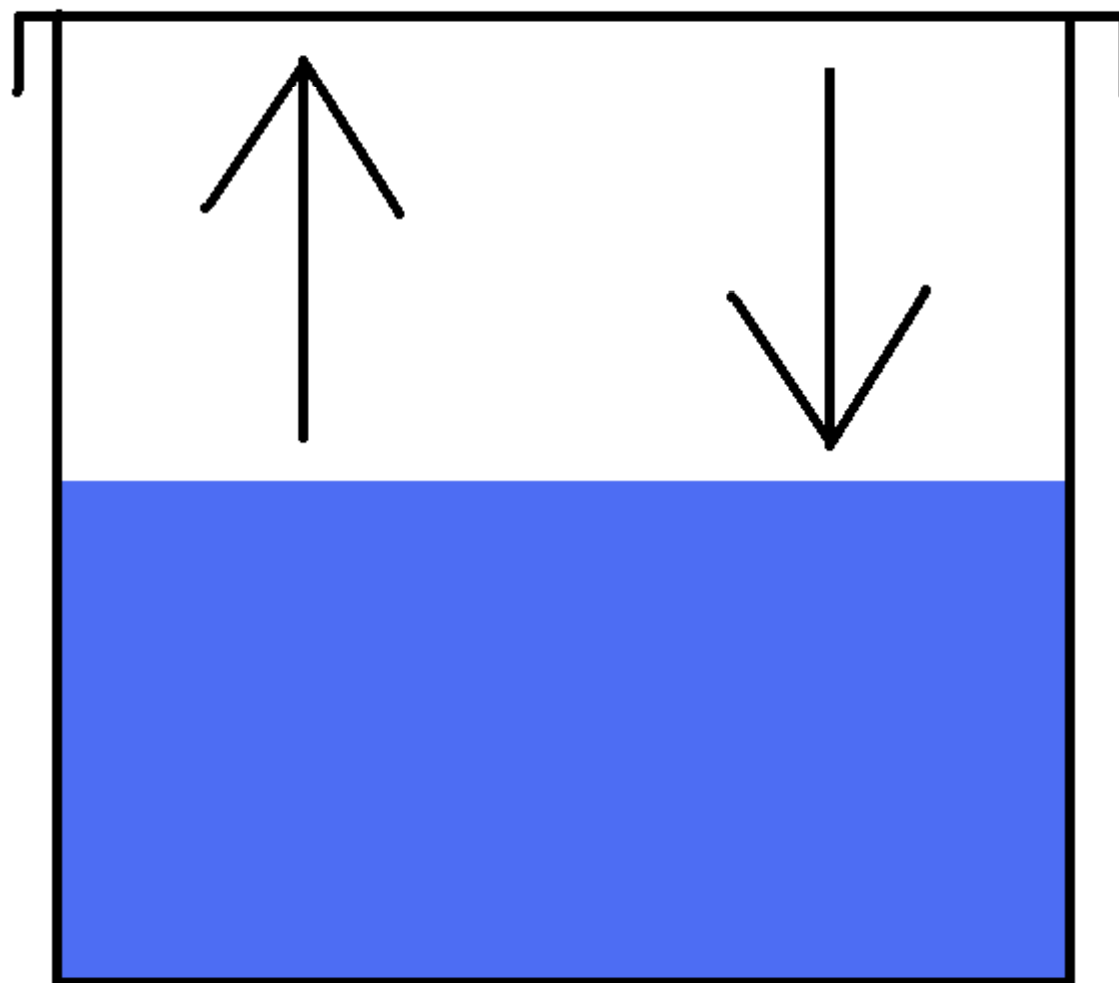


Introduction to Equilibrium



2011-05-09 SCH4U1 Dvorsky

- Equilibrium is a process in which two opposing processes occur at the same time and at the same rate such that there is no net change.
- The phenomena of equilibrium occurs in chemical systems
- Such systems are said to be **reversible**, which means that a process occurs in one direction but the reverse process can also occur at the same time and at the same rate.



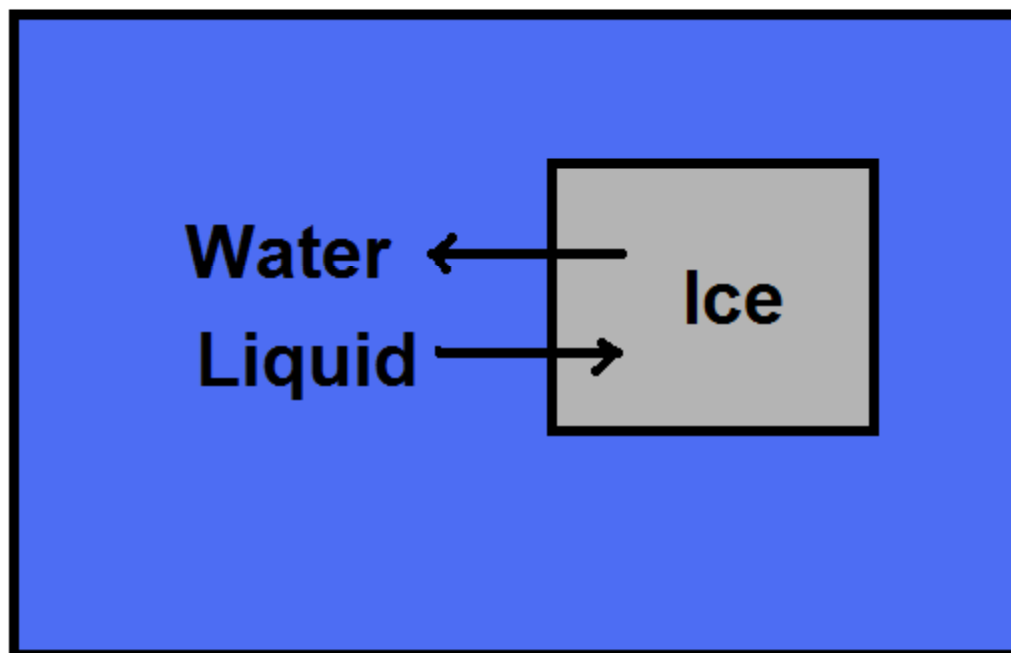
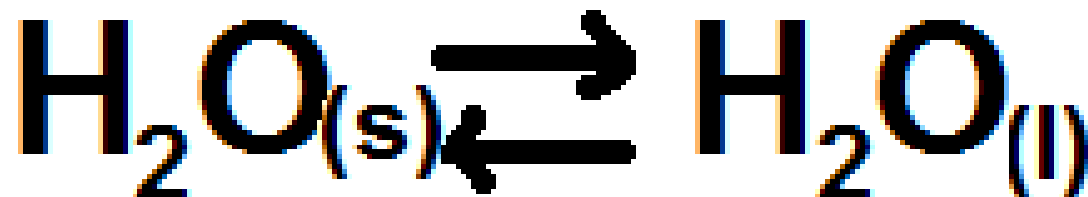
- Chemists utilize a double arrow symbol to designate systems at equilibrium. For example the equilibrium occurring in our beaker of water can be expressed as follows:



-it is important to remember that this equilibrium can only occur when the container is sealed. If it was not sealed, the water vapour would escape into the air and would not be available for the reverse reaction to occur.

- The melting of ice is also reversible. An equilibrium occurs in a beaker containing liquid water and crushed ice in a uniform slushy mixture in surroundings that are held at a constant temperature of 0 C.
- Under these conditions, liquid water is freezing at the same time and at the same rate as the ice is melting.

- The water never completely freezes and the ice never completely melts. The equilibrium can be expressed as follows



Third example:

The behaviour of a solute when given a choice of two solvents in which to dissolve.

The dissolving of a solute in a solvent is reversible. Imagine a water solution of iodine (I_2), and imagine introducing a water immiscible organic solvent, such as hexane into a container.

WTH? LOLZ immiscible - not forming a homogeneous mixture when added.

- After vigorous shaking the layers separate again and the hexane layer appears pink due to iodine being dissolved in it.
- It is actually an equilibrium system because the iodine is moving into the hexane at the same rate as it moving back into the water layer as expressed by the following:

Chemical Equilibrium

The two opposing processes in the definition of equilibrium may be chemical reactions.

Imagine placing two chemicals that react with each other A & B, into a reaction vessel.

Let us say that the products of the reaction are C and D and that the balancing coefficients are a, b, c, and d.



As the reaction proceeds, C and D begin to form, and their concentrations increase while the concentrations of A and B decrease.



Now let us say that C and D also react with each other and that A and B are the products.



This means that the reverse reaction occurs at the same time. After a period of time imagine that these two opposing chemical reactions occur not only at the same time but also at the same rate. When this happens, **chemical equilibrium** occurs.

Chemical equilibrium thus refers to two opposing chemical reactions occurring at the same time and at the same rate with no net change. Such a reaction is written with a double arrow:

As with the vapour pressure example, equilibrium will not occur if any of the chemicals, reactants, or products escape or are removed from the container.

Characteristics of a System at Equilibrium

1. The system is closed.
2. The forward reaction rate equals the reverse reaction rate.
3. The concentration of the reactants and products are constant.
4. The temperature and pressure remain constant.
5. The same equilibrium state can be reached by starting with reactants or products.