

Chemistry Chapter 1 Notes

1-1: The Scientific Method

- Natural laws- concise statements, often in mathematical form, about natural phenomena; formulated when enough observations have been made so that a pattern begins to emerge
- Induction- the form of reasoning in which a general statement or natural law is inferred from a set of observations
- Natural laws are not absolute truths; future experiments may require the law to be modified
- Natural law is verified through experiments that show whether the conclusions deduced from the natural law are supported by experimental results
- Hypothesis- tentative explanation of a natural law
- Theory- model or way of looking at nature that can be used to explain natural laws and make further predictions about natural phenomena; if hypothesis survives testing by experiments, it becomes a theory
- Scientific method- the combination of observation, experimentation, and the formulation of laws, hypotheses, and theories
- Paradigm- a pattern of thinking about a particular field
- Serendipity- chance; when discoveries are made by accident

1-2: Properties of Matter

- Matter- anything that occupies space and displays the properties of mass and inertia
- Composition- the parts or components of a sample of matter and their relative proportions (ex: composition of water- 11.19% hydrogen, 88.81% oxygen by mass)
- Properties- those qualities or attributes that we can use to distinguish one sample of matter from others
 - Physical:
 - Physical property- one that a sample of matter displays without changing its composition
 - Ex: color, conductor of electricity
 - Malleable- can be hammered into a thin sheet
 - Brittle- crumbles to a powder when hammered
 - Physical change- physical properties may change, but composition remains the same (ex: water freezing into ice)
 - Chemical:
 - Chemical change or reaction- one or more kinds of matter are converted to new kinds of matter with different compositions
 - Ex: burning of paper
 - Chemical property- the ability (or inability) of a sample of matter to undergo a change in composition under stated conditions
 - Ex: gold does not tarnish or rust

1-3: Classification of Matter

- Atom- the basic building block of matter
- Element- a substance composed of a single type of atom; cannot be broken down into simpler substances by chemical reactions
- Compounds- substances comprising atoms of two or more elements joined together; does not change its identity in physical changes, but can be broken down into its constituent elements by chemical changes
- Molecule- a group of bonded atoms held together by covalent bonds and existing as a separate entity; smallest entity having the characteristic proportions of the constituent atoms present in a substance
- Ex: molecule of water consists of 3 atoms: 2 hydrogen atoms joined to 1 oxygen atom
- Substances- has a constant composition and properties throughout a given sample and from one sample to another; either an element or a compound
- Mixtures:
 - Homogeneous mixture (solution)- uniform in composition and properties (ex: seawater, gasoline)
 - Heterogeneous- not uniform: components separate into distinct regions (ex: sand and water)
- Filtration- process of separating a solid from the liquid in which it is suspended; used for heterogeneous mixtures
- Distillation- pure liquid is condensed from the vapor given off by a boiling solution; used for homogeneous mixtures
- Chromatography- relies on the differing abilities of compounds to adhere to the surfaces of various solid substances
- Chemical compounds can be decomposed into its constituent elements by chemical changes
- Solid- atoms or molecules are close in contact, sometimes in a highly organized arrangement (crystal); definite shape
- Liquid- atoms or molecules are separated by somewhat greater distances than in a solid; has ability to flow, assuming shape of its container
- Gas- distances between atoms or molecules are much greater than in a liquid; expands to fit container
- Macroscopic level- how we perceive matter with our eyes, through the outward appearance of objects
- Microscopic level- describes matter in terms of atoms and molecules and their behavior

1-4: Measurement of Matter: SI (Metric) Units

- Qualitative- non-numerical information, such as color
- Quantitative- numbers and units
- SI- Systeme Internationale d' Unites (International system of units)
- SI Base Quantities:
 - Length- meter (m)
 - Mass- kilogram (kg)
 - Time- second (s)
 - Temperature- kelvin (K)
 - Amount of substance- mole (mol)
 - Electric current- ampere (A)

- Luminous intensity- candela (cd)
- Mass- describes the quantity of matter in an object
- Weight- the force of gravity on an object; directly proportional to mass ($w=g \times m$)
- Object's mass is fixed; weight can change because acceleration due to gravity (g) varies from one point on earth to another
- Balances used to measure mass; scales used for weight
- SI standard of time- second (s)
- Second defined as duration of 9,192,631,770 cycles on radiation emitted by cesium (cesium-133)
- Celsius- melting point of ice is 0; boiling point of water is 100
- Fahrenheit- melting point is 32; boiling point of water is 212
- Kelvin scale- assigns a value of 0 to the lowest possible temperature; $0K=-273.15C$
- No degree symbol for Kelvin; no negatives
- Derived units- properties expressed as combinations of base quantities (ex: $v=d/t$)
- Volume- uses derived units (cm³ and liters)

1-5: Density and Percent Composition: Their Use in Problem Solving

- Density
 - The ratio of mass to volume; $d=m/v$
 - Dense= matter is more concentrated
 - Extensive properties- dependent on the quantity of matter observed (ex: mass and volume)
 - Intensive property- independent of the amount of matter observed (ex: density of water is same, no matter how much water there is)
 - Solid that is less dense than liquid will float; solid that sinks to the bottom is more dense than liquid

1-6: Uncertainties in Scientific Measurements

- Systematic errors- one that recurs regularly in series of measurements because of an inherent error in the measuring system
- Random errors- results that are too high or low due to experimenter's skill limitations or ability to read a scientific instrument
- Precision- the degree of reproducibility of a measured quantity; closeness of agreement when the same quantity is measured several times; high precision if each of a series of measurements is close
- Accuracy- how close a measured value is to the accepted or actual value
- High precision measurements are not always accurate

1-7: Significant Figures

- Digits in an experimentally measured quantity that establish the precision with which the quantity is known
- Rules:
 - All nonzero digits are significant (1,5,4, etc.)
 - Any zeros preceding the decimal point are not significant (0.9)