Chapter Nine

Chemical Reactions

Fire Works are Chemical Reactions

→ **CO 9.1**

Jeff Hunter/Getty Images

Zinc reacts with sulfur

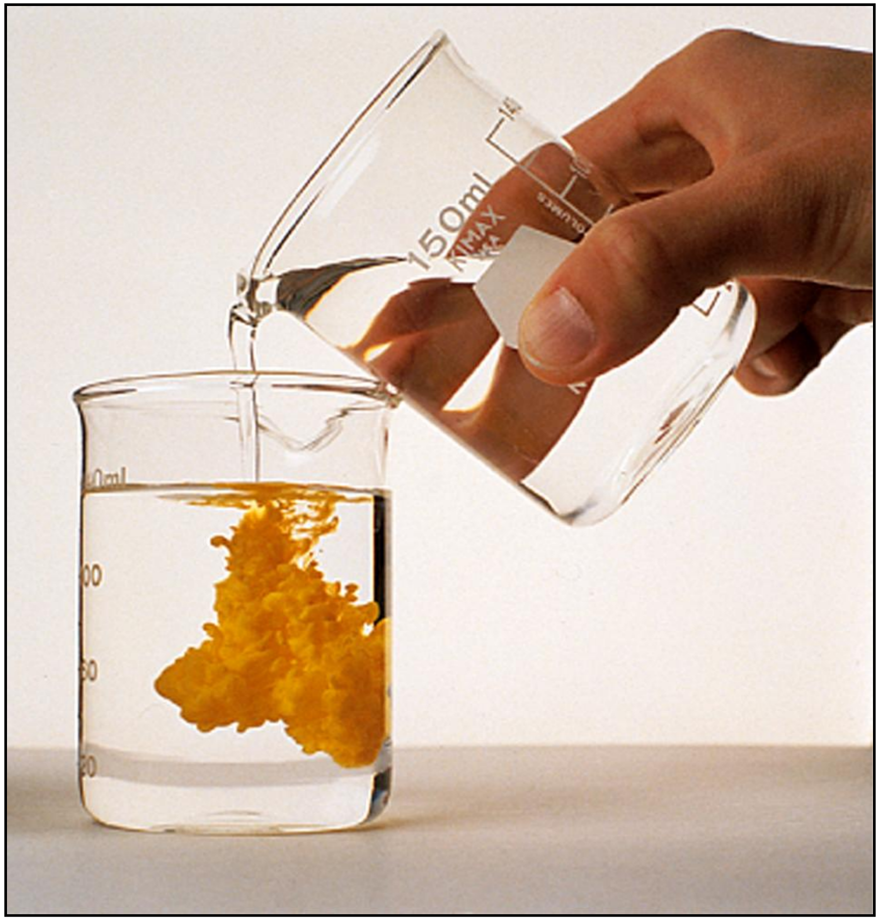
← **Fig. 9.1**

When a hot nail is stuck into a pile of zinc and sulfur, a fiery combination reaction occurs and zinc sulfide forms.

Precipitation of lead iodide In solution

→ **Fig. 9.2**

A double-replacement reaction involving solutions of potassium and lead nitrate produces yellow, insoluble lead iodide as one of the products.

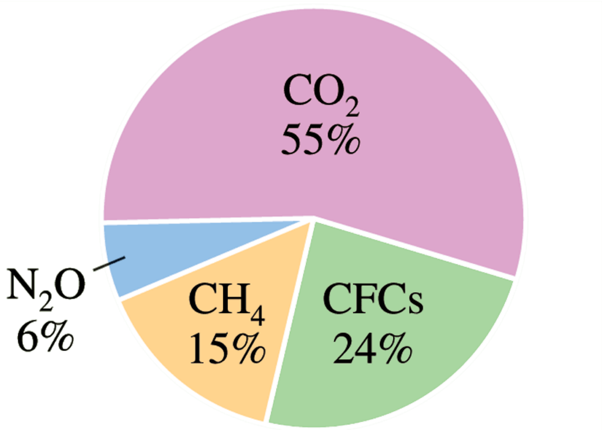


James Scherer/Houghton Mifflin Company

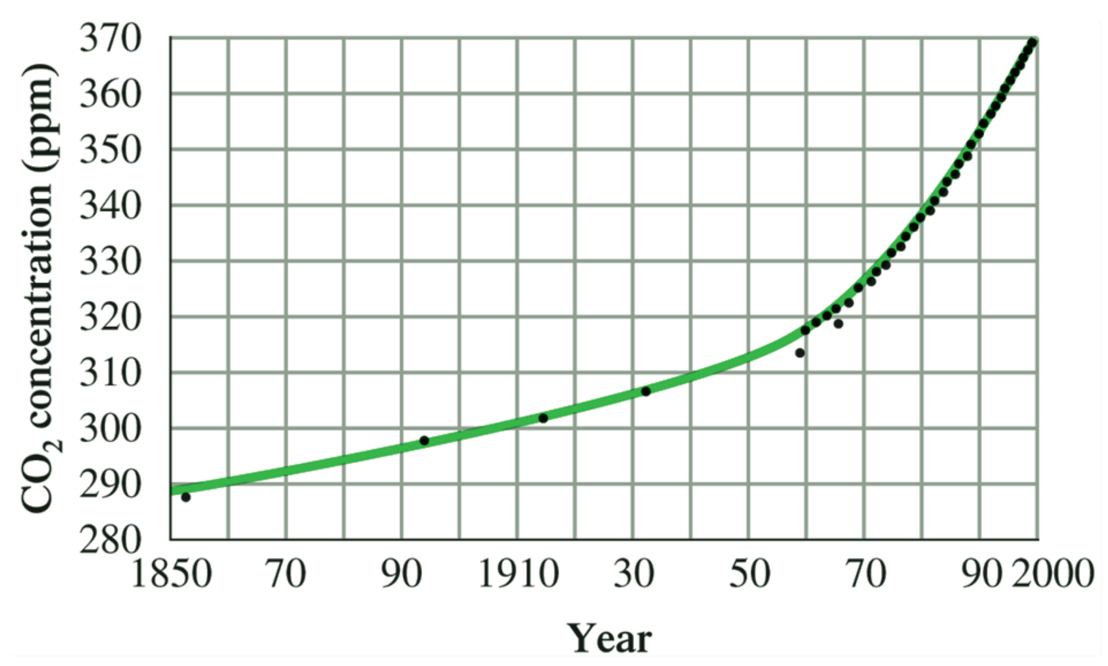
Combustion reaction and CO_2

→ **CC 9.1**

Combustion reaction and global warming



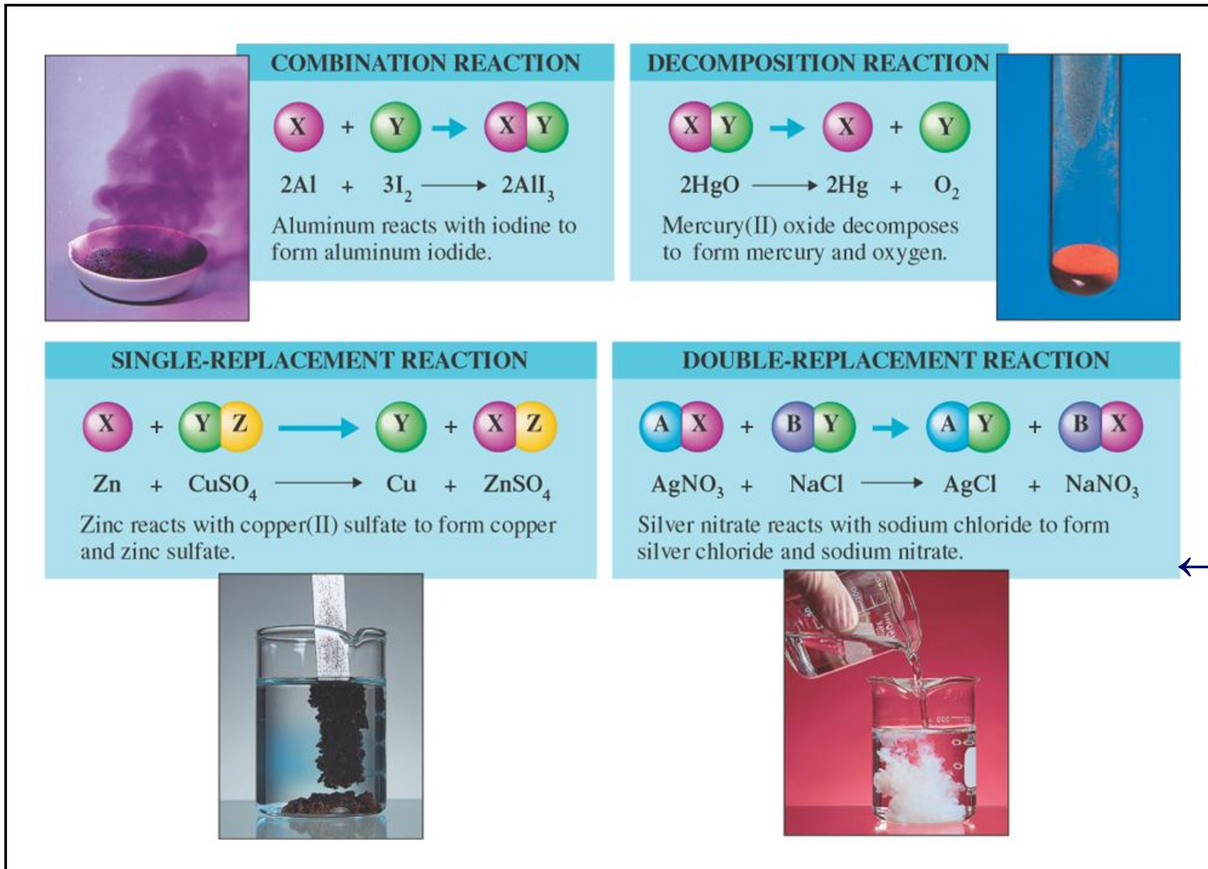
Contributions of various gases to the greenhouse effect



Types of Chemical Reactions

→ **Aluminum reacting with iodine (purple smoke)**

→ **Formation of copper and zinc sulfate**

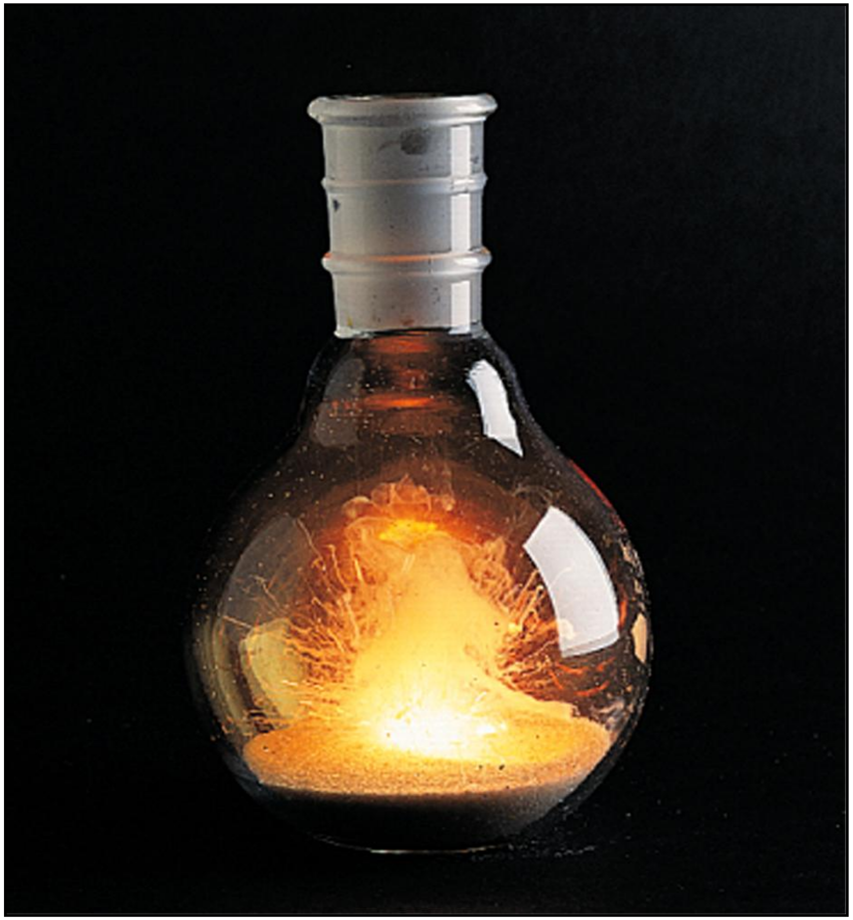


← **Mercury oxide decomposing (orange solid)**

← **Formation of silver chloride and sodium nitrate**

Redox Reactions: Electron transfer

→ **Fig. 9.3**
The burning of calcium metal in chlorine is a redox reaction.



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Oxidation Number

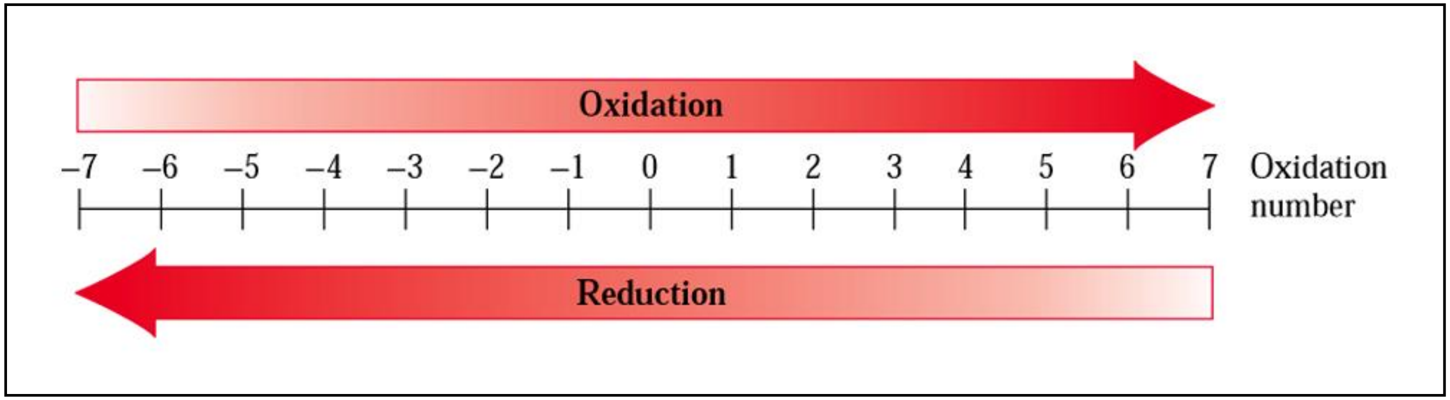


Fig. 9.4

An increase in oxidation number is associated with the process of oxidation, a decrease with the process of reduction.

Redox terminology

LEO the Lion goes GER!

Term	Electron Transfer
oxidation	loss of electron(s)
reduction	gain of electron(s)
oxidizing agent (substance reduced)	electron(s) gained
reducing agent (substance oxidized)	electron(s) lost

Table 9.1

Corrosion of metal is redox

← **CC 9.2**

Activation Energy

→ **Fig. 9.5**

Rubbing a match head against a rough surface provides the activation energy needed for the match to ignite.

Collisions orientation matters

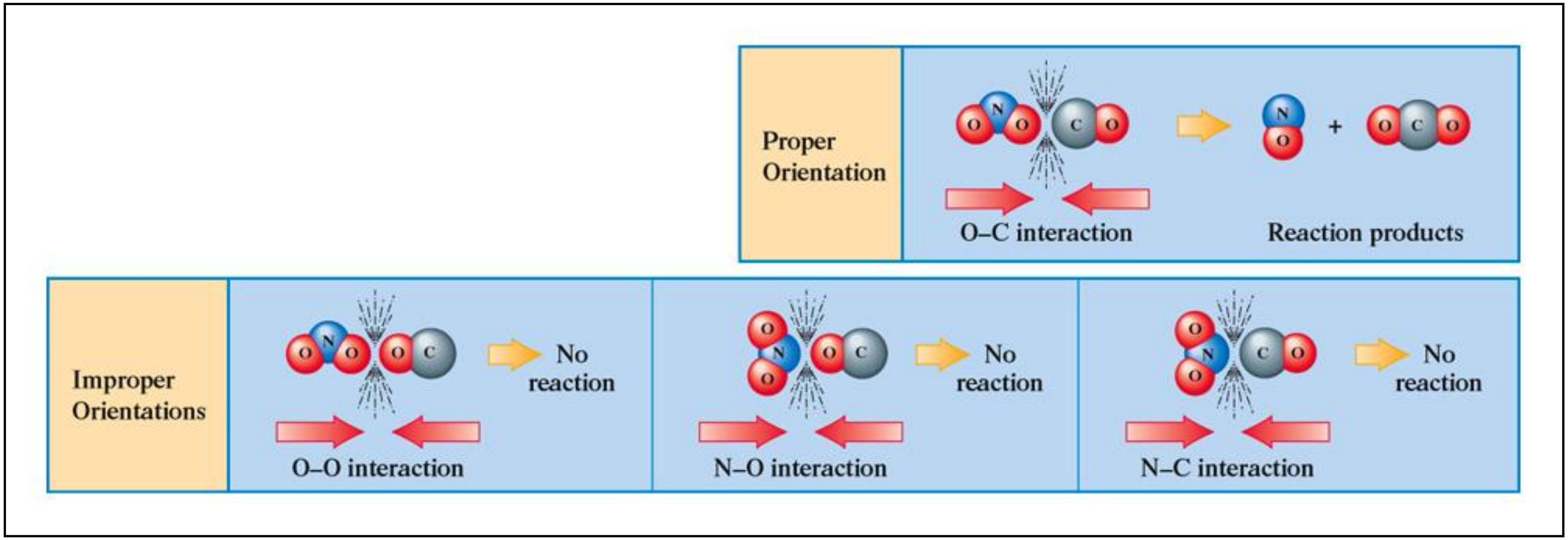
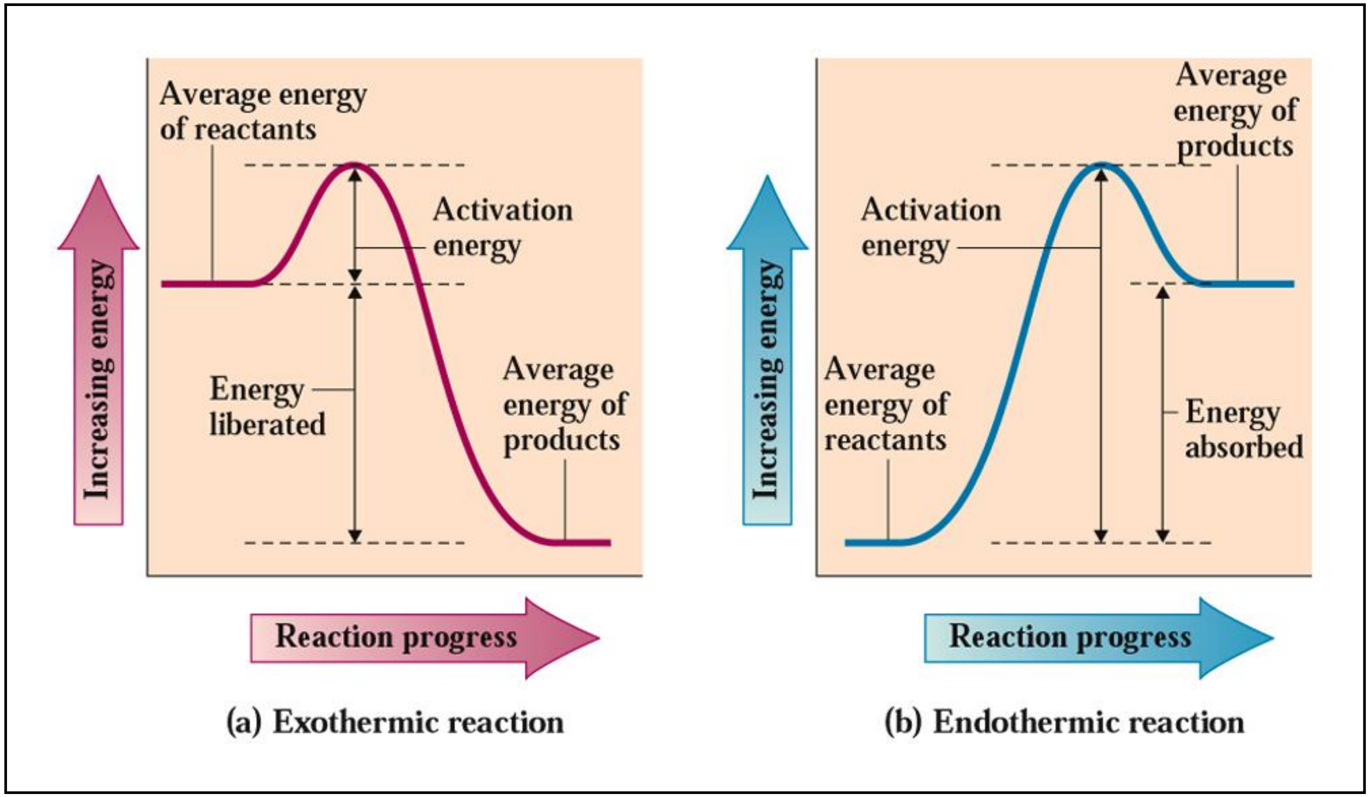


Fig. 9.6

The most favorable collision orientation is one that puts an O atom from NO_2 in close proximity to the C atom of CO.

Energy graphs: Exothermic or Endothermic

→ **Fig. 9.7**
Energy graphs showing the difference between an exothermic and an endothermic reaction.



Rates of reactions are different

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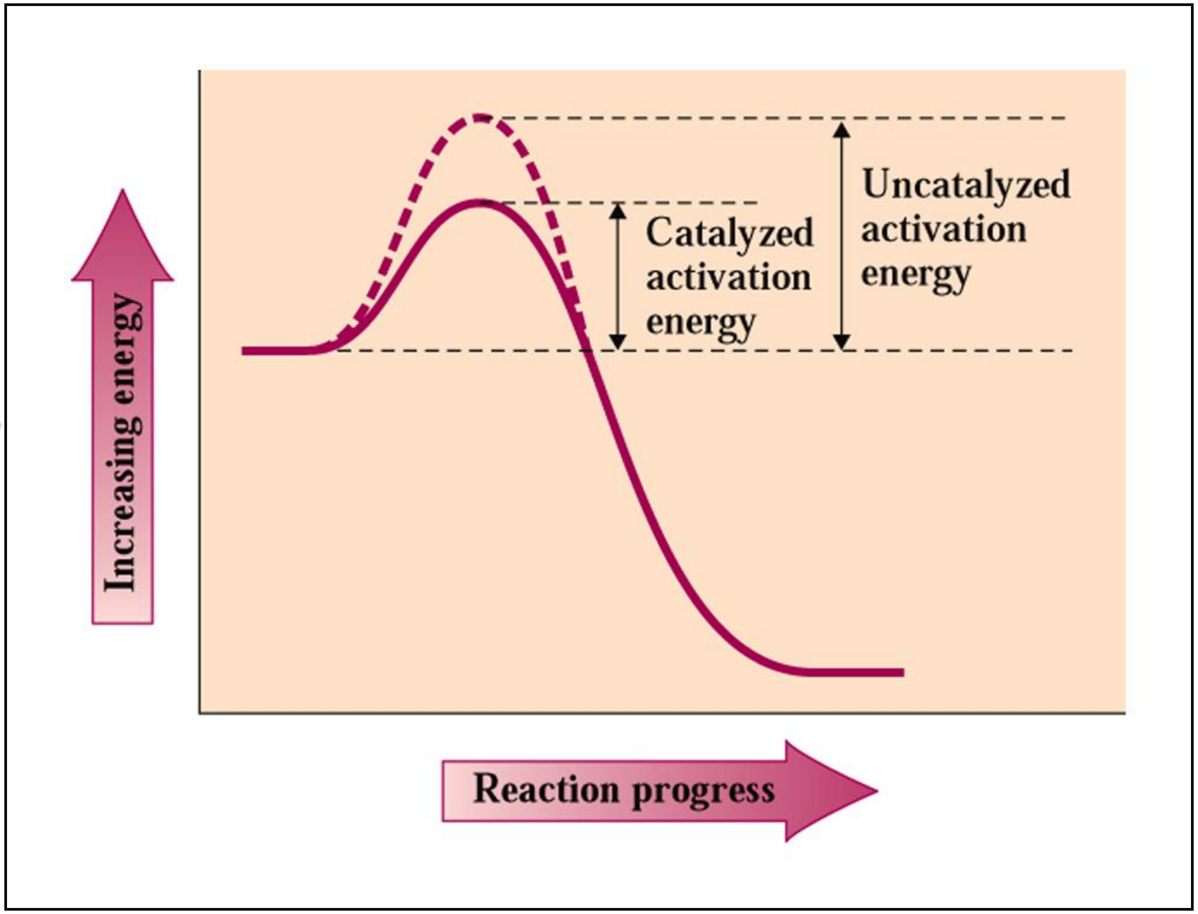
Figs. 9.8a-d

A fire (a) is a much faster reaction than the ripening of fruit (b), which is much faster than the process of rusting (c), which is much faster than the process of aging (d).

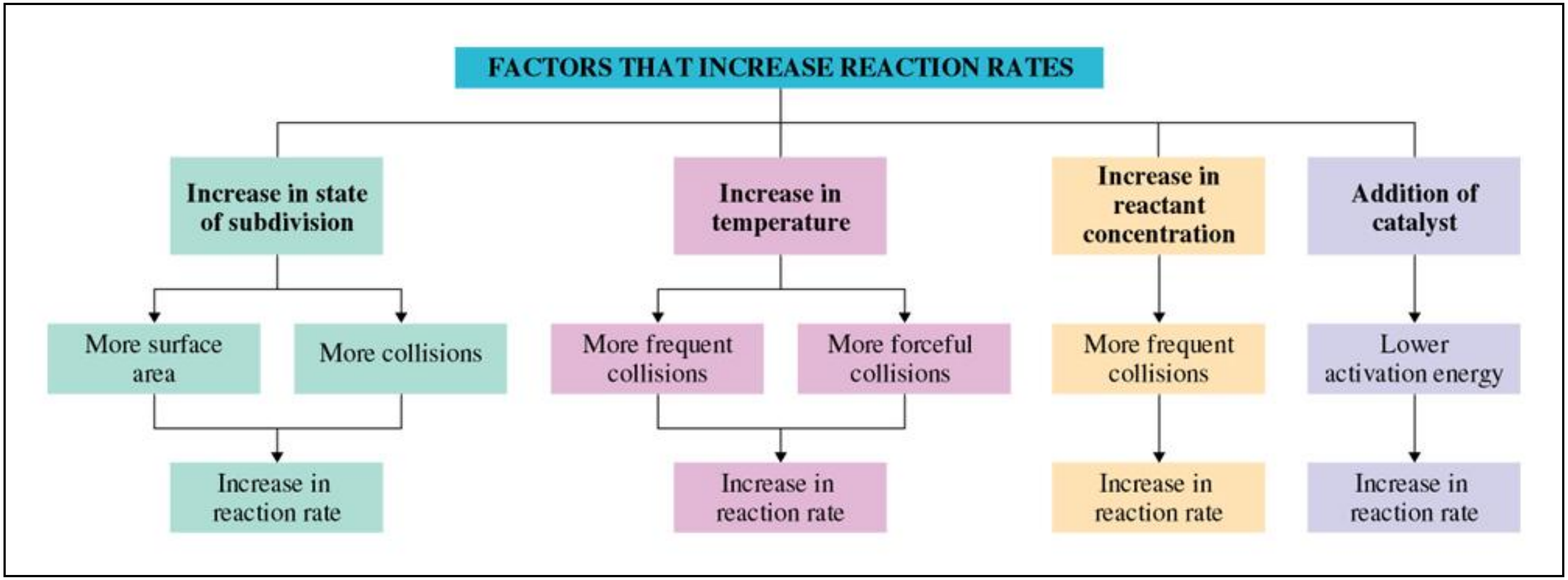
Catalysts lowers activation energy

→ **Fig. 9.9**
Catalysts lowers the activation energy for chemical reactions.



Factors affecting chemical ceactions

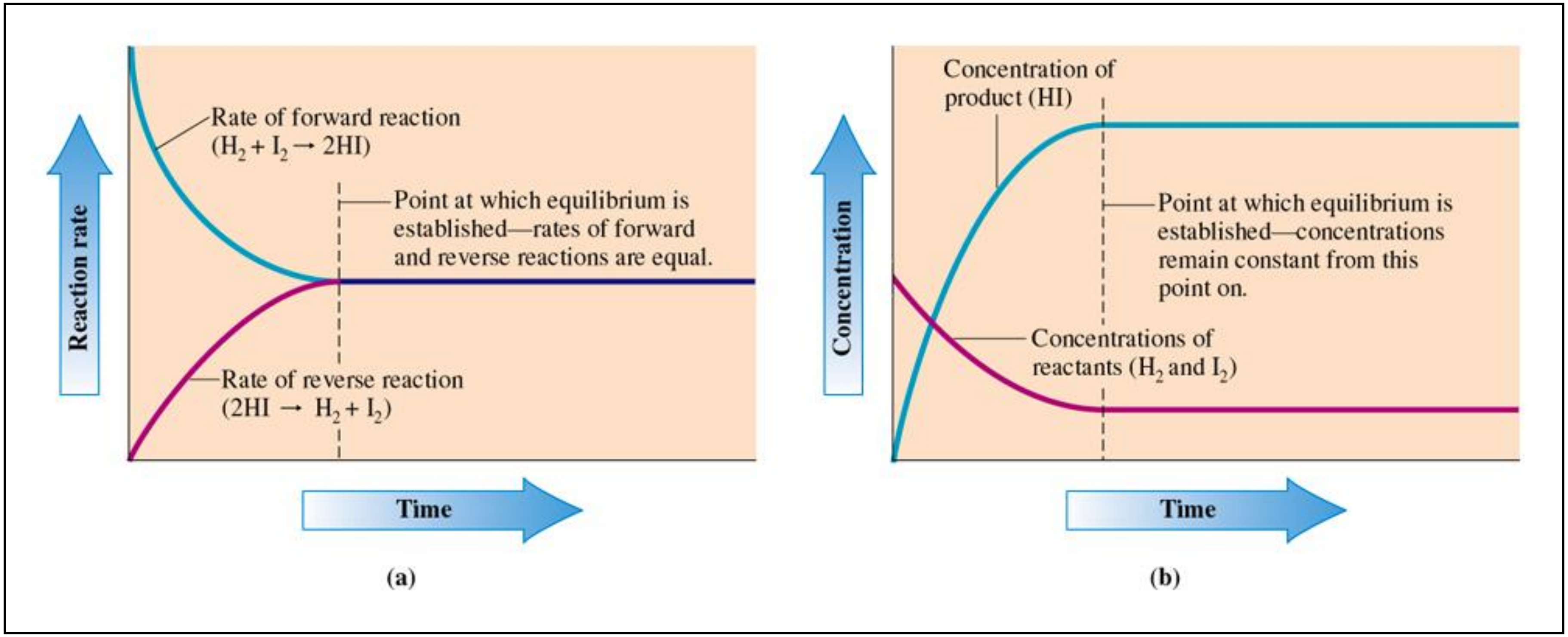
CC 9.3



Reaction rates and reactant concentration

Fig. 9.10

Graphs showing how reaction rates and reactant concentration vary with time.



Smog is caused by automobile-emissions

Tom McHugh/Photo Researchers

← **CC 9.3 Los Angeles Smog**

What does equilibrium constant K_{eq} means?

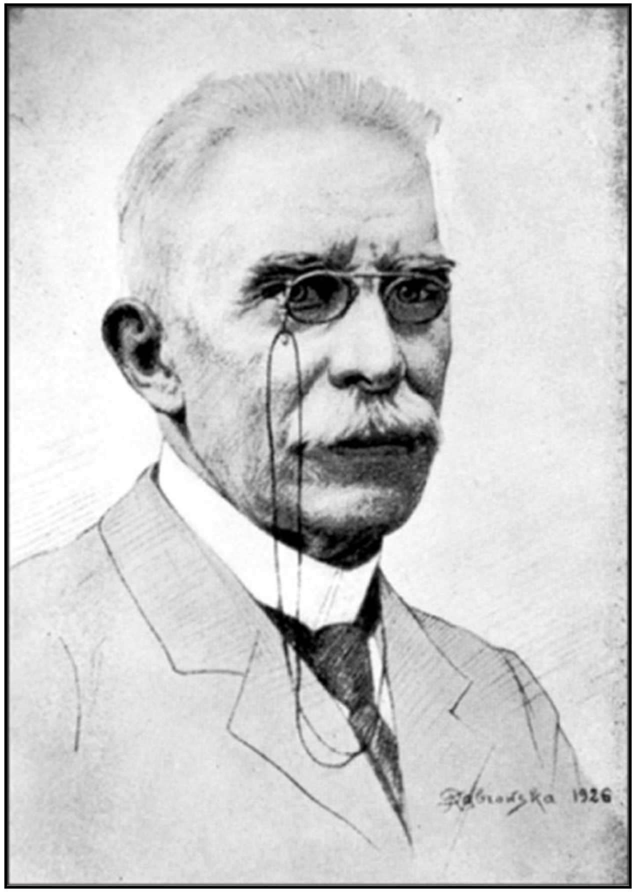
Value of K_{eq}	Relative Amounts of Products and Reactants	Description of Equilibrium Position
very large (10^{30})	essentially all products	far to the right
large (10^{10})	more products than reactants	to the right
near unity (between 10^{3} and 10^{-3})	significant amounts of both reactants and products	neither to the right nor to the left
small (10^{-10})	more reactants than products	to the left
very small (10^{-30})	essentially all reactants	far to the left

Table 9.2

Louis Chatelier Principle

→ **Fig. 9.11**

Henri Louis Chatelier was amazingly diverse in his interests.



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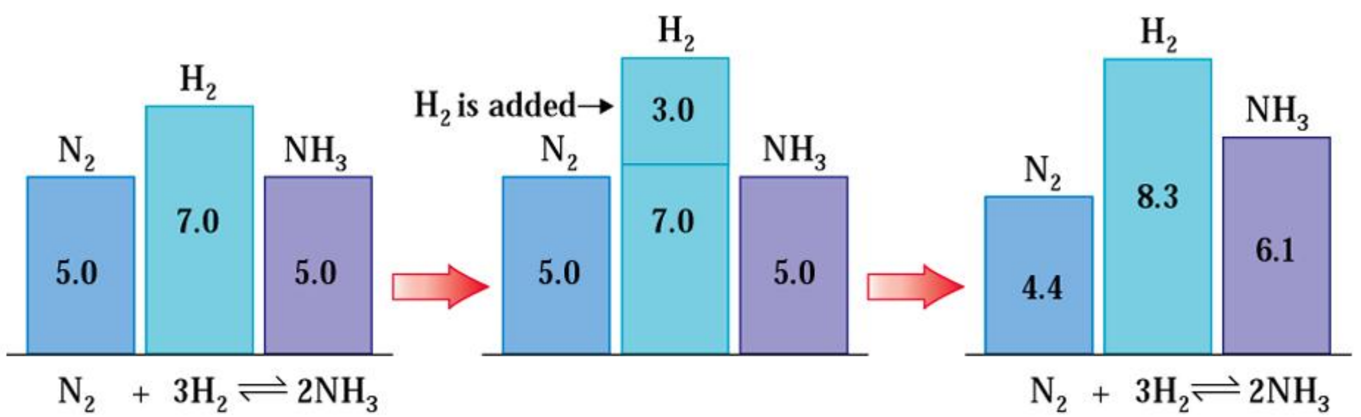
Shifts in equilibrium

← **Fig. 9.12**

Concentration changes that result when H_2 is added to an equilibrium mixture.



(a) Original equilibrium conditions

(b) Increase in $[H_2]$ upsets equilibrium; reaction shifts to the right as more N_2 reacts with the additional H_2.

(c) New equilibrium conditions. Compared with the original equilibrium in (a):
$[N_2]$ has decreased.
$[H_2]$ has increased because of addition. (Note that $[H_2]$ is actually decreased from conditions at (b) because some of it has reacted with N_2 to form more NH_3).
$[NH_3]$ has increased.

Temperature can shift the equilibrium

→ **Fig. 9.13**
Equilibrium mixtures changing color with difference in temperatures.