*, etc.

Periodic Table Trends of charges Group 1 (+1), 2(+2), 3(+3), 6(-2), 7(-1)

Metals lose electrons + cations

Non-metals gain e⁻ to form – anions

Metals																		Non-metals																		
H																	He																			
Li	Be											B	C	N	O	F	Ne																			
Na	Mg											Al	Si	P	S	Cl	Ar																			
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																			
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																			
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																			
Fr		Ra		Ac														Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu					
																		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr					

Ionic compounds:

Substances composed of ions; “salts” (ion =wander)

Demonstrate with conductivity apparatus (d' H₂O and salts or molecules). Electrons are free to move as (i) or (aq)

High melting point. Overall charge is neutral, zero.

Q: Write formulas for the following substances:

Aluminum, Oxygen

Compound that contains (Na⁺ and Br⁻), name it.

Compound that contains (Mg²⁺ and Cl⁻), name it.

Compound that contains (Al³⁺ and S²⁻), name it.

Homework: P. 80 # 61, 65, 66, 71, 75, 76, 77, 78, 79, 85, 87-90, 93, 95-108, 128, 129, 131, 133