Chem211

General Chemistry

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Contents

Chapter 1

Chemistry: The Science of Change

1.1 The Study of Chemistry

Chemistry is the branch of science that deals with the identification of the substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine, and change; and the use of these processes to form new substances.

Matter is a physical substance in general, as distinct from mind and spirit; (in physics) that which occupies space and possesses rest mass, especially as distinct from energy:

Scientific Method

- Ask a Question: The scientific method starts when you ask a question about something that you observe: How, What, When, Who, Which, Why, or Where?
- Construct a Hypothesis: A hypothesis is an educated guess about how things work. It is an attempt to answer your question with an explanation that can be tested.
- Test Your Hypothesis by Doing an Experiment: Your experiment tests whether your prediction is accurate and thus your hypothesis is supported or not. It is important for your experiment to be a fair test. You conduct a fair test by making sure that you change only one factor at a time while keeping all other conditions the same.
- Analyze Your Data and Draw a Conclusion: Once your experiment is complete, you collect your measurements and analyze them to see if they support your hypothesis or not.
- Communicate Your Results

1.2 Classification of Matter

Substances

Substance is a form of matter with definite composition and distinct properties.

Every pure element is a substance.

Every pure compound is a substance.

`Examples Include: salt (sodium chloride), iron, water, mercury, carbon dioxide, oxygen`

Substances differ from one another in composition and may be identified by appearance, smell, taste, and other properties.

Mixtures

Mixture is a physical combination of multiple substances.

- Mixtures are unlike Chemical Compounds:
  - Substances in a mixture can be separated using physical methods such as filtration, freezing, and distillation.
  - There is little or no energy change when a mixture forms.
  - Mixtures have variable compositions, while compounds have a fixed, definite formula.
  - When mixed, individual substances keep their properties in a mixture, while if they form a compound their properties can change.

Homogeneous mixture is a mixture which has uniform composition and properties throughout

`Examples: any gases at equilibrium in a closed space; the hydrocarbons in gasoline; a sugar solution in water at equilibrium;`
`Vinegar Dissolved in Water; Seawater; Apple Juice`

Heterogeneous mixture is a mixture that does not have uniform composition and properties throughout.

`Examples: Trail Mix and Chicken Noodle Soup`

States of Matter

- Substances exist as a:
  - Solid
    * Its volume is fixed; it will not expand to fill a container - Unlike gases and plasmas
    * Most solids are incompressible - their volume hardly changes when pressure changes - Unlike gases and plasmas
    * Solids are not fluids, so they cannot flow. Their shapes do not adapt to that of their containers - Unlike liquids, gases, and plasmas
    * Solids are condensed matter, so their volumes are similar to those of liquids, and much smaller than gases and plasmas
  - Liquid
    * Its volume is fixed; It will not expand to fill a container - Unlike gases and plasmas
    * Most liquids are incompressible - Their volume hardly changes when pressure changes - Unlike gases and plasmas
    * Liquids are fluids, so they can flow. Provided there is gravity, their shapes adapt to that of their containers - Unlike solids
    * Liquids are condensed matter, so their volumes are similar to those of solids, and much smaller than gases and plasmas
  - Gas
    * Its volume is not fixed; It will expand to fill a container
    * It is compressible - Its volume changes when pressure changes
    * Gases are fluids, so they can flow. Their shapes adapt to that of their containers
    * The atoms or molecules in a gas are spread much more thinly than the particles in solids and liquids.

They can change from one state to another without changing the chemical identities

1.3 Properties of Matter

Quantative Properties

Exists in a range of magnitudes, and can therefore be measured with a number. Measurements of any particular quantitative property are expressed as a specific quantity, referred to as a unit, multiplied by a number.

Qualitative Properties

Properties that are observed and can generally not be measured with a numerical result.

Physical Properties

A property that can be measured without changing the chemical composition of a substance.

`Examples: Color, Melting/Boint Point, Young's Modulus, Sheer Modulus`

Physical Change

Usually reversible change in the physical properties of a substance, as size or shape

`Examples: Freezing, Melting, Condensing, Subliming`

Chemical Properties

Property or characteristic of a substance that is observed during a reaction in which the chemical composition or identity of the substance is changed

`Examples: Flammability, Corrosiveness`

Chemical Changes

Usually irreversible chemical reaction involving the rearrangement of the atoms of one or more substances and a change in their chemical properties or composition, resulting in the formation of at least one new substance

`Examples: Digestion, Combustion, Oxidation`

Extensive Properties

A property that depends upon the amount of material in a sample.

`Examples: Mass; Volume; Size, Weight, Length`

Intensive Properties

A property that does not depend upon the amount of material in a sample.

`Examples: Temperature; Density; Specific Gravity; Molality, Boiling/Melting Point; Odor`

1.4 Scientific Measurement

Measureable Properties are Quantitative and must include a unit

English System Has units such as feet(ft), gallons(gal) and pounds(lbs) (Not typically used outside of the US)

Metric system is used much more common and includes units such as the metere (m), liters(L), and kilgrams(kg)

SI Base Units

Current Metric System

Base Quantity	Name	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric Current	Ampere	A
Temperature	Kelvin	K
Amount of Substance	Mole	mol
Luminous Intesity	Candela	cd

Prefix	Symbol	Meaning	Example
Tera-	T	$1x10^{12}$	
Giga-	G	$1x10^{9}$	
Mega-	M	$1x10^{6}$	
Kilo-	k	$1x10^{3}$	
Deci-	d	$1x10^{-1}$	
Centi-	c	$1x10^{-2}$	
Milli-	m	$1x10^{-3}$	

Prefix	Symbol	Meaning	Example
Micro-	?	$1x10^{-6}$	
Nano-	n	$1x10^{-9}$	
Pico-	p	$1x10^{-12}$	

Mass

Mass is a measure of the amount of matter in an object. Mass is usually measured in grams (g) or kilograms (kg).

Mass measures the quantity of matter regardless of both its location in the universe and the gravitational force applied to it. An object's mass is constant in all circumstances; contrast this with its weight, a force that depends on gravity.

Your mass on the earth and the moon are identical. Your weight on the moon is about one-sixth of your weight on the earth.

- Kilogram (kg)
  - The kilogram is the SI unit for mass
  - $1000g = 1kg$
- Gram (g)
  - In Chemistry it is more common for the gram to be used
  - $1g = \frac{1}{1000}kg$
- Atomic Mass Unit (amu)
  - AMU is used to express that mass of atoms and molecules
  - $1amu = 1.6605x10^{-24}g$

Temperature

- Celsius (?C)
  - Freezing Point: 0
  - Boiling Point: 100
- Kelvin (?K) "Absolute Scale"
  - $K = C + 273.15$
  - Lowest Possible Temperature is 0K (This is absolute zero)
  - Absoulte 0 is a therotical limit and has not bene achieved but have gotten close to.
- Farenheit (?F)
  - $F = (\frac{9}{5} * C) + 32$
  - Freezing Point: 32
  - Boiling Point: 212

Derived Units

Many quantities require units not included in the base SI units, such as; Voume and Density

- Density
  - Density is the ratio of mass to volume
  - The SI unit is Kilogram per cubic meter ($\frac{kg}{m^3}$)
  - $Density = \frac{Mass}{Volume}$
  - Other Common units include;
    - $\frac{g}{cm^3}$ (solids)
    - $\frac{g}{mL}$ (liquids)
    - $\frac{g}{L}$ (gases)
- Volume
  - The derived SI unit for volume is the meter cubed m^3
  - The more practical unit is the liter(L)
  - $Volume = \frac{Mass}{Density}$
  - $1dm^3 = 1L$
  - $1cm^3 = 1mL$

1.5 Uncertainty in Measurement

Accuracy

Tells how close a measurement is to the true value

Precision

Tells how close a series of replicae measurements are to each other + Precision is the same as reproducibility

Types of Numbers

- Exact:
  - Have Defined Values
- Inexact
  - Measure by any method besides counting

Signifigant Figues

1.6 Using Units and Solving Problems

Chapter 2

Atoms First

Subatomic Particles and Atmoic Structure

Discovery of the Electron

Radioactivity

The Proton and the Nuclear Model of the Atom

The Neutron

Atomic Number, Mass Number, and Isotopes

Average Atomic Mass

The Periodic Table

The Mole and Molar

The Mole

Molar Mass

INterconverting Mass, Moles. and Nummbers of Atoms

Reference