Combustion Reaction of Carbon

Reactant   Product

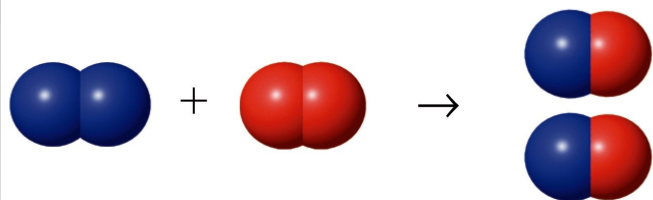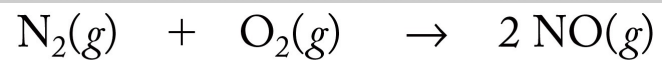**Chemical Equation** $C(s) + O_2(g) \longrightarrow CO_2(g)$
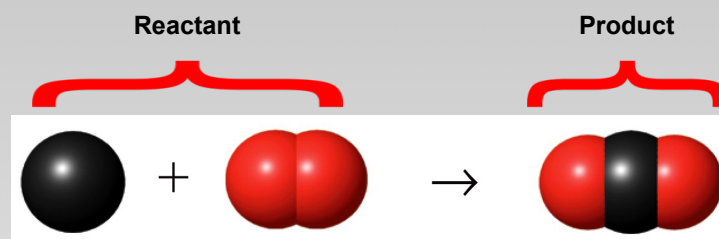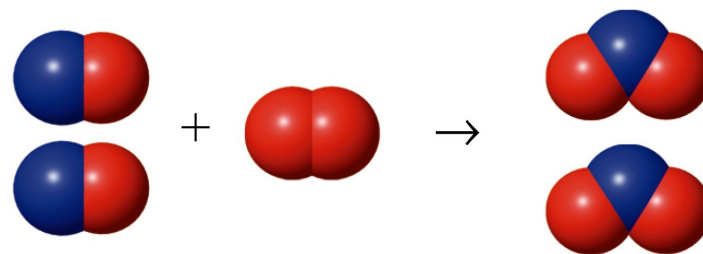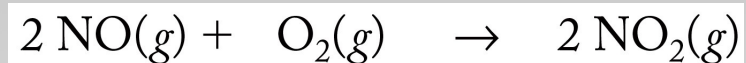
Law of Conservation of Mass:
The sum of the masses of the reactants always equals the sum of the masses of the products

Formation of Nitrogen Oxides and Nitric Acid

Formation of nitrogen monoxide

$$N_2(g) \;+\; O_2(g) \;\rightarrow\; 2\,NO(g)$$

Formation of nitrogen dioxide

$$2\,NO(g) +\; O_2(g) \;\rightarrow\; 2\,NO_2(g)$$

Formation of dinitrogen pentoxide

$$4\,NO_2(g) \;+\; O_2(g) \;\rightarrow\; 2\,N_2O_5(g)$$
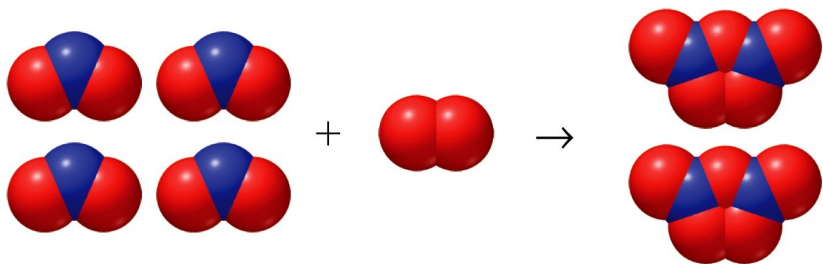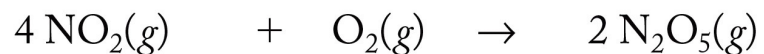
Formation of nitric acid

$$N_2O_5(g) \;+\; H_2O(\ell) \;\rightarrow\; 2\,HNO_3(aq)$$
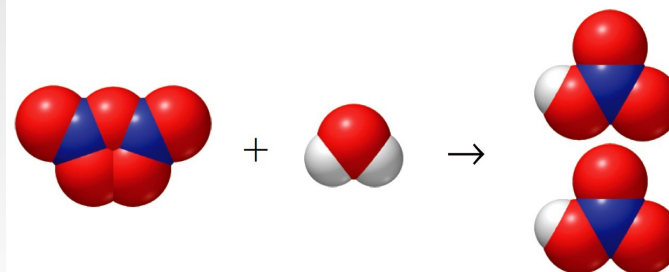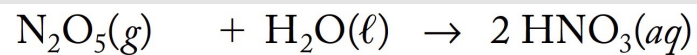
Automotive Catalytic Converter

$$2CO + O_2 \longrightarrow 2CO_2$$
$$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2\,H_2O$$
$$2CO + 2NO \longrightarrow 2CO_2 + N_2$$
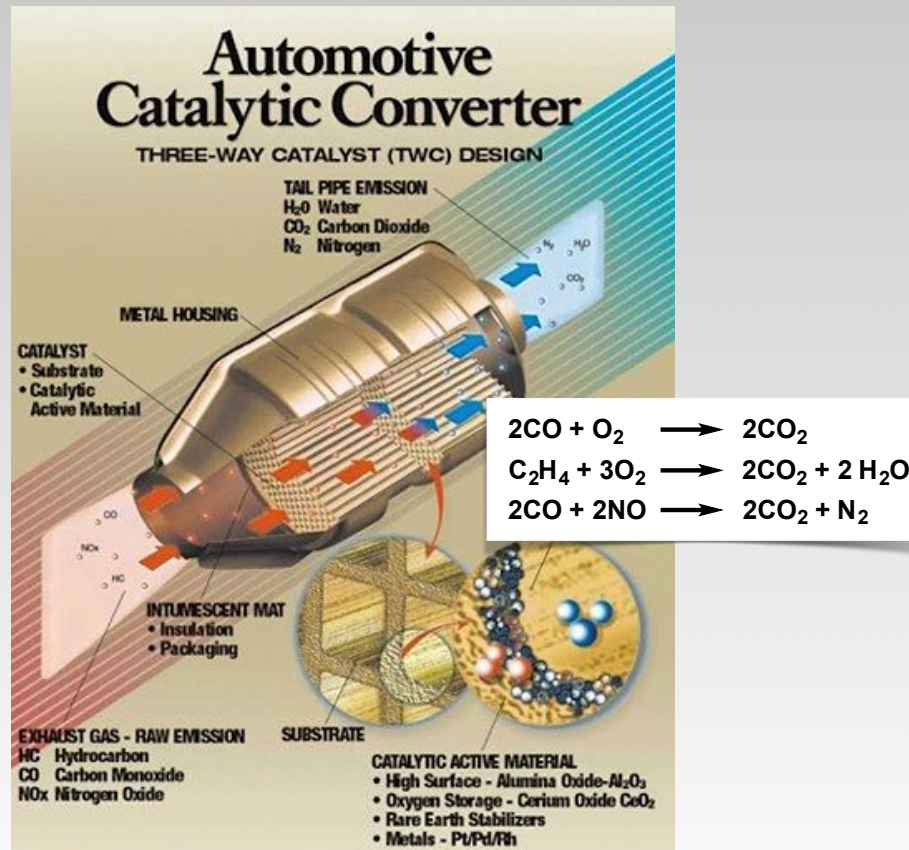
Balancing Chemical Equations

Example 1: Write a balanced equation for the reaction between solid cobalt(III)oxide and solid carbon to produce solid cobalt and carbon dioxide gas

1). Write a skeletal (unbalanced) equation by writing chemical formulas for each of the reactants and products (if a skeletal equation is provided go to step 2)

2). Balance atoms that occur in more complex substances first. Always balance atoms in compounds before atoms in pure elements.

3). Balance atoms that occur as free elements on either side of the equation last. Always balance free elements by adjusting the coefficient on the free element.

4). If the balanced equation contains coefficient fractions, clear these by multiplying the entire equation by the denominator of the fraction.

5). Check to make certain the equation is balanced by summing the total number of each type of atom on both sides of the equation.

Balancing Chemical Equations

Example 2: Write a balanced equation for the combustion of gaseous butane (C_4H_{10}) fuel used in portable stoves and grills, in which it combines with gaseous oxygen to form gaseous carbon dioxide and gaseous water.

1). Write a skeletal (unbalanced) equation by writing chemical formulas for each of the reactants and products (if a skeletal equation is provided go to step 2)

2). Balance atoms that occur in more complex substances first. Always balance atoms in compounds before atoms in pure elements.

3). Balance atoms that occur as free elements on either side of the equation last. Always balance free elements by adjusting the coefficient on the free element.

4). If the balanced equation contains coefficient fractions, clear these by multiplying the entire equation by the denominator of the fraction.

5). Check to make certain the equation is balanced by summing the total number of each type of atom on both sides of the equation.

Balancing Chemical Equations containing Ionic Compounds with Polyatomic Ions

Example 3: Write a balanced reaction between aqueous strontium chloride and aqueous lithium phosphate to form solid strontium phosphate and aqueous lithium chloride.

1). Write a skeletal (unbalanced) equation by writing chemical formulas for each of the reactants and products (if a skeletal equation is provided go to step 2)

2). Balance metal ions (cations) first. If a polyatomic cation exists on both sides of the equation, balance it as a unit.

3). Balance nonmetal ions (anions) second. If a polyatomic anion exists on both sides of the equation, balance it as a unit.

4). If the balanced equation contains coefficient fractions, clear these by multiplying the entire equation by the denominator of the fraction.

5). Check to make certain the equation is balanced by summing the total number of each type of ion on both sides of the equation.