Writing Chemical Equations

Hints:

- Don't write phases (g, aq, l, s)
- Substances that dissociate extensively should be written as ions
- Only write net ionic equations (leave out molecules or ions that remain unchanged in the reaction)
- 1 point for correct reactants, 2 points for correct products

I. Two uncombined elements

Combine the two elements, giving each element a sensible oxidation state.

Hydrogen gas is burned in air: $H_2 + O_2 \rightarrow H_2O$

Solid magnesium is heated in nitrogen gas: $Mg + N_2 \rightarrow Mg_3N_2$

II. A single reactant

If there is only one reactant, then it is a decomposition reaction. Decomposition reactions usually produce simple salts and oxide gases.

A solution of hydrogen peroxide is placed under a bright light: $H_2O_2 \rightarrow H_2O + O_2$

Solid calcium carbonate is heated: $CaCO_3 \rightarrow CaO + CO_2$

III. Water as a Reactant

A. *A metal reacts with water to form a base and nonmetals react with water to form an acid.*

A pure metal or metal hydride reacts with water to form a base and hydrogen gas.

Sodium metal is added to distilled water: $Na + H_2O \rightarrow Na^+ + OH^- + H_2$

Solid lithium hydride is added to distill water: $LiH + H_2O \rightarrow Li^+ + OH^- + H_2$

B. A metal oxide reacts with water to produce a base.

Solid potassium oxide is added to water: $K_2O + H_2O \rightarrow K^+ + OH^-$

Solid barium oxide is added to water: $BaO + H_2O \rightarrow Ba^{2+} + OH^-$

C. A nonmetal oxide reacts with water to produce an acid.

Solid dinitrogen pentoxide is added to water: $N_2O_5 + H_2O \rightarrow H^+ + NO_3^-$

Carbon dioxide gas is bubbled through water: $CO_2 + H_2O \rightarrow H_2CO_3$

IV. An acid-base neutralization

A. An acid and a base.

Equal molar amounts of potassium hydroxide and hydrochloric acid are mixed:
$H^+ + OH^- \rightarrow H_2O$ strong acid/strong base

A solution of sodium hydroxide is added to a solution of acetic acid.
$HC_2H_3O_2 + OH^- \rightarrow C_2H_3O_2^- + H_2O$ weak acid/strong base

Solutions of ammonia and sulfuric acid are mixed: $NH_3 + H^+ \rightarrow NH_4^+$
(strong acid/weak base)

Solutions of ammonium and hydrofluoric acid are mixed: $HF + NH_3 \rightarrow F^- + NH_4^+$
(weak acid/weak base)

B. *An acid and a basic salt.*

Solutions of hydrochloric acid and sodium bicarbonate are mixed.
$H^+ + HCO_3^- \rightarrow H_2CO_3$

C. *A base and an acidic salt*

Sodium hydroxide solution is added to a solution of ammonium nitrate.
$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

D. *An acid anhydride and a base*

You should look at these in two steps:

Carbon dioxide gas is bubbled through a potassium hydroxide solution

$$\begin{array}{l} (CO_2 + H_2O \rightarrow H_2CO_3) \\ \underline{+ (H_2CO_3 + OH^- \rightarrow HCO_3^- + H_2O)} \\ CO_2 + OH^- \rightarrow HCO_3^- \end{array}$$

V. A mixture of two salt solutions

You have to predict which salt precipitates; therefore you need to be familiar with the solubility rules.

Solutions of calcium nitrate and sodium sulfate are mixed: $Ca^{2+} + SO_4^{2-} \rightarrow CaSO_4$

VI. Combustion of a carbon compound

Combustion of a carbon compound produces carbon dioxide and water.

Ethane is burned in air: $C_2H_2 \rightarrow CO_2 + H_2O$

VII. Solid transition metal placed in solution

This is a redox reaction and the metal is always oxidized.

A. *The solution is a neutral transition metal salt solution (the metal ion in solution will be reduced)*

Solid manganese flakes are placed in a solution of copper (II) sulfate:
$Mn + Cu^{2+} \rightarrow Mn^{2+} + Cu$

B. *The solution is a strong oxyacid solution (the anion of the oxyacid will be reduced to an oxide gas and water will form)*

A piece of copper is immersed in dilute nitric acid:
$Cu + H^{+} + NO_3^{-} \rightarrow Cu^{2+} + NO + H_2O$

VIII. Transition metal ions in solution with ammonia, hydroxide, cyanide, or thiocyanate (SCN^-)

Transition metal ions form complex ions with the above species. It won't matter how many you place around the transition metal, but you must get the charge on the complex correct.

Excess ammonia is added to a solution of silver nitrate: $Ag^{+} + NH_3 \rightarrow Ag(NH_3)_2^{+}$