Chapter 2 & 3

Property & States of Matter

Objectives

- Define chemistry
- Define matter
- Classifying pure substances as elements or compounds
- Describe the characteristics of and element and compound
- Distinguish pure substance from mixtures
- Classify mixtures as solutions, suspensions, or colloids

Introduction to Chemistry

- Definition

- study of matter and the changes it undergoes

- Divided into five major areas
  - Organic: study of essential all substances containing carbon
  - Inorganic: study of substances that do not contain carbon
  - Analytical: study of the composition of substances

Introduction to Chemistry Cont.

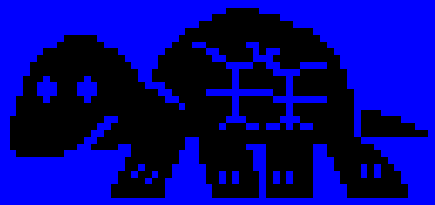
- Physical: study of theories and experiments that describe the behavior of chemicals
- Biochemistry: study of the chemistry of living organisms

Matter

- Definition

- anything that has mass or takes up space

ex. everything



Pure Substances

- Matter that always has the same composition

ex. table salt, sugar, sulfur,

- fixed, uniform composition: every sample of a given substance has the same properties
- 2 categories
- elements

ex. H, O, Si, C

- compounds

ex. NaCl, KBr

Elements

- - a substance that can not be broken down into simpler substances

- 119 elements
- 88 are found naturally, about 90%
- not equally common
- others are made in laboratories

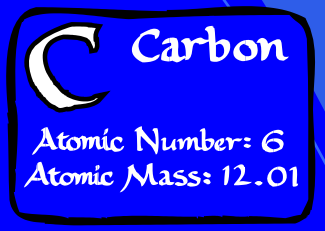
- Why?

- heaviest elements are too unstable to occur naturally
- elements heavier then hydrogen are manufactured in stars, enormous temperatures and pressures cause hydrogen atoms to fuse into more complex elements

Elements Cont.

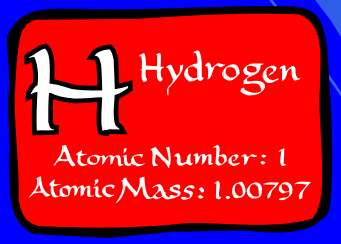
- exception of hydrogen, and a few other trace elements are all remnants of stars that exploded long before our solar system came into existence
- these remnants are the building of all matter
- each element is represented by a symbol

ex.



Elements Cont…

- majority of the elements are not found in abundance
- some are exceedingly rare
  - only a dozen or so make up everyday things
- primarily: carbon, hydrogen, oxygen, nitrogen



Compounds

- Definition

- a substance made of atoms of more than one element bound together

- unique and different from the elements it contains

ex. Water: (H_2O) liquid, clear, non toxic

hydrogen & oxygen

- gas, colorless- gas, colorless

- non toxic- non toxic

- volatile

Classifying Matter Cont.

- Mixtures

- combination of more than one pure substance

ex. salsa, air, salad, pepper

- Two types of mixtures

- heterogeneous

- homogenous

Classifying Mixtures Cont.

- Heterogeneous

- not uniform in composition
- different components can be seen as individual substances

ex: Oj: juice & water, pulp

- Suspension (Heterogeneous)

- mixtures that separates into layers over time
- suspended particles settle out of solution or are trapped by filter
- larger particles can scatter light: will be cloudy

ex. O.J., sand/water, muddy water

Classifying Matter Cont.

- Homogenous

- substances are so evenly distributed that it is difficult to distinguish one substance from another

-appears to contain only one substance

ex. stainless steel: iron, nickel, chromium

- 3 categories
  - solutions, and collides
  - based upon the size of the largest particles

Classifying Matter Cont.

- Solutions (Homogenous)

- mixtures that forms when substances dissolve and form a homogenous solution

- particles are too small to settle, scatter light, or be trapped

ex. salt water, windshield wiper fluid

- Colloids (Homogeneous)

- mixtures that contain some particles that are intermediate in size between the small particles in a solution and the larger particles in a suspension

- do not separate into layers

ex. homogenized milk vs. cow's milk, fog

Objectives

- Describe the physical and chemical properties of matter
- Describe the clues that indicates that a chemical change is taking place
- Distinguish chemical and physical changes

Properties of Matter

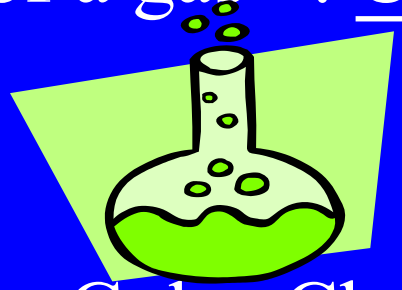
- Two types of properties

- chemical and physical

- Which ones do you think are physical properties?

Evolution

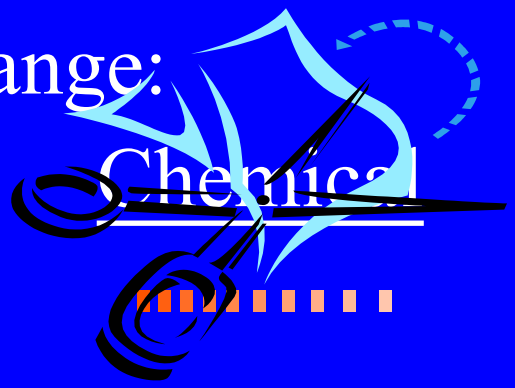
of a gas : Chemical



Color Change:

Cutting: Chemical

Physical



Physical Properties of Matter

- Definition

- a characteristic of a substance that can be observed or measured without changing the composition of the substance

ex. viscosity, conductivity, malleability
melting point, boiling point

- remain the same for all pure substances

ex. water always boils at 100 and freezes at 0

Physical Properties of Matter

- Viscosity

- the tendency of a liquid to keep from flowing

- the greater the viscosity, the slower the liquid moves

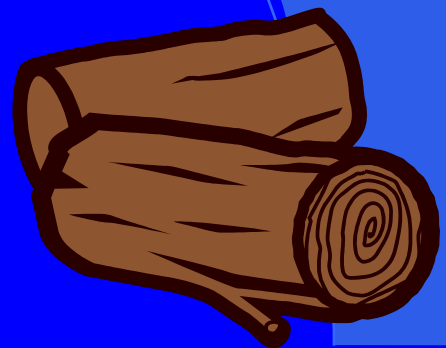
ex. oil vs. honey

- will usually decrease when it is heated

- Conductivity

- materials ability to allow heat to flow

ex. metal vs. wood



Physical Properties of Matter

- Malleability

- ability of a solid to be hammered without shattering

ex. silver vs. glass

- Hardness

- can be compared by examining which object scratched

ex. knife against copper sheet

copper sheet will scratch

Physical Properties of Matter

- Melting/Boiling points

- Melting pt.: temperature at which a substance changes from a solid to liquid

ex. ice cube at room temperature

- Boiling Pt.: temperature at which a substance boils

ex. water boils at 100^{o} C

- Density

- the ratio of a materials mass to its volume

- D= M/V

Physical Properties of Matter

- What do we use physical properties for?

- identify a material

ex. crime scene, paint chips

- chose a material for a specific purpose

ex. construction worker might wear a titanium ring instead of a gold ring for scratching

- separate the substances in a mixture

filtration: separates materials based on size

Physical Properties of Matter

distillation: separates the substances in a solutions based on the boiling points

- When does a physical change occur?

- some of the properties of the material have changed, but the material remains the same

ex. tearing/crumpling a piece of paper

cutting your hair

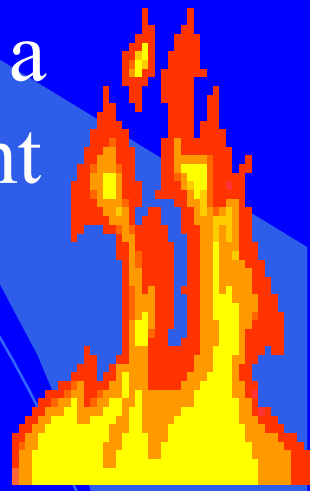
ask yourself is it still the SAME substance

Chemical Properties of Matter

- Definition

- any ability to produce a change in the composition of matter

- can only be observed when the substances in a sample of matter are changing into a different substance



- Flammability

- material's ability to burn in the presence of oxygen

ex. newspaper, gasoline

Chemical Properties of Matter Cont.

- Reactivity

- describes how readily a substance combines chemically with other substances

ex. iron turns to rust in the presence of oxygen

Chemical Changes of Matter

- Chemical Change

- a change that produces one or more new substances

ex. ripening fruit: banana

- all chemical changes are accompanied by changes in energy, hence either endothermic or exothermic

- atoms rearrange during chemical change, forming and breaking bonds, its new arrangement of atoms results in a material completely different from the starting material

Chemical Changes Cont.

- How do you know if a chemical changed occurred?

- look for evidence

- Evidence of a chemical change

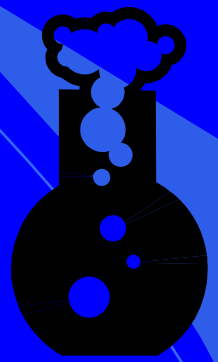
- the evolution of a gas

- the formation of a precipitate

- the evolution or absorption of heat

- emission of light

- color change in the reaction system



Chemical vs. Physical Change

- How do you know if it's a physical or chemical change?

- can be very tricky, they will both change some of the substances attributes

- a chemical change will produce a new substance

ex. burning paper

Objectives

- Describe the five states of matter
- Classify materials as solid, liquids, or gases
- Explain the behavior of gases, liquids, and solids, using kinetic theory

States of Matter

- one of the most important ways we can describe matter is by its phase, also known as its state

- 5 states of matter, solid, liquid, gas, plasma, BEC (Bose-Eistein condensate)

- Solid: definite shape and volume and is not readily deformed

ex. rock

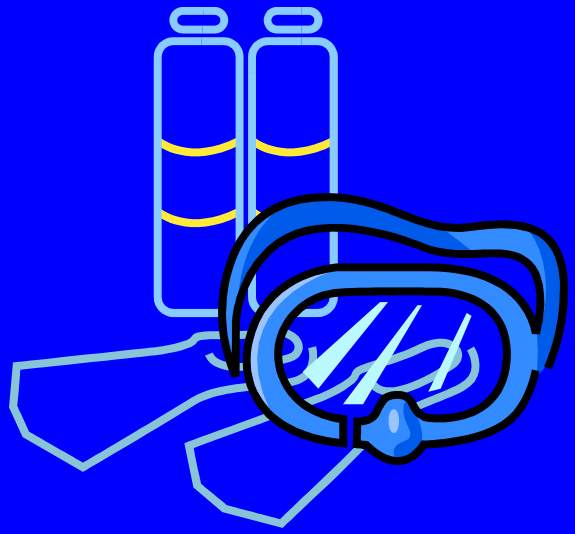
- Liquid: definite volume but indefinite shape

ex. milk may take the shape of its carton or the shape of a bowl, but its volume remains the same

States of Matter Cont.

- Gas: a diffuse, having neither definite shape or volume

ex. compressed air may assume the volume and shape of a toy balloon or an automobile tire



States of Matter Cont.

- Plasma

- state of matter in which atoms have been striped of their electrons
- exist at extremely high temperatures

- Bose-Einstein condensate (BEC)

- exists at extremely low temperatures -273^0C
- behave as though they were a single particle

States of Matter Cont.

- Solid matter

- the attractions among the submicroscopic particles are strong enough to hold them together in some fixed 3D arrangement

ex.

- particles are able to vibrate about their fixed positions, but they can not move past one another, adding heat causes these vibrations to increase

States of Matter Cont.

- Liquid matter

- once a certain temperature is achieved, (they are rapid enough to disrupt the fixed arrangement) particles then slip past one another and tumble around much like a bunch of marbles held within a plastic bag --- this is now the liquid phase of matter, and it is the mobility of submicroscopic particles that give rise to the liquids fluid character, taking shape of its container

- can be heated so that it transforms to the gas phase

- Gas

- phase in which the submicroscopic particles are widely separated due to high speeds

States of Matter Cont.

- occupies much more volume than it does in its solid or liquid phase

Why?

- explains how gases are easily compressed

ex. air tanks for scuba diving

- move at high speeds, but they do not drift very far because they are constantly hitting one another

ex. Baking cookies, BBQ

What Will the Subatomic Particles Look like at each State

- Solid
- Liquid
- Gas

Characteristics of Phase Changes

- Phase Change

- the reversible physical change that occurs when a substances changes from one state of matter to another

ex. Ice ----- water

- energy is either absorbed or released

- absorbed: endothermic

- released: exothermic

- Common phase changes

- freezing, melting, vaporization, condensation, sublimation, deposition

Kinetic Theory

- Kinetic Theory

- all particles of matter are in constant motion

ex. a pitched baseball

- Kinetic Energy (KE)

- the energy an object has due to it's motion

- faster the object moves the more KE

Kinetic Energy Relationships

- Kinetic Energy relationship to

  - Temperature

  - interdependent

  - as temperature increases KE increases

  - Mass

- interdependent

- greater the mass the greater the KE

Melting

- Melting

- molecules are becoming less orderly
- subatomic level: molecules gain energy and begin to vibrate
- when all molecules have enough energy to move melting is complete

ex. Ice (solid) → Water (liquid)

Water molecules keep the molecules in a fixed position. Heat flows from surrounding area increasing the KE, therefore the temperature

Freezing

- Freezing

- molecules are becoming more orderly
- subatomic level: molecules lose energy and begin to slow down
- when all molecules are have been drawn into an orderly arrangement, freezing is complete

ex. water (liquid) → ice (solid)

molecules posses energy and are able to move, as the temperature decreases the KE decreases, slowing down molecules

Vaporization

- Definition

-phase change in which a substance changes from a liquid into a gas

- endothermic (absorbs energy)

- two processes

- boiling

- evaporation

Vaporization Cont.

- Boiling

- takes place throughout a liquid (boiling pt)
- depends upon the atmospheric pressure
- will differ for all substances

ex. pot of water on the stove In Phoenix vs. Flagstaff

- Evaporation

- takes place at the surface of a liquid, occurs at temperatures below the boiling pt.

ex. puddles after a rainy day within a few hours may disappear

Condensation

- Definition

- phase change in which a substance changes from a gas/vapor to a liquid

- exothermic (gives off heat)

ex. morning dew on grass

water on mirror after a shower

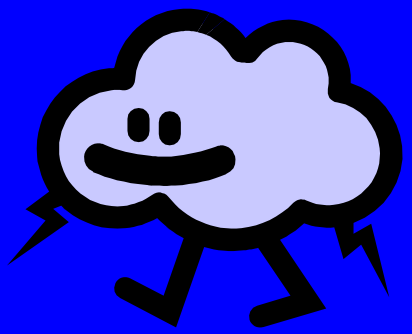
Sublimation

- Definition

- phase change in which a substance changes from a solid to a gas/vapor without changing into a liquid first

- endothermic (absorbs heat)

ex. dry ice (solid carbon dioxide)→ vapors form clouds



Deposition

- Definition

- a gas/vapor changes directly into a solid without first changing to a liquid

ex. dry ice: solid carbon dioxide

water vapor → ice

when cold air hits window

Pressure

- Pressure

- the result of a force distributed over an area

ex. two people of differing weight sit on a padded booth (imprint left behind)

- SI unit

- N/m^2 :due to force and area

- pascal (Pa)

- Factors

- temperature

- volume

- number of particles

Factors Affecting Pressure

- Temperature

- increase in temperature increase in pressure

ex. tires of a car after traveling a distance

* Increase in temperature = increase in KE, the movement of particles = more collision = more pressure

- Volume

- reducing volume increases pressure

ex. empty water bottled: crush it, unscrew the lid just enough to let air seep out, cap will shoot off

Factors Affecting Pressure Cont.

- Number of particles

- increasing the number of particles increases the pressure

ex. blowing up a balloon: too much air and it will burst

Charles's Law

- The volume of a gas is directly proportional to its temperature in kelvins if the pressure and the number of particles of the gas are constant

- the volume of gas increases at the same rate as the temperature of gas

- extended this graph until –273.15°C, absolute zero = 0 K

- Mathematical Expression

$$\frac{V^1}{T_1} = \frac{V^2}{T_2}$$

Temperature must be in kelvins

Boyle's Law

- The volume of a gas is inversely proportional to its pressure if the temperature and the number of particles are constant.
- Mathematically

$$P_1V_1 = P_2V_2$$

(Before) (After)

Combined Gas Law

- Relationship of Boyle's and Charles's Law:

- when the number of particles are constant the relationship among temperature, volume, pressure

- Mathematically

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Gas Law Problems

- A cylinder that contains air at a pressure of 100 kPa has a volume of 0.75 L. The pressure is increased to 300 kPa. The temperature does not change. Find the new volume of air?

- identify formula: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

- get rid of constant variables (temperature)

$P_1V_1 = P_2V_2$

- solve for V_2

- $100 \text{ kPa} \times \frac{0.75 \text{ L}}{300 \text{ kPa}} = 0.25 \text{ L}$