EQUILIBRIUM
HOMOGENEOUS EQUILIBRIA

❖ CHEMICAL EQUILIBRIUM

Equilibrium

Basically, the term refers to what we might call a “balance of forces”. In the case of mechanical equilibrium, this is its literal definition. A book sitting on a table top remains at rest because the downward force exerted by the earth’s gravity acting on the book’s mass is exactly balanced by the repulsive force between atoms that prevents two objects from simultaneously occupying the same space, acting in this case between the table surface and the book. If you pick up the book and raise it above the table top, the additional upward force exerted by your arm destroys the state of equilibrium as the book moves upward. If you wish to hold the book at rest above the table, you adjust the upward force to exactly balance the weight of the book, thus restoring equilibrium. An object is in a state of mechanical equilibrium when it is either static or in a state of unchanging motion. From the relation f=ma, it is apparent that if the net force on the object is zero, its acceleration must also be zero, so if we can see that an object is not undergoing a change in its motion, we know that it is in mechanical equilibrium.

Another kind of equilibrium we all experience is thermal equilibrium. When two objects are brought into contact, heat will flow from the warmer object to the cooler one until their temperatures become identical. Thermal equilibrium is a “balance of forces” in the sense that temperature is a measure of the tendency of an object to lose thermal energy. A metallic object at room temperature will feel cool to your hand when you first pick it up because the thermal sensors in your skin detect a flow of heat from your hand into the metal, but as the metal approaches the temperature of your hand, this sensation diminishes. The time it takes to achieve thermal equilibrium depends on how readily heat is conducted within and between the objects; thus a wooden object will feel warmer than a metallic object even if both are at room temperature because wood is a relatively poor thermal conductor.

- **Chemical equilibrium**

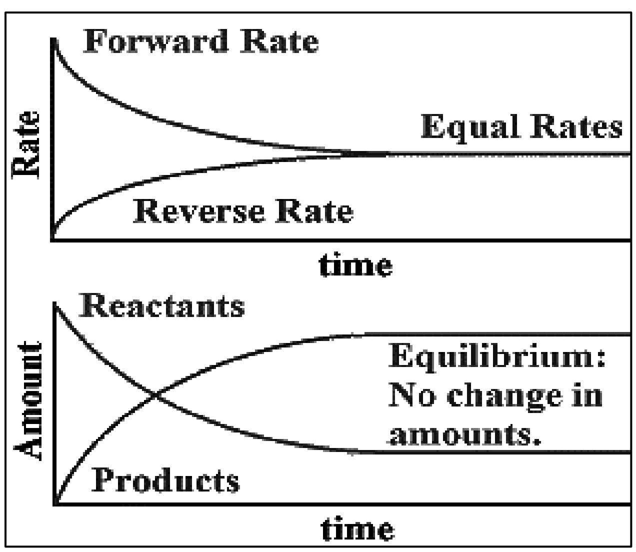
When a chemical reaction e.g., 2HI(g)H_2(g)+I_2(g) takes place in a closed container the quantities of components change as some are consumed and others are formed. Eventually this change will come to an end, after which the composition will remain unchanged as long as the system remains undisturbed. The system is then said to be in its equilibrium state, or more simply, "at equilibrium".

It makes no difference whether we start with two moles of HI or one mole each of H_2 and I_2; once the reaction has run to completion, the quantities of these two components will be the same. In general, then, we can say that the composition of a chemical reaction system will tend to change in a direction that brings it closer to its equilibrium composition.

- **Dynamic equilibrium characteristics:**

- The state at which concentrations of reactants or products do not change with time.
- It is attained when rate of forward reaction becomes equal to rate of backward reaction.
- A dynamic equilibrium, attained from either side.

CHEMICAL EQUILIBRIUM WITH GRAPH



Reversible reaction

A chemical equation of the form A → B represents the transformation of A into B, but it does not imply that all of the reactants will be converted into products, or that the reverse reaction B → A cannot also occur. In general, both processes can be expected to occur, resulting in an equilibrium mixture containing all of the components of the reaction system. If the equilibrium state is one in which significant quantities of both reactants and products are present then the reaction is said to incomplete or reversible. In principle, all chemical reactions are reversible, but this reversibility may not be observable if the fraction of products in the equilibrium mixture is very small, or if the reverse reaction is kinetically inhibited.

Irreversible reactions	**Reversible reactions**
1. Unidirectional	1. Both directional
2. Goes for completion	2. Never goes for completion
3. No equilibrium is attained	3. Attains equilibrium
4. A reaction is said to be irreversible	4. Otherwise, the reaction is

reversible e.g.,

when either of the product is settled $CaCO_{3(s)}\ \ CaO_{(s)} + CO_{2(g)}$

down as solid or escapes out as gas, e.g., (in closed container)

$$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 \downarrow + 2NaCl$$

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)} \uparrow$$

HOMOGENEOUS EQUILIBRIUM

The system in which all the reactant and product have same physical state.

$CH_3COOC_2H_5(aq) + H_2O\ (aq)\ \ CH_3COOH\ (aq) + C_2H_5OH\ (aq)$