

Chemical Equations

**Preparation for College Chemistry
Columbia University
Department of Chemistry**

Chapter Outline

The Chemical Equation

Writing and Balancing Equations

Information in an Equation

Types of Chemical Equations

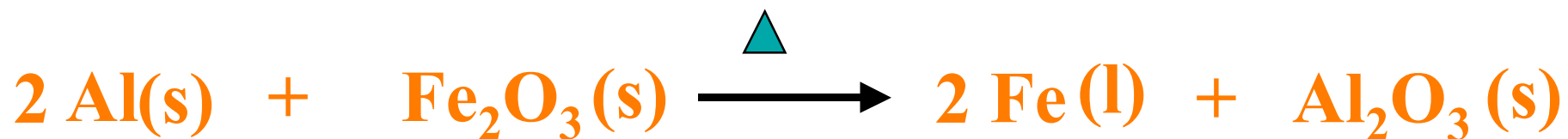
Heat in Chemical Equations

The Greenhouse Effect

The Chemical Equation

Shorthand Expression for a Chemical Change

- **Reactants**
- **Products**
- **Stoichiometric Coefficients**
- **Conditions**
- **Physical State**



Writing Chemical Equations

1 Identify the Reaction

magnesium hydroxide + phosphoric acid \longrightarrow *magnesium phosphate + water*

2 Write the skeleton equation

3 Find the Stoichiometric Coefficients (Balance)



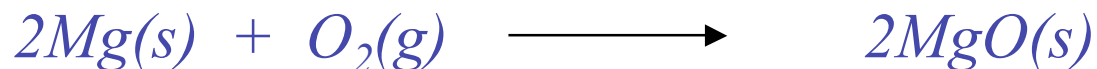
<i>R</i>	<i>3 Mg</i>	<i>2 PO₄</i>	<i>14 O</i>	<i>12 H</i>
<i>P</i>	<i>3Mg</i>	<i>2PO₄</i>	<i>14 O</i>	<i>12 H</i>

Types of Chemical Equations

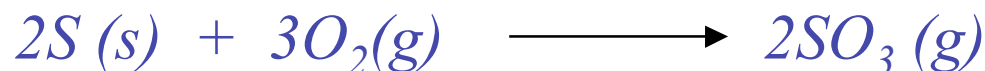


Combination Reactions

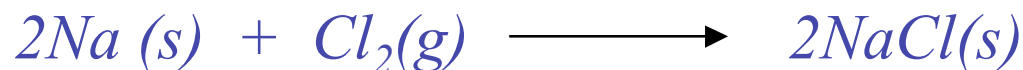
□ *metal + Oxygen* \longrightarrow *metal oxide*



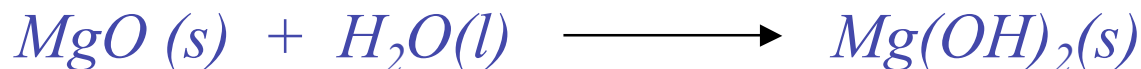
□ *nonmetal + Oxygen* \longrightarrow *non metal oxide*



□ *metal + nonmetal* \longrightarrow *Salt*



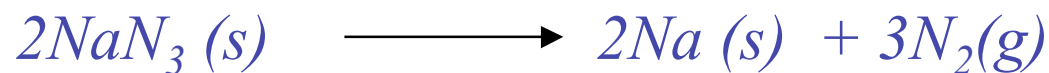
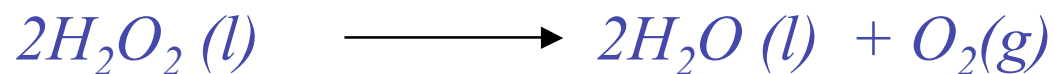
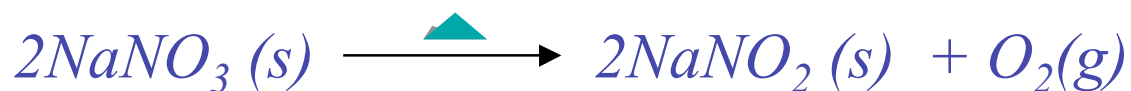
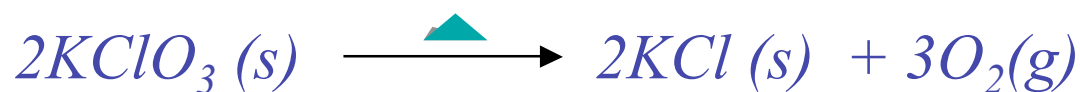
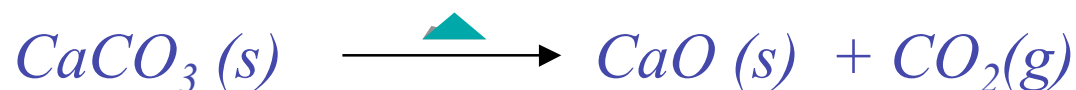
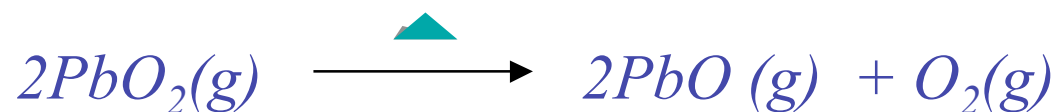
□ *metal oxide + water* \longrightarrow *Metal Hydroxide*



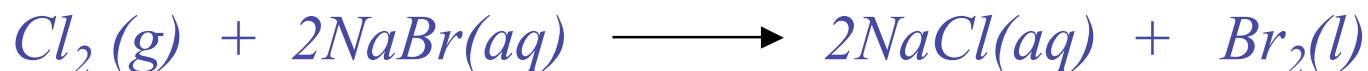
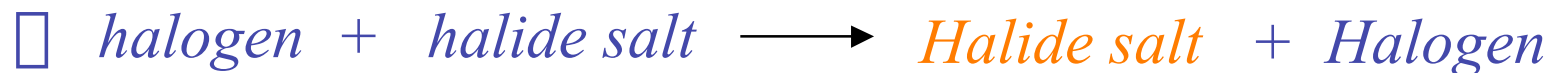
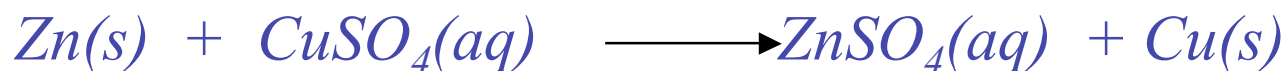
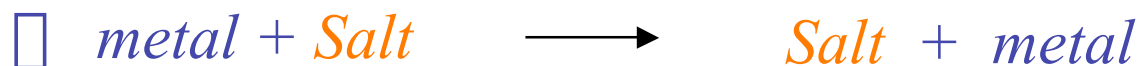
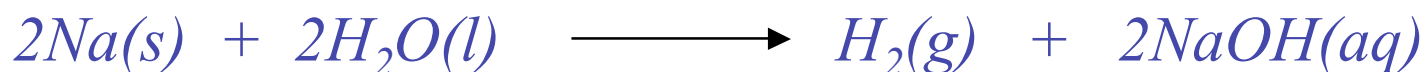
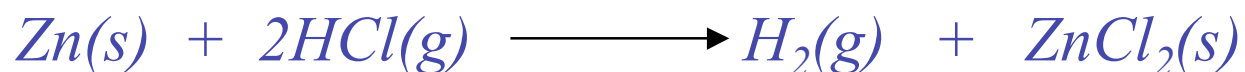
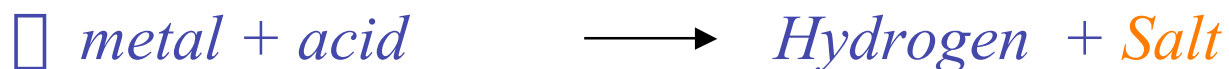
□ *nonmetal oxide + water* \longrightarrow *Oxy-acid*



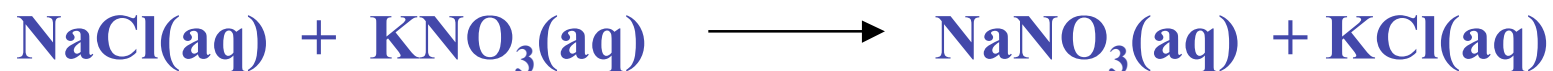
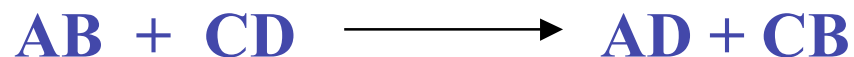
Decomposition Reactions



Single-Displacement Reactions



Double-Displacement Reactions



Physical Evidences for double-displacement

- Formation of an Insoluble precipitate**
- Evolution of Heat (Neutralization Reactions)**
- Gas Formation**

Precipitation Reactions

Appendix V Solubility Table

NO_3^- All nitrates are soluble

Cl^- All chlorides are soluble, except AgCl , Hg_2Cl_2 , PbCl_2

**SO_4^{2-} Most sulfates are soluble, except SrSO_4 , PbSO_4 and BaSO_4
 CaSO_4 is slightly soluble**

CO_3^{2-} All carbonates are insoluble, except Group I and NH_4^+

OH^- All hydroxides are insoluble, except group I $\text{Sr}(\text{OH})_2$ and $\text{Ba}(\text{OH})_2$. $\text{Ca}(\text{OH})_2$ is slightly soluble

S^{2-} All sulfides except Groups I and II and NH_4^+ are insoluble

Solubility Rules

Used to predict results of precipitation reactions

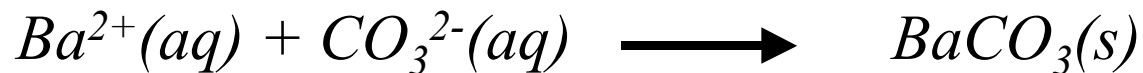
Example 1

What happens when solutions of $Ba(NO_3)_2$ and Na_2CO_3 are mixed?

Ions present: $Ba^{2+}_{(aq)}$, $NO_3^-_{(aq)}$, $Na^+_{(aq)}$, $CO_3^{2-}_{(aq)}$

Possible precipitates: $BaCO_3$, $NaNO_3$

According to solubility rules, $BaCO_3$ is insoluble



Solubility Rules

Example 2

Mix solutions of $BaCl_2$, $NaOH$

ions present: $Ba^{2+}_{(aq)}$, $Cl^{-}_{(aq)}$, $Na^{+}_{(aq)}$, $OH^{-}_{(aq)}$

possible precipitates: $Ba(OH)_2$, $NaCl$

both are soluble; no reaction

Net Ionic Equations

(Spectator ions do not appear)

Example *Mix solutions of $\text{Cu}(\text{NO}_3)_2$, NaOH*

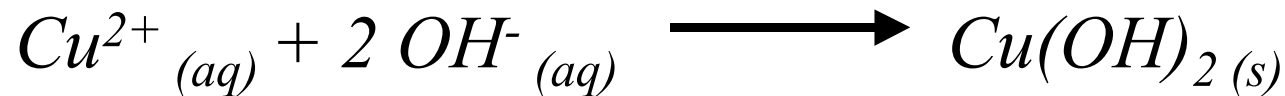
ions present: $\text{Cu}^{2+}_{(aq)}$, $\text{NO}_3^{-}_{(aq)}$, $\text{Na}^{+}_{(aq)}$, $\text{OH}^{-}_{(aq)}$

possible precipitates: $\text{Cu}(\text{OH})_2$, NaNO_3

NaNO_3 is soluble; $\text{Cu}(\text{OH})_2$ is not.

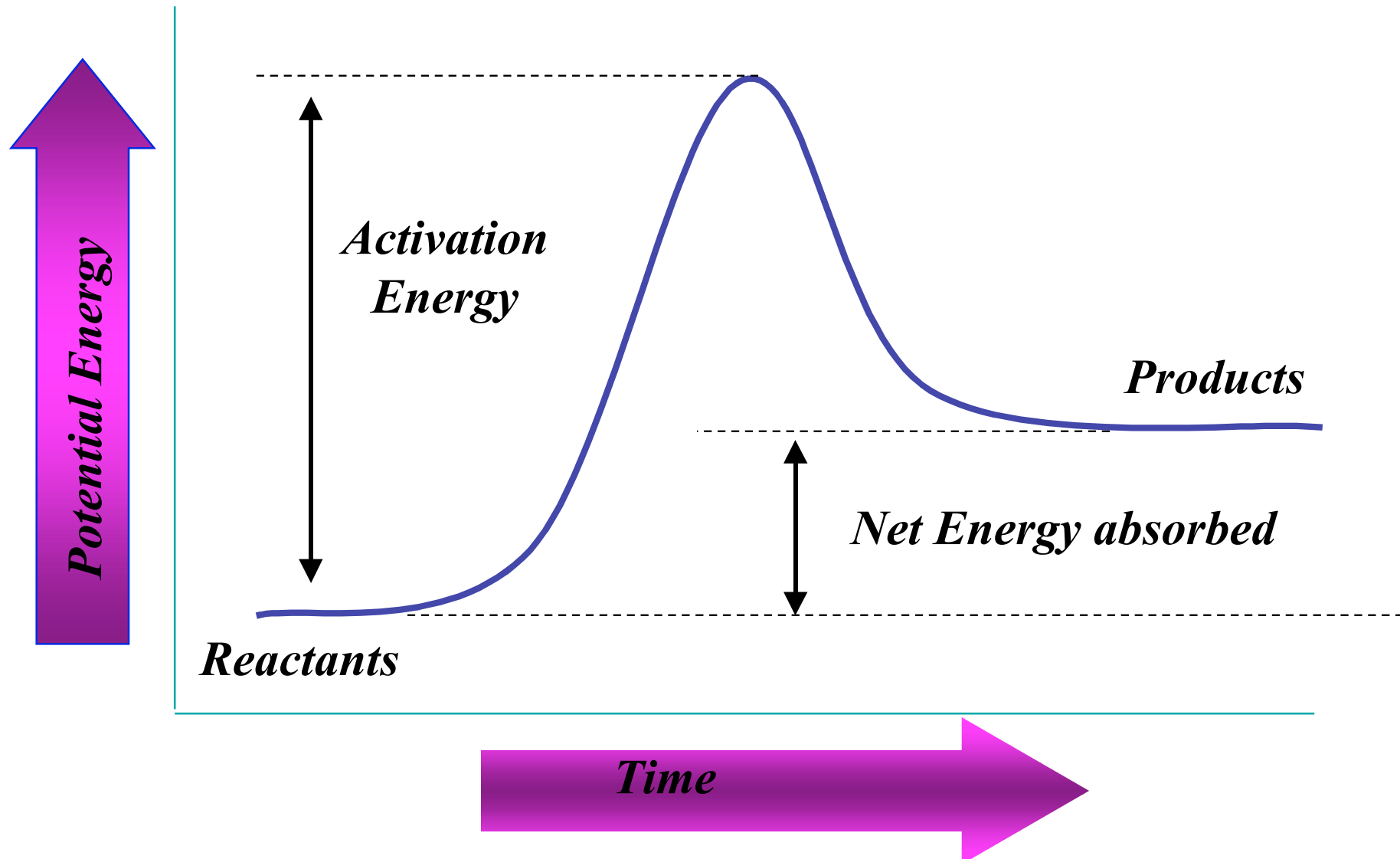
Spectator ions: $\text{Na}^{+}_{(aq)}$, $\text{NO}_3^{-}_{(aq)}$

Net Ionic Equation:



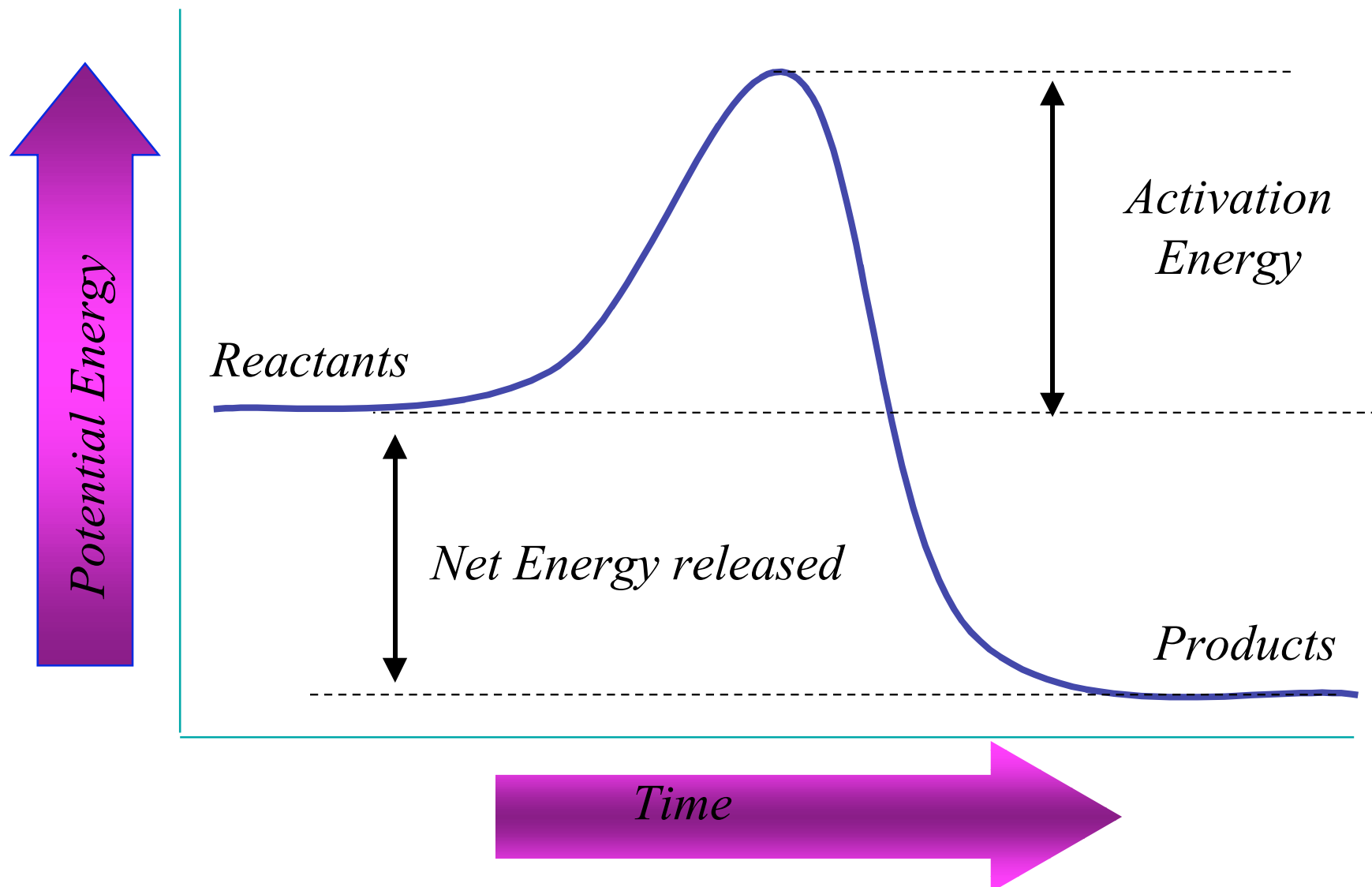
Heat in Chemical Reactions

Endothermic Reaction



Heat in Chemical Reactions

Exothermic Reaction



The Greenhouse Effect



Some solar radiation is reflected by the earth and the atmosphere

Solar radiation passes through the clear atmosphere

Most radiation is absorbed by the earth's surface and warms it

Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the earth's surface and the lower atmosphere.

Infrared radiation is emitted from the earth's surface

