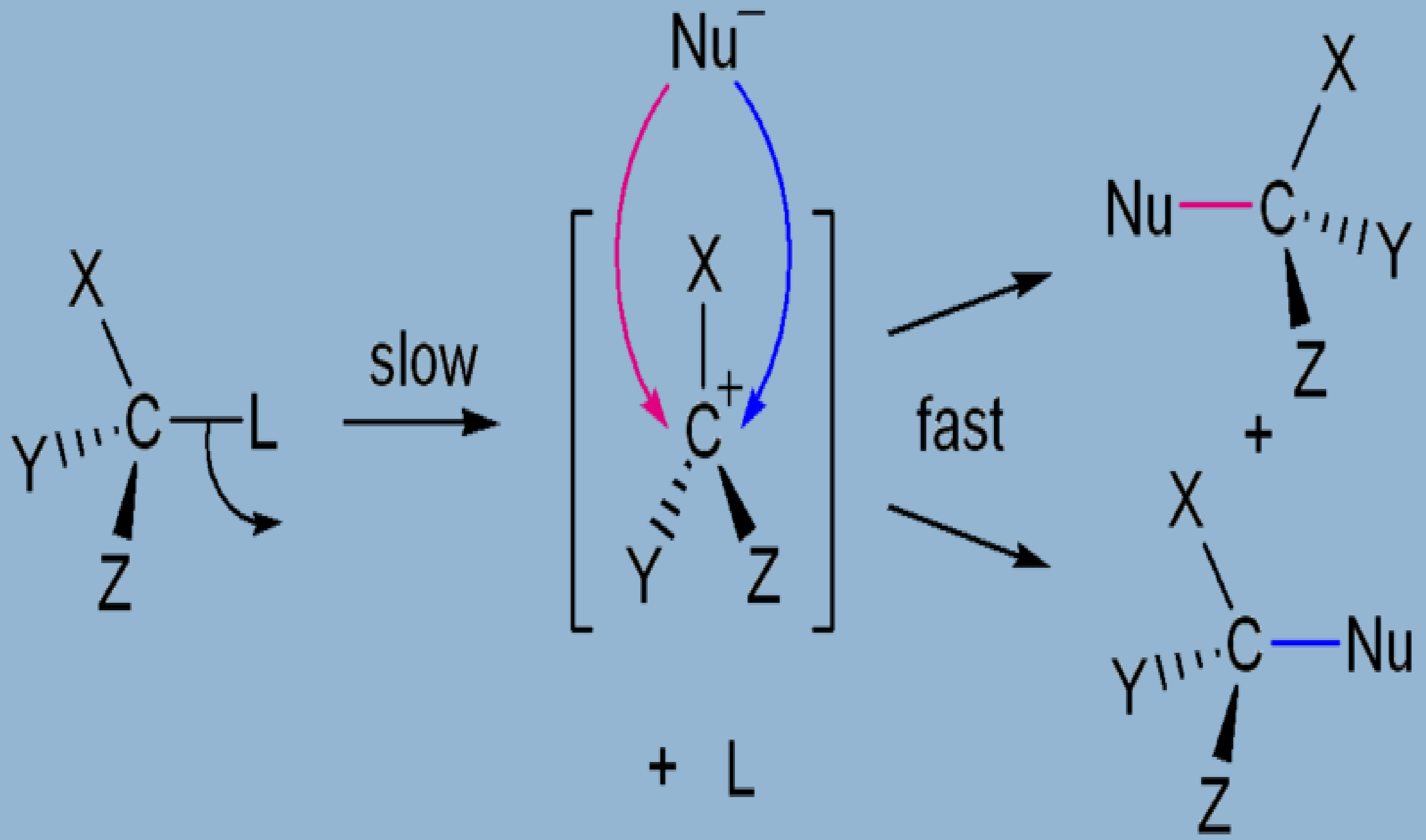
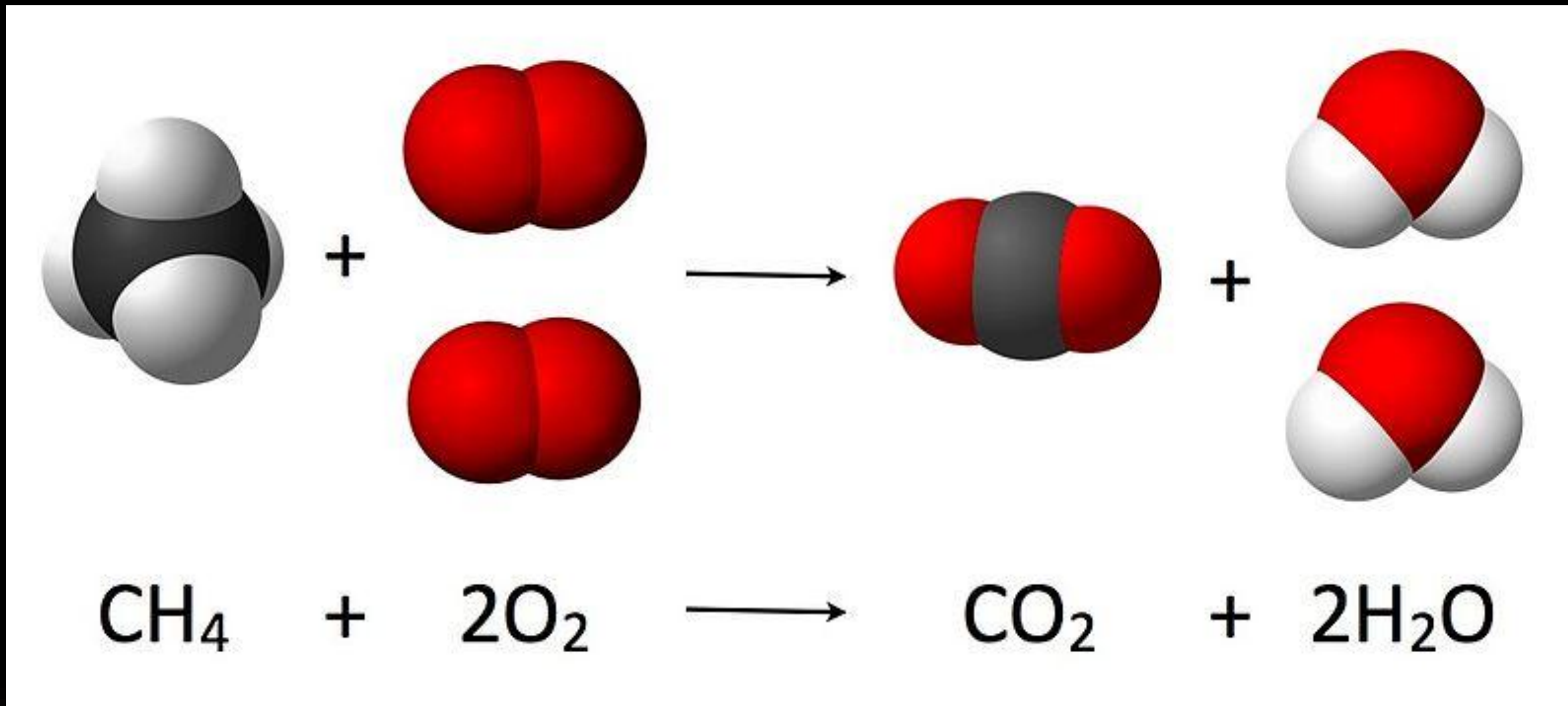
Equations

Chemical equations are used to graphically illustrate chemical reactions. They consist of chemical or structural formulas of the reactants on the left and those of the products on the right. They are separated by an arrow (⟶) which indicates the direction and type of the reaction; the arrow is read as the word "yields".[7] The tip of the arrow points in the direction in which the reaction proceeds. A double arrow (⇌) pointing in opposite directions is used for equilibrium reactions. Equations should be balanced according to the stoichiometry, the number of atoms of each species should be the same on both sides of the equation. This is achieved by scaling the number of involved molecules (A , B , C {\displaystyle {\ce {A, B, C}}} and D {\displaystyle {\ce {D}}} in a schematic example below) by the appropriate integers *a, b, c* and *d*.[8]

a A + b B ⟶ c C + d D {\displaystyle {\ce {{\mathit {a}}A{}+{\mathit {b}}B->{\mathit {c}}C{}+{\mathit {d}}D}}}



Nu⁻
X
Y
C
L
Z
slow
C+
fast
Nu
+
+ L


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

- More elaborate reactions are represented by reaction schemes, which in addition to starting materials and products show important intermediates or transition states. Also, some relatively minor additions to the reaction can be indicated above the reaction arrow; examples of such additions are water, heat, illumination, a catalyst, etc. Similarly, some minor products can be placed below the arrow, often with a minus sign.

- **Chemical equilibrium**
- Main article: Chemical equilibrium
- Most chemical reactions are reversible, that is they can and do run in both directions. The forward and reverse reactions are competing with each other and differ in reaction rates. These rates depend on the concentration and therefore change with time of the reaction: the reverse rate gradually increases and becomes equal to the rate of the forward reaction, establishing the so-called chemical equilibrium. The time to reach equilibrium depends on such parameters as temperature, pressure and the materials involved, and is determined by the minimum free energy. In equilibrium, the Gibbs free energy must be zero. The pressure dependence can be explained with the Le Chatelier's principle. For example, an increase in pressure due to decreasing volume causes the reaction to shift to the side with the fewer moles of gas.[13]
- The reaction yield stabilizes at equilibrium, but can be increased by removing the product from the reaction mixture or changed by increasing the temperature or pressure. A change in the concentrations of the reactants does not affect the equilibrium constant, but does affect the equilibrium position.