Outline

- Chemical Equations
- Precipitation Reactions
- Acid-Base and Gas Evolution Reactions
- Oxidation-Reduction Reactions
- Classification of Reactions

Chemical Equations

Chemical reactions are represented with chemical equations

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

reactants products

Chemical equations give important information about reactants and products:

1. relative amounts
2. physical states (phases)

Phases are indicated in chemical equations:

solid	(s)	liquid	(l)
gas	(g)	aqueous	(aq)

Chemical equations must have mass and charge balance…

total number and type of atoms don't change

total charge of reactants same as products

Chemical equations are balanced by…

adjusting coefficients in front of reactants and products

"inspection"

1. start with most complicated formula
2. start with species that appears once on each side
3. use simplest whole number coefficients

$3MnO_2(s) + 4Al(s) \rightarrow 2Al_2O_3(s) + 3Mn(s)$

$PCl_5(g) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(aq)$

$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$

Every 2 molecules of H_2O_2 produce…

2 molecules of H_2O and 1 molecule of O_2

Every 2 moles of H_2O_2 produce…

2 moles of H_2O and 1 mole of O_2

Precipitation Reactions

Some substances dissolve in water to produce homogeneous mixture: aqueous solution

Ionic compounds (salts) dissociate into ions when dissolved…

soluble salts: dissolve
insoluble salts: do not dissolve

Solubility of salts predicted from solubility rules…

$(NH_4)_2CO_3$	soluble	NH_4^+ salts soluble!
$Zn(NO_3)_2$	soluble	NO_3^- salts soluble!
$Al(OH)_3$	insoluble	OH^- insoluble, except for…?
$BaSO_4$	insoluble	SO_4^{2-} soluble, except for...?

Ions in solution can react to form insoluble substance (precipitate)

Reactions that form precipitates are <u>precipitation reactions</u>

Write equations for reactions between:

$NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3$

$2KCl(aq) + Na_2CO_3(aq) \rightarrow K_2CO_3(aq) + 2NaCl(aq)$

$K_2SO_4(aq) + Pb(C_2H_3O_2)_2(aq) \rightarrow 2KC_3H_2O_2(aq) + PbSO_4(s)$

$2LiOH(aq) + Pb(NO_3)_2(aq) \rightarrow Pb(OH)_2(s) + 2LiNO_3(aq)$

Description of chemical reaction with…

formula equation: all reactants and products, no individual ions

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

total ionic equation: all reactants and products are given as ions

$$Ag^+(aq)+NO_3^-(aq)+Na^+(aq)+Cl^-(aq) \rightarrow AgCl(s)+Na^+(aq)+NO_3^-(aq)$$

net ionic equation: includes only those species involved in reaction

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

Ions present that do not participate in reaction are spectator ions

NO_3^- and Na^+

Write net-ionic equations for:

$K_2SO_4(aq) + Pb(C_2H_3O_2)_2(aq) \rightarrow PbSO_4(s) + 2KC_2H_3O_2(aq)$

nie: $Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$

$2LiOH(aq) + Pb(NO_3)_2(aq) \rightarrow Pb(OH)_2(s) + 2LiNO_3(aq)$

nie: $Pb^{2+}(aq) + 2OH^-(aq) \rightarrow Pb(OH)_2(s)$

Acid-Base and Gas Evolution Reactions

Acids react with bases by transferring hydrogen ions (H^+)

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

Acid-base reactions are termed neutralization reactions…

the reactions produce "hot salty water"!

Predict the products…

$$HBr(aq) + LiOH(aq) \rightarrow LiBr(aq) + H_2O(l)$$

$$H_2SO_4(aq) + Ba(OH)_2 \rightarrow BaSO_4(s) + 2H_2O(l)$$

The net-ionic equation for an acid-base reaction is…

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Some products in aqueous reactions are gaseous…

$$H_2S(aq) \rightarrow H_2S(g)$$

$$H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$$

$$H_2SO_3(aq) \rightarrow H_2O(l) + SO_2(g)$$

$$NH_4OH(aq) \rightarrow H_2O(l) + NH_3(g)$$

Oxidation-Reduction Reactions

Reactions involving the transfer of electrons are oxidation-reduction reactions (redox reactions)

a substance reacts with oxygen (O_2)

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

a metal reacts with a nonmetal

$$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$$

a substance transfers electrons to another

$$Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$$

Classification of Reactions

Chemical reactions can be classified into different types…

combination: simpler substances combine to form complex substance

$A + B \rightarrow AB$

decomposition: complex substance decomposes to form simpler substances

$AB \rightarrow A + B$

single-displacement: one element displaces another in a compound

$A + BX \rightarrow B + AX$

double-displacement: two elements (groups) displace one another

$$AX + BY \rightarrow AY + BX$$

Classify the reaction type…

$Cu(s) + AgNO_3(aq) \rightarrow Ag(s) + Cu(NO_3)_2(aq)$

$Na + O_2 \rightarrow Na_2O$

$KHCO_3(s) \rightarrow K_2CO_3(s) + H_2O(g) + CO_2(g)$

$Mg(s) + F_2(g) \rightarrow MgF_2(s)$

$BaCl_2(s) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + NaCl(aq)$