SCIENCE 1206

CHEMICAL REACTIONS UNIT II: Part II

Types of changes in matter: physical, chemical and nuclear

Each type of change involves changes in energy; amount increases from physical to chemical to nuclear.

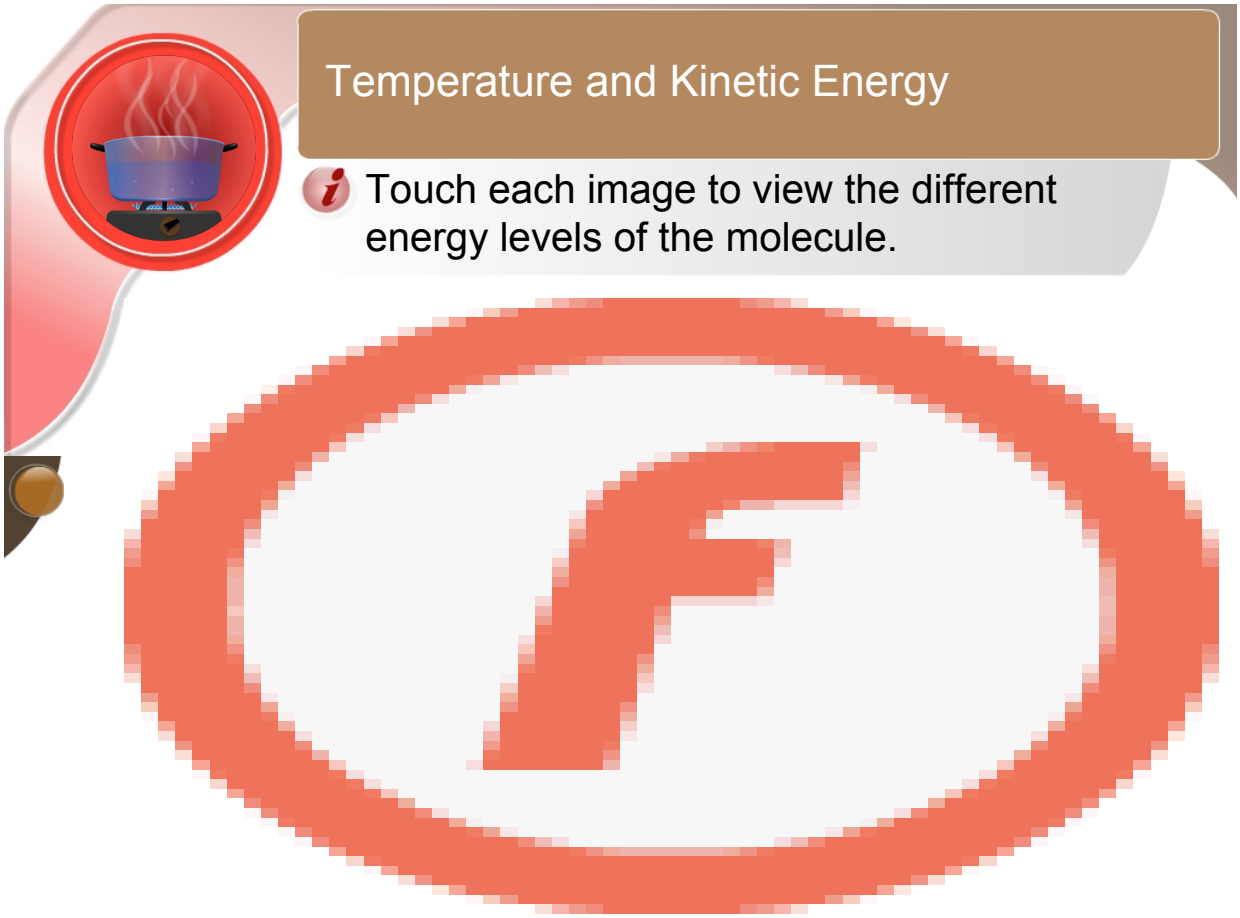
Physical Changes

- fundamental particles remain unchanged, therefore no change in chemical formula

E.g. Phase (state) change: $H_2O_{(s)} \rightarrow H_2O_{(l)} \rightarrow H_2O_{(g)}$

adding Heat

g → l → s (cooling) Removing heat



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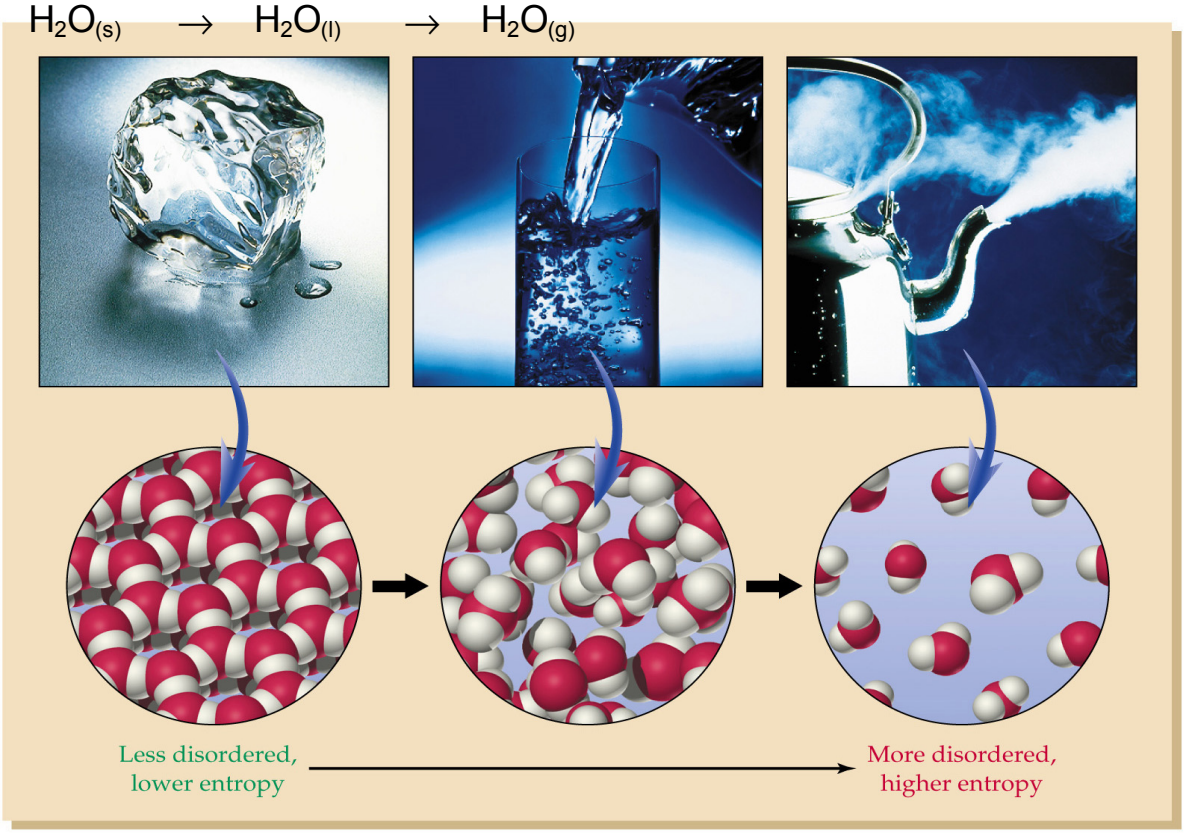
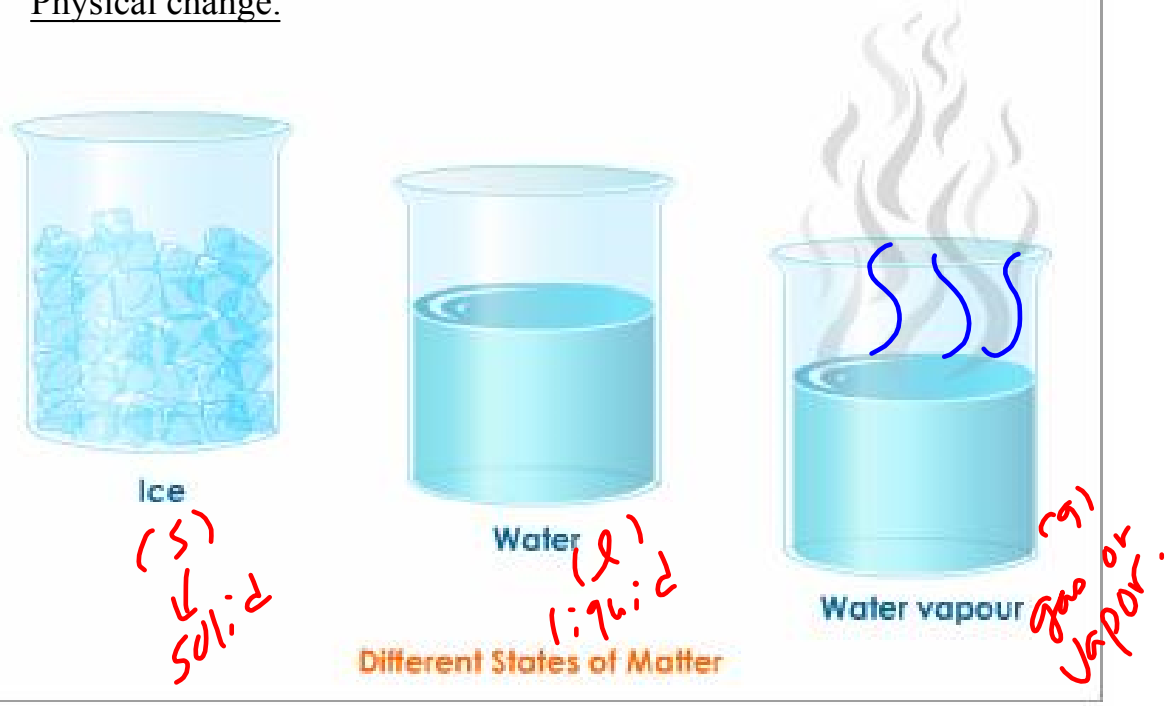


Physical change:



Chemical Changes:

- involve changes in chemical bonds between atoms and/or ions
- old bonds are broken (reactants) and new bonds are formed (products)
- a rearrangement of atoms and/or ions occurs, therefore chemical formulas do change.

Reactants product

$Fe_{(s)} + O_{2(g)} \rightarrow Fe_2O_{3(s)}$

rust

Chemical change

Ex: $Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2(g)}$

1.

Elemental sodium is placed in water

2.

The sodium reacts with water and begins to melt

3.

The hydrogen produced self-ignites...

4.

...and burns with a bright flame

stop

- at least one new substance is formed, with different properties than the reactants
- may be accompanied by changes in color, odor, state (solid precipitate or gas)
- always accompanied by a change in energy: a net amount is absorbed or released

Solid is form

Ex: $Pb(NO_3)_{2(aq)} + KI_{(aq)} \rightarrow KNO_{3(aq)} + PbI_{2(s)}$

http://www.youtube.com/watch?v=DITY2rXYU-I&feature=PlayList&p=3E4BD6C4FEDD6F47&index=0

Nuclear change: involves the changes with in the nuclei of atoms.

Physical Change	~Chemical Change
~No new or different substance is formed. The composition of the substance, that undergoes the change, remains unchanged	~Results in the formation of at least one new substance. The constituent particles of the new substance are different from the constituent particles of the original substance
~It is temporary change and in most cases it can be reversed by the reversal of conditions	~It is permanent change and cannot be reversed by mere reversal of conditions
~No change occurs in the mass of the substances undergoing the change	~Mass of the individual substances that undergoes the change, always, either increases or decreases. However, the total mass of all the reactants is equal to the tota mass of all the products

CHEMICAL TESTS:

These are distinctive chemical reactions that allow you to identify an unknown substance.

1. Oxygen test: If a glowing splint, held in a gas, bursts into flame, then $O_{2(g)}$ is present.

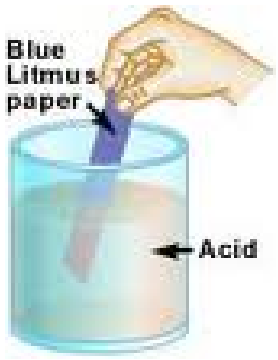
2. Carbon Dioxide: If limewater, a clear, colorless solution of calcium hydroxide, turns cloudy (white precipitate forms), then carbon dioxide is present.

3. Hydrogen test: If a POP sound is heard when a burning splint is held in a gas, then $H_{2(g)}$ is present.

http://www.youtube.com/watch?v=sfAbVX6UXRs&feature=related

4. Water: If cobalt(II)chloride paper changes from blue to pink, then water is present.

5. Acid: If blue litmus paper turns red, an acid is present.



6. Base: If red litmus paper turns blue, a base is present.

1. Exothermic reactions:

- release a net amount of energy
- more energy is released by the products than is absorbed by the reactants

Products Exothermic

E.g Combustion of coal: $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + \text{Energy}$

Produces or release a large amount of heat or energy

2. **Endothermic reactions:**
- absorb a net amount of energy
- more energy is absorbed by the reactants than is released by the products

E.g. Decomposition of $CaCO_3$:

$$\underbrace{CaCO_{3(s)}}_{\text{Reactants}} + \text{Energy} \rightarrow CaO_{(s)} + CO_{2(g)}$$

endothermic

absorb large amount of energy from surroundings. It will feel very cold

ex: ice pack

Note: Physical changes are also exothermic or endothermic

s → l → g

E.g. melting of ice: $H_2O_{(s)} \rightarrow H_2O_{(l)}$ ***Endothermic*** (adding heat)

E.g. freezing of water: $H_2O_{(l)} \rightarrow H_2O_{(s)}$ ***Exothermic***

g → l → s (Removing heat, cooling)

http://www.youtube.com/watch?v=KDqIE3ba0GQ&feature=related

Law of Conservation of Energy:
Energy is neither created nor destroyed (during any chemical or physical change), but can be converted from one form of energy to another.

e.g. photosynthesis:

$$6\,CO_{2(g)} + 6\,H_2O_{(g)} + \text{Energy} \rightarrow C_6H_{12}O_{6(s)} + 6\,O_{2(g)}$$

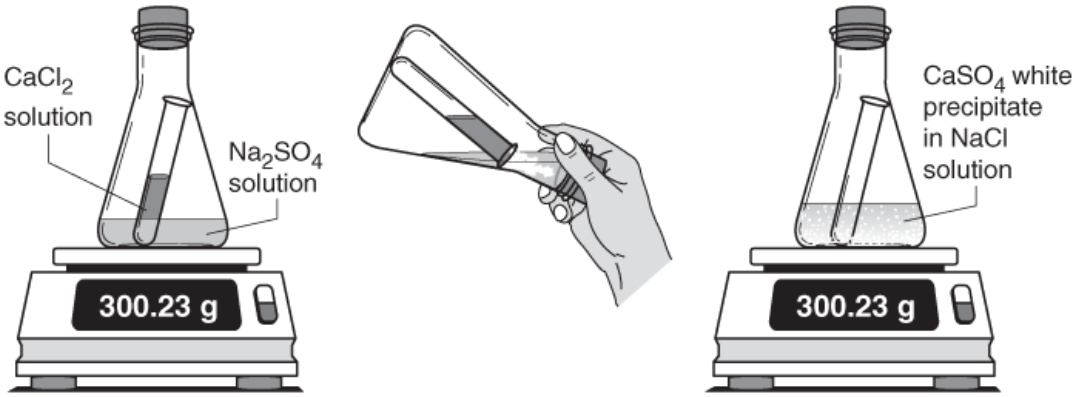
Plants use sunlight (solar energy) to convert carbon dioxide and water into carbohydrates such as glucose (stored chemical energy = potential energy).

Law of Conservation of Mass (Matter):
In any chemical or physical change, mass (matter) is neither created nor destroyed.
i.e. total mass of the reactants = total mass of the products.

This leads us to believe that atoms of reactants are not changed, but simply rearranged.
For example;Methane + oxygen→ water + carbon dioxide

http://www.youtube.com/watch?v=dExpJAECSL8

closed system



Or symbolically,

$$CH_4 + O_2 \rightarrow H_2O + CO_2$$

1 carbon atom 1 carbon atom
4 hydrogen atoms 2 hydrogen atoms
2 oxygen atoms 3 oxygen atoms

Note that the numbers of carbon, hydrogen and oxygen atoms are different. Have we violated the law of conservation of mass? No, we have simply not correctly written the balanced chemical equation describing the reaction.

- Demonstrated by Lavoisier (1700's), the father of modern chemistry.
- His experiments led to the emphasis on quantitative measurement, close observation and careful recording of data. All of his experiments were carried out in closed vessels.

Ex1. Lavoisier dehydrated gypsum by heating it.

Reactants Products

$CaSO_4 \; 2H_2O_{(s)} \rightarrow CaSO_{4(s)} + 2 \; H_2O_{(g)}$

172.2 g 136.2 g + 36.0 g

Ex 2: Lavoisier burned mercury in air. Then he heated the product further, which decomposed back into its elements.

mercury + oxygen → mercuric oxide → mercury + oxygen

201 g + 32 g → 233 g → 201 g + 32 g

Ex 3: He also burned phosphorus in air:

$P_{4(s)} + 5 \; O_{2(g)} \rightarrow P_4O_{10(s)}$

124 g + 160 → 284 g

Reactants = Products