

Basic Skills for Chemistry
CHEM-1020
Chapter 1 Lecture Notes
Kroschwitz, 3rd edition

Classifications of Matter

Chemistry: The study of *matter* and its *changes*

Matter: Anything that has mass and occupies volume

Examples: iron, air, water, dust, helium gas.

Not; light, sound, energy.

Many possible ways to classify matter, depending on the discipline.

For the purposes of studying *chemistry*, one reasonable way is by physical state;

The three (common) states of matter:

Solid, Liquid and Gas

Molecular basis of each state's properties

Crystal models

Names of all six transitions

Definition of "standard state"

What are the properties of each state?

Shape, Volume, Compressibility, Density, etc.

What is the molecular basis? Example of NaCl crystal lattice

Changes in the Physical state of matter:

Meaning and measurement of: Melting Point, Normal Boiling Point, Reduced Pressure Boiling Point

The Scientific Method

The basis of all modern investigative science

Great importance to modern science

Scientific Method is designed to weed out bias, erroneous ideas, incorrect measurements.

Designed to encourage and allow critical peer review.

- Observation of Phenomena
- Formulation of Hypothesis to explain observed phenomena
- Additional observations to confirm or refute hypothesis
- Conclusion about original hypothesis, modification if necessary
- Publication of Results
- Checks and balances, peer review, etc.

Chemists classify matter as: 1) Pure Substances and 2) Mixtures

Pure Substances

Pure Substances exist as two main divisions, **Elements** and **Compounds**

All Pure Substances always have the same composition

All Pure Substances have the same properties under the same conditions of temperature and pressure.

Examples:

Elemental Mercury; density, mp, bp, remain the same

The compound water: density, mp, bp, and % composition (of H and O) remain the same

Elements

Substances consisting of one kind of atom.

Elements cannot be broken down by chemical means into simpler substances.

Examples are Iron, Oxygen, Carbon, Gold, Sodium, Sodium, etc.

Examples of element names and atomic symbols.

Periodic Table and its Divisions

(Remember weekly periodic table assignments)

Compounds

Pure substances made of one or more elements *chemically combined*.

Compounds are not mixtures

Differences in properties between mixtures and compounds

Compounds can only be broken down to their constituent elements by *chemical* means

Examples: H₂O, CO₂, CO, CH₄, NaCl, C₆H₁₂O₆,

Law of Definite Proportions

Law of Multiple Proportions

Compounds can be distinguished and identified on the basis of their properties such as physical state, density, mp, bp, color, water solubility.

How to look up selected properties in the Handbook of Chemistry and Physics

(Division of Handbook into organic and inorganic chemistry sections; element names are at the very beginning of lists of compounds)

Other resources include Wikipedia, or chemfinder.com.

Mixtures

Mixtures can have varying compositions
Examples are sea water, mud, battery acid, wine, salad.

Properties of Mixtures depend on their *composition*.

Two classifications of Mixtures are **Homogeneous** and **Heterogeneous**

Examples of **Heterogeneous Mixtures**:

Beef Stew, Sand & Salt, Dirty Seawater, Dusty Air

Examples of **Homogeneous Mixtures** (aka Solutions):

Clean Seawater, Clean Air, Vodka, 18-carat gold, Vegetable Oil.

Mixtures are easily separated into their components using *physical* means.

Changes in Matter

Physical and Chemical changes

Physical Changes

No loss of *identity*

No new substance is ever produced.

Physical changes are usually easy to reverse

Sometimes and energy change may occur, usually no color change

Examples:

Cutting, grinding, atomizing,

State Change Examples;

Solution Formation

Chemical Changes

Chemical changes always involve loss of identity

During the process of a Chemical Changes, substance(s) “destroyed” and new substance(s) formed.

During a chemical change, mass is conserved and all atoms retain their individual identities.

Signs of a chemical change:

New color (not a blended color)

New gas formed in the absence of heating; (new odor often detected)

New solid formed (not a precipitate due to cooling a saturated solution)

Energy change (emission of energy during combustion)

(Absorption of energy is less obvious and harder to detect)

Examples:

Combustion of C, Fe, H₂, CH₄

Acid plus Na₂CO₃

Decomposition of hydrogen peroxide

Decomposition of mercuric oxide

Use of Chemical Language

- 1) Atomic symbols written correctly
- 2) How to write formula for elemental substances

Fe, Na, etc for all metals.

S or S₈,

H₂, not H

Cl₂, not Cl

O₂ and O₃

P, P₄ and P_∞

- 3) Formulas of Compounds

(Distinction between Covalent and Ionic Compounds)

CO and CO₂

H₂O, not HO; H₂O₂

NaCl, CaCl₂, AlF₃

NO_x

C₂H₂, C₆H₆

C₆H₁₂O₆

- 4) Chemical Equations

(The chemical equivalent of a sentence)

Reactants, Products, Arrow, Catalysts, Conditions, State Subscripts, Mass Balance

