6-1 Introduction to Chemical Reactions (page 105)

- Evidence of a chemical reaction:

- Chemical reactions can be expressed as chemical _____.

- The starting materials (what you have before the reaction) are called _____

- The substances produced by the reaction are called _____.

- Label the products and reactants in the chemical reaction between HCl and NaOH.

$HCl + NaOH$	→	$NaCl + H_2O$

- A chemical equation will tell you what happens *before* and *after* a reaction takes place.

- A chemical equation uses _____ and _____ to give all the essential information about a chemical reaction.

- Fill in the following table of **STANDARD SYMBOLS** and examples.

Symbol	Meaning	Example
(*g*)		
(*l*)		
(*s*)		
(*aq*)		
$2X_yZ$ i.e. what does # 2 mean?		

H_2O i.e. what does # 2 mean?		
+		
→		

- A chemical _____ equation uses words to describe reactants and products:

6-2 The Conservation laws
(page 106-107)

- A _____ (part of the universe being studied) can be open or closed.
- If a system is left _____ during its reaction what may happen?

- If a system is _____, nothing can enter or leave the system

- Law of Conservation of _____

States that energy can be neither created nor destroyed in a closed system; it can only be changed from one form to another

- Law of Conservation of _____

States that mass is neither created nor destroyed in a closed system

- Law of Conservation of _____

The total number and type of atoms in a closed system does not change during a chemical reaction

- Law of Conservation of _____ _____

The total electrical charge in a closed system does not change in a chemical reaction

6-3 Balancing Chemical Equations
(page 107-112)

- For an equation to be valid, the number of atoms of each element must be the same on _____ _____ of the reaction.

- In addition mass, and electrical charge must be conserved for an equation to be balanced.

- An equation that has the same # of atoms of each type on each side of an equation is called a **BALANCED Chemical equation** (_____).

$$Mg(s) + O_2(g) \rightarrow MgO(s)$$

NOT balanced yet!!

$$Mg(s) + O_2(g) \rightarrow MgO(s)$$

Ahh! That's better!!

- Notice that the number of magnesium atoms is the same on both sides of the equation, as is the number of oxygen atoms.

- **Here are the steps you go through balance equations**:

1. Write the _____ to represent **reactants** and **products**.

$$H_2(g) + O_2(g) \rightarrow H_2O(l)$$

- Count the number of _____ for each element on both the reactants and products. Are the 2 sides _____? If not, the equation is _____ balanced
- Balance by placing _____ in front of each element or molecule.
- They can **ONLY** be placed _____ _____ of the elements or compounds.
- You can _____ change the _____.

- Begin balancing in the following order:

_____

_____

_____

_____

- Keep in mind that when you change or add coefficients you may change the number of elements or molecules you had just balanced. You may have to _____ _____to the metals to _____ _____ that they are still balanced.

- Please note that a "_____" is _____ written and is simply _____ if no coefficient is present (same as with subscripts)

- Once all elements are balanced, count the final number of reactants and products and write the BCE

- Once the equation is balanced, as yourself if the coefficients in the equation be simplified by using a common factor?

Example: if your coefficients are 2 +4 → 2 + 6, they all have a common factor of 2 and can then be reduced to 1 + 2 → 1 + 3

a.	$AgNO_3$ + $CuCl_2$	→	$AgCl$ + $Cu(NO_3)_2$
b.	$BaCl_2$ + $NH_4)_2CO_3$	→	$BaCO_3$ + NH_4Cl
c.	$Mg(ClO_3)_2$	→	$MgCl_2$ + O_2
d.	$FeCl_2$ + Na_3PO_4	→	$Fe_3(PO_4)_2$ + $NaCl$
e.	ZnO + HCl	→	$ZnCl_2$ + H_2O

6-4 Writing Phases in Reactions and Using Chemical Word Equations (page 113-114)

It is often important to know in a chemical reaction what state or phase (solid, liquid, etc.) each reactant and each product is in. We indicate this by the following symbols.

(s) = _____
(l) = _____
(g) = _____
(aq) = _____ = dissolved in water

Thus:

$AgCl_{(s)}$ means _____.

$H_2O_{(l)}$ means _____.

$H_{2(g)}$ means _____.

$KNO_{3\,(aq)}$ means _____ _____ (aqueous potassium nitrate).

Note the difference between (l) and (aq). $KCl_{\,(l)}$ means potassium chloride heated until it _____. $KCl_{\,(aq)}$ means potassium chloride _____in water. Identify the phase of each compound in the following reaction:

$$3\ Ag_{\,(s)} + 4\ HNO_{3\,(aq)} \rightarrow 3\ AgNO_{3\,(aq)} + NO_{\,(g)} + 2\ H_2O_{\,(l)}$$

The Periodic Table can be an aid for determining the phase of elements at _____ temperature and pressure. Mercury is a liquid ($Hg_{\,(l)}$) and helium is a gas ($He_{\,(g)}$) according to the Periodic Table.

$H_2O(s) \rightarrow H_2O(l)$ . . . _____
$H_2O(s) \rightarrow H_2O(g)$ . . . _____
$C_2H_5OH(l) \rightarrow C_2H_5OH(g)$ . . . _____
$NH_3(g) \rightarrow NH_3(l)$ . . . _____

Remember the 7 diatomic gases:

When these gases exist in their own out side of a compound that with exist as a pair (with a subscript 2). Remember that this subscript is NOT its combining capacity!!

6-5 Types of Chemical Reactions
(page 114-118)

The 5 major types of Chemical Reactions:

1.

2.

3.

4.

5.

1. _____ Reactions (also called combination) (SYN)

- When two or more substances (usually elements) combine to form a one substance (compound)
- LOOK FOR _____ elements on the reactant side and one substance eon the product side

$$3\ H_{2\,(g)} + N_{2\,(g)} \rightarrow 2\ NH_{3\,(g)}$$

- Two non-metallic elements (hydrogen and nitrogen) have combined to form a covalent compound (ammonia).
- The reaction of oxygen and other elements is another common combination reaction.

$$2\ Cu_{(s)} + O_{2\,(g)} \rightarrow 2\ CuO_{(s)}$$

- In this example, a metal and a nonmetal have combined to produce the compound, copper (II) oxide.
- Predict the products of the following:

2. _____ Reactions (DEC)

- **When one substance breaks up into two or more new substances a decomposition reaction takes place.**
- This is the opposite of a synthesis reaction
- **LOOK FOR one substance on the reactant side**

$$H_2O_{(1)} \rightarrow H_{2(g)} + O_{2(g)}$$

$$2\ KClO_{3\,(s)} \rightarrow 2\ KCl_{\,(s)} + 3\ O_{2\,(g)}$$

$$H_2SO_4 \rightarrow H_2O_{\,(g)} + SO_{3\,(g)}$$

- The explosive reaction of nitroglycerin is another decomposition reaction.

$$4\ C_3H_5(NO_3)_{3(l)} \rightarrow 12\ CO_{2\,(g)} + 10\ H_2O_{\,(g)} + 6\ N_{2\,(g)} + O_{2\,(g)} + \text{Energy}$$

- Predict the products of the following:

3. _____ _____ Reaction (SR)

- **Involves replacing _____ atom in a compound being replaced by another atom**
- **LOOK FOR a single element (metal or nonmetal) replacing its equal in another compound**

$$I_{2\,(s)} + 2\ NaCl_{\,(aq)} \rightarrow Cl_{2\,(g)} + 2\ NaI_{\,(aq)}$$

- Predict the products:

4. _____ **Replacement (DR)**

- **Involves two compounds reacting to form two new compounds.**
- Generally, the compounds will be ionic and the reaction will take place in water.
- The evidence for a reaction is the formation of a solid material (a precipitate) or the neutralization of an acid and a base, forming water.

- **LOOK FOR TWO compounds reacting**
- Precipitate formation (solid forming when two solutions are mixed):

$$Pb(NO_3)_{2\,(aq)} + 2\ NaI_{\,(aq)} \rightarrow PbI_{2\,(s)} + 2\ NaNO_{3\,(aq)}$$

$PbI_{2\,(s)}$ is the precipitate.

- Note that the elements or polyatomic ions switch "partners."
- A special type of double replacement reaction involved and ACID and a BASE = NEUTRALIZATION
- An ACID + BASE → SALT + WATER
- _____ **reactions occur when an acid (such as HCl $_{(aq)}$) and a base (such as NaOH $_{(aq)}$) react to form a salt (such as NaCI $_{(aq)}$) and water.**

$$HCl_{\,(aq)} + NaOH_{\,(aq)} \rightarrow NaCI_{\,(aq)} + H_2O_{\,(l)}$$

($H_2O_{\,(l)}$ = H - Hydrogen from the acid and OH- from the base)

- Predict the products:

5. _____ Reactions (COMB)

- **Combustion, or burning, usually involves a fuel (an element or compound) combining rapidly with oxygen from the air.**
- **LOOK FOR a hydrocarbon on the reactant side (compound containing a C's and H's) and the products containing $CO_{2\,(g)}$ and H_2O**
- Hydrocarbons like natural gas or methane (CH_4) burn in oxygen to produce carbon dioxide and water. The products are always $CO_{2\,(g)}$ and $H_2O_{(g)}$
- Here are a couple of examples:

$$CH_{4\,(g)} + O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2\ H_2O_{(g)}$$

$$C_{10}H_{24\,(g)} + 16\ O_{2\,(g)} \rightarrow 10\ CO_{2\,(g)} + 12\ H_2O_{(g)}$$

Summary:

Type	How to recognize	How to predict the products
Synthesis or combination		
Decomposition		
Single replacement (SR)		
Double Replacement (DR)		
Neutralization (type of DR)		
Combustion		

6-6 Energy Changes in Chemical Reactions (page 119-122)

_____ Energy

_____ **energy is the energy due to movement**

"Kinetic" means "_____." Hence, kinetic energy is the energy due to movement. A thrown ball, a rolling log, a flying atom, and the electrons orbiting the nucleus of an atom all have kinetic energy.

_____ Energy

_____ **energy is stored energy, energy which can be converted into kinetic energy when the conditions are right.**

A rock at the top of a hill has potential energy. Give it a push and it rolls downhill converting its potential energy to kinetic. The potential energy in the gasoline burned in an automobile engine is transformed partly into the motion of the car. Because the internal combustion engine is notoriously inefficient, much of the potential energy of the gasoline is converted into wasted heat energy, which is a form of kinetic energy.

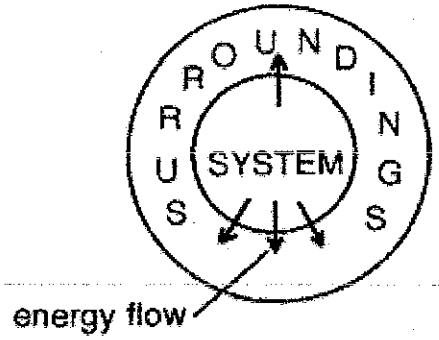
Energy in reactions

- All molecules have energy stored in their _____.
- When a chemical reaction occurs bonds are broken and formed to rearrange the atoms.
- Breaking bonds _____ energy, forming bonds _____ energy.
- When more energy is released, due to breaking bonds, than is needed to form the new bonds the reaction is exothermic.

Exothermic reactions

- Reactions of this sort which produce energy are called exothermic

reactions. "Exo" means "out" and "therm" refers to heat. So, "exothermic" means that heat is coming out or being produced.



- An energy coordinate diagram represents the change in potential energy graphically. For an exothermic reaction, the graph looks like:

- As you can see high energy reactants produce low energy products. The energy that is released is used to heat the surroundings.

- The energy released by the reaction will become a product when the reaction is written out.

Reactants → Products + _____

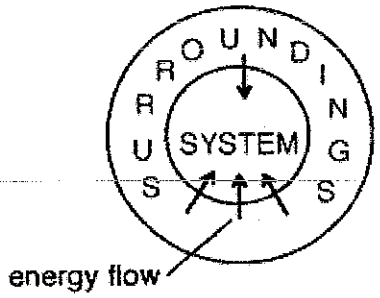
$$C_6H_{12}O_{6\,(s)} + 6\ O_{2\,(g)} \rightarrow 6\ CO_{2\,(g)} + 6\ H_2O_{(l)} + 2803\ kJ$$

- The _____ term can be expressed in _____

- When a reaction needs more energy to make bonds than it releases when all the bonds break it is an endothermic reaction.

Endothermic reactions

- Such reactions which _____ energy are called endothermic reactions. ("Endo" means "into.")



- The reaction starts at a low potential energy.
- As it progresses it absorbs thermal energy from the surroundings to end at a higher potential energy.

- Since energy is needed in the reaction it is written as a reactant:

_____ + Reactants → Products

- Alternatively is the amount of energy needed is known this can be added as an energy value as well

$6\ CO_{2\,(g)} + 6\ H_2O_{(l)} + 2803\ kJ\ (\text{from the sun}) \rightarrow C_6H_{12}O_{6\,(s)} + 6\ O_{2\,(g)}$

_____

- An alternative way to represent energy in a chemical reaction is to use enthalpy values.

- Enthalpy is The change in enthalpy, ΔH,

- Positive ΔH values are _____ reactions.
- Negative ΔH values are _____ reactions.

1. $2\ N_2(g) + O_2(g) + 164\ kJ \rightarrow 2\ N_2O(g)$
   $2\ N_2(g) + O_2(g) \rightarrow 2\ N_2O(g)$; $H = +164\ kJ$

2. $H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g) + 184\ kJ$
   $H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$ $H = -184\ kJ$

Example questions:

1. $\Delta H = -140\ kJ$

a.) Draw the energy diagram
b.) Is this reaction exothermic or endothermic?
c.) Write a sample equation using the reactants A and B and the products AB, include the energy term
d.) Will the surrounding become warmer or cooler?
e.) Are bonds being formed or broken?