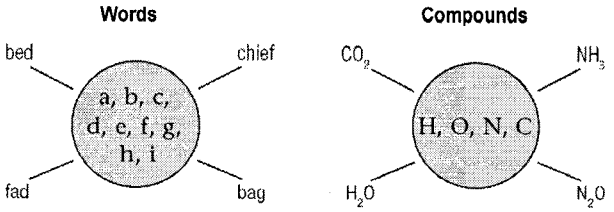
Objectives

1. To learn about the relative abundances of the elements
2. To learn the names of some elements
3. To learn the symbols of some elements

The Elements

- All of the materials in the universe can be chemically broken down into about 100 different elements.
- Compounds are made by combining atoms of the elements just as words are constructed from the letters in the alphabet.



A. Abundances of Elements

- Nine elements account for about 98% of the earth's crust, oceans and atmosphere.

Table 3.1
Distribution (Mass Percent) of the 18 Most Abundant Elements in Earth's Crust, Oceans, and Atmosphere

Element	Mass Percent	Element	Mass Percent
oxygen	49.2	titanium	0.58
silicon	25.7	chlorine	0.19
aluminum	7.50	phosphorus	0.11
iron	4.71	manganese	0.09
calcium	3.39	carbon	0.08
sodium	2.63	sulfur	0.06
potassium	2.40	barium	0.04
magnesium	1.93	nitrogen	0.03
hydrogen	0.87	fluorine	0.03
		all others	0.49

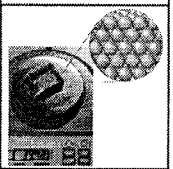
A. Abundances of Elements

- The elements in living matter are very different from those in the earth's crust.
- In the human body, oxygen, carbon, hydrogen and nitrogen are the most abundant elements.

Top Ten Elements in the Human Body

Element	Mass Percent
Oxygen	65.0
Carbon	18.0
Hydrogen	10.0
Nitrogen	3.0
Calcium	1.4
Phosphorus	1.0
Magnesium	0.50
Potassium	0.34
Sulfur	0.26
Sodium	0.14

Element can have several meanings

Word	Meaning	
Element	**Microscopic form** Single atom of that element	
Element	**Macroscopic form** Sample of that element large enough to weigh on a balance	
Element	**Generic form** When we say the human body contains the element sodium or lithium, we do not mean that free elemental sodium or lithium is present. Rather we mean that atoms of these elements are present in some form.	

B. Names and Symbols for the Elements

- Each element has a name and a symbol.
  - The symbol usually consists of the first one or two letters of the element's name.
    - Examples:
      Oxygen O
      Krypton Kr
  - Sometimes the symbol is taken from the element's original Latin or Greek name.
    - Examples:
      gold Au aurum
      lead Pb plumbum

Objectives

1. To learn about Dalton's theory of atoms
2. To understand and illustrate the Law of constant composition
3. To learn how a formula describes a compound's composition

Law of Constant Composition

- A given compound always contains the same proportion by mass of the elements of which it is composed.

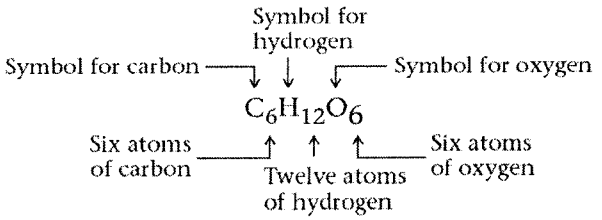
A. Dalton's Atomic Theory

- Dalton's Atomic theory states:
  - All elements are composed of atoms.
  - All atoms of a given element are identical.
  - Atoms of different elements are different.
  - Compounds consist of the atoms of different elements.
  - Atoms are not created or destroyed in a chemical reaction.

B. Formulas of Compounds

- A compound is represented by a chemical formula in which the number and kind of atoms present is shown by using the element symbols and subscripts.

Example: the simple sugar, glucose



B. Formulas of Compounds

Tools for Writing Formulas

1. Each atom present is represented by its element symbol.
2. The number of each type of atom is indicated by a subscript written to the right of the element symbol.
3. When only one atom of a given type is present, the subscript 1 is not written.

Section 3.3

Atomic Structure

Objectives

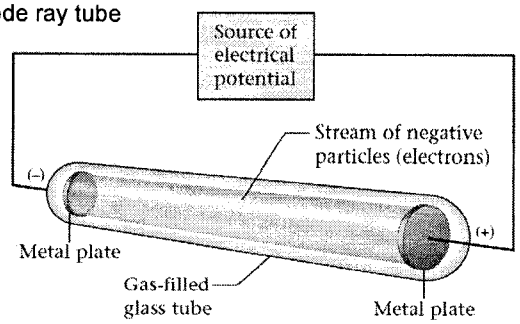
1. To learn about the internal parts of an atom
2. To understand Rutherford's experiment
3. To describe some important features of subatomic particles
4. To learn about the terms isotope, atomic number, and mass number
5. To understand the use of the symbol ${}^{A}_{Z}X$ to describe a given atom

Section 3.3

Atomic Structure

A. The Structure of the Atom

- Experiments by J.J. Thomson showed that atoms contain electrons.
- Cathode ray tube

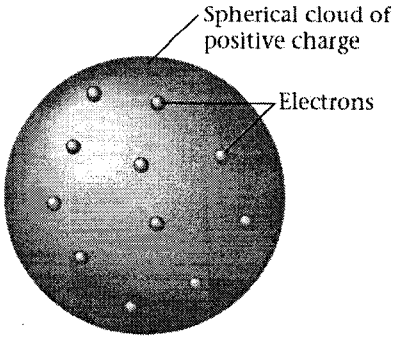


Section 3.3

Atomic Structure

A. The Structure of the Atom

The Plum Pudding Model

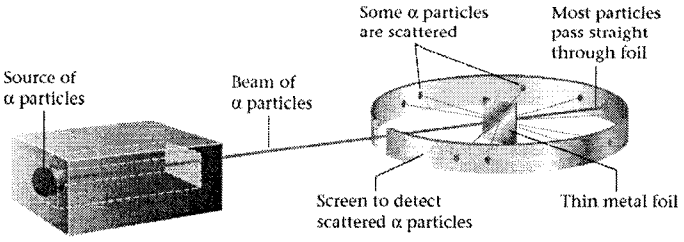


Section 3.3

Atomic Structure

A. The Structure of the Atom

Rutherford's Experiment

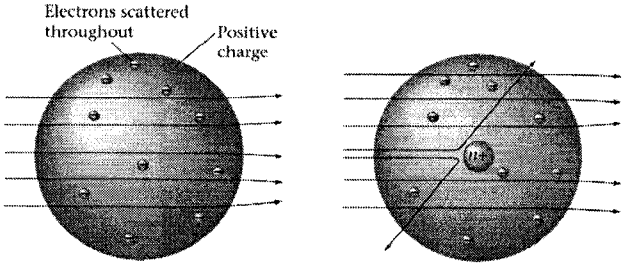


Section 3.3

Atomic Structure

A. The Structure of the Atom

- Results of the Rutherford experiment



(a) The results that the metal foil experiment would have yielded if the plum pudding model had been correct

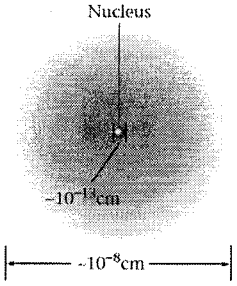
(b) Actual results

Section 3.3

Atomic Structure

B. Introduction to the Modern Concept of Atomic Structure

- Ernest Rutherford showed that atoms have internal structure.
  - The nucleus, which is at the center of the atom, contains protons (positively charged) and neutrons (uncharged).
  - Electrons move around the nucleus.



Section 3.3

Atomic Structure

B. Introduction to the Modern Concept of Atomic Structure

Comparing the Parts of an Atom

Table 3.4

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

Particle	Relative Mass*	Relative Charge
electron	1	1−
proton	1836	1+
neutron	1839	none

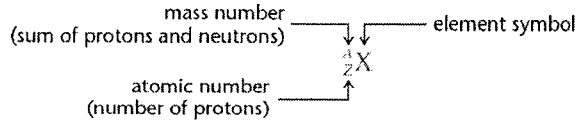
*The electron is arbitrarily assigned a mass of 1 for comparison.

Section 3.3

Atomic Structure

C. Isotopes

- A particular isotope is represented by the symbol ${}^{A}_{Z}X$.

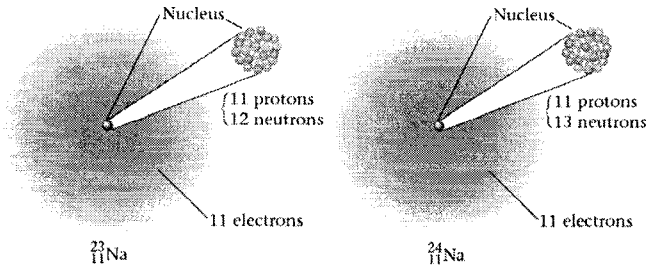


Section 3.3

Atomic Structure

C. Isotopes

- Isotopes are atoms with the same number of protons but different numbers of neutrons.



Section 3.4

Using the Periodic Table

Objectives

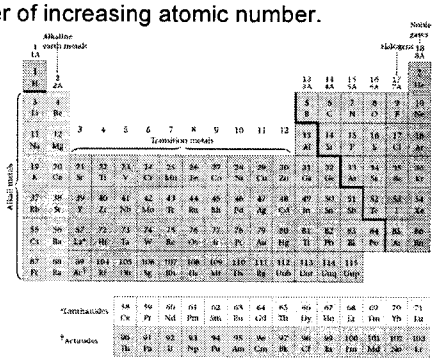
1. To learn the various features of the periodic table
2. To learn some of the properties of metals, nonmetals and metalloids
3. To learn the natures of the common elements

Section 3.4

Using the Periodic Table

A. Introduction to the Periodic Table

- The periodic table shows all of the known elements in order of increasing atomic number.

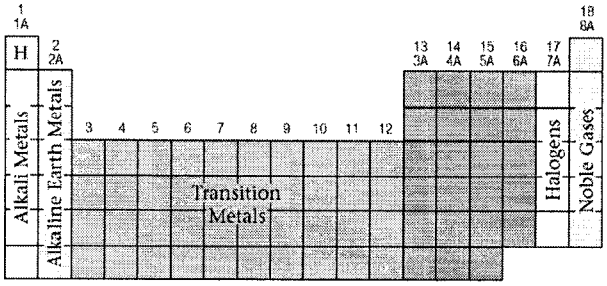


Section 3.4

Using the Periodic Table

A. Introduction to the Periodic Table

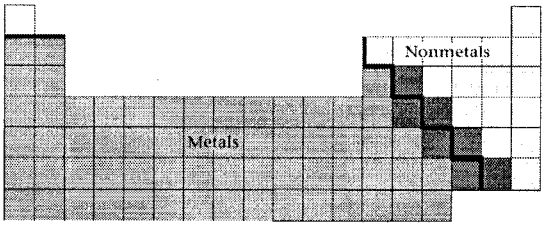
- The periodic table is organized to group elements with similar properties in vertical columns.



Section 3.4

Using the Periodic Table

A. Introduction to the Periodic Table



- Most elements are metals and occur on the left side.
- The nonmetals appear on the right side.
- Metalloids are elements that have some metallic and some nonmetallic properties.

Section 3.4

Using the Periodic Table

A. Introduction to the Periodic Table

- Physical Properties of Metals
  1. Efficient conduction of heat and electricity
  2. Malleability (can be hammered into thin sheets)
  3. Ductility (can be pulled into wires)
  4. A lustrous (shiny) appearance

Section 3.4

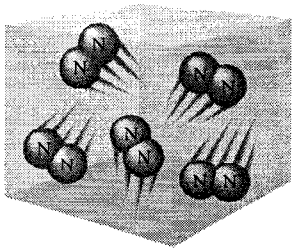
Using the Periodic Table

B. Natural States of the Elements

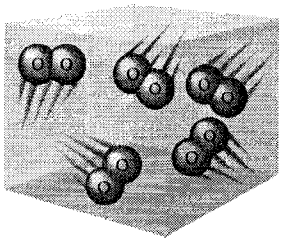
- Most elements are very reactive.
- Elements are not generally found in uncombined form.
  - Exceptions are:
    - Noble metals – gold, platinum and silver
    - Noble gases – Group 8

B. Natural States of the Elements

- Diatomic Molecules



Nitrogen gas contains N_2 molecules.



Oxygen gas contains O_2 molecules.

Section 3.4
Using the Periodic Table

B. Natural States of the Elements

- Diatomic Molecules

Table 3.5

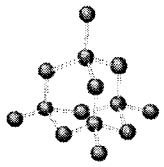
Elements That Exist as Diatomic Molecules in Their Elemental Forms

Element Present	Elemental State at 25 °C	Molecule
hydrogen	colorless gas	H_2
nitrogen	colorless gas	N_2
oxygen	pale blue gas	O_2
fluorine	pale yellow gas	F_2
chlorine	pale green gas	Cl_2
bromine	reddish-brown liquid	Br_2
iodine	lustrous, dark-purple solid	I_2

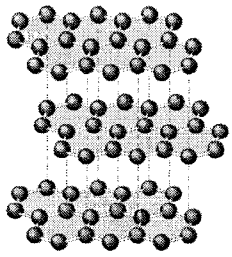
Section 3.4
Using the Periodic Table

B. Natural States of the Elements

- Elemental Solids



Diamond



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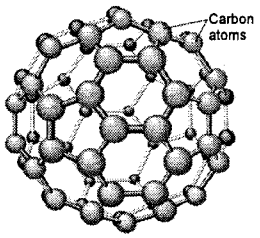


Buckminsterfullerene

Section 3.5

Ions and Their Compounds

Objectives

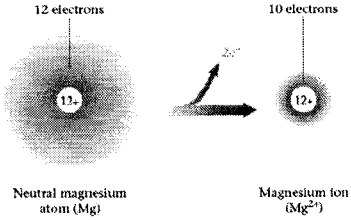
1. To describe the formation of ions from their parent atoms
2. To learn to name ions
3. To predict which ion a given element forms by using the periodic table
4. To describe how ions combine to form neutral compounds

Section 3.5

Ions and Their Compounds

A. Ions

- Atoms can form ions by gaining or losing electrons.
  - Metals tend to lose one or more electrons to form positive ions called cations.



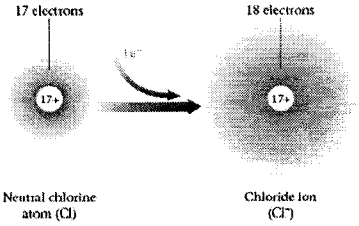
  - Cations are generally named by using the name of the parent atom.

Section 3.5

Ions and Their Compounds

A. Ions

- Nonmetals tend to gain one or more electrons to form negative ions called anions.



- Anions are named by using the root of the atom name followed by the suffix *–ide*.

Section 3.5

Ions and Their Compounds

A. Ions

Ion Charges and the Periodic Table

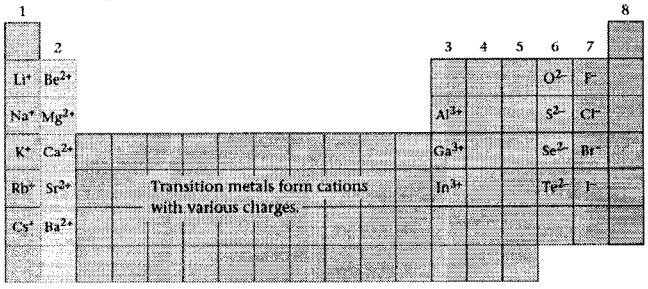
- The ion that a particular atom will form can be predicted from the periodic table.
  - Elements in Group 1 and 2 form 1+ and 2+ ions, respectively
  - Group 7 atoms form anions with 1- charges
  - Group 6 atoms form anions with 2- charges

Section 3.5

Ions and Their Compounds

A. Ions

Ion Charges and the Periodic Table

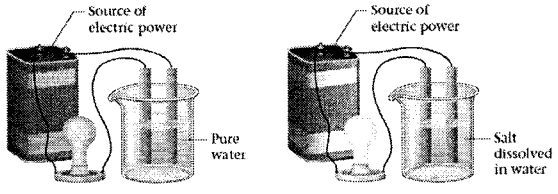


Section 3.5

Ions and Their Compounds

B. Compounds That Contain Ions

- Ions combine to form ionic compounds.
- Properties of ionic compounds
  - High melting points
  - Conduct electricity
    - If melted
    - If dissolved in water



B. Compounds That Contain Ions

- Ionic compounds are electrically neutral.
- The charges on the anions and cations in the compound must sum to zero.

Section 3.5
Ions and Their Compounds

B. Compounds That Contain Ions

Formulas for Ionic compounds

- Write the cation element symbol followed by the anion element symbol.
- The number of cations and anions must be correct for their charges to sum to zero.