

Chem12 Acids-20

Brønsted - Lowry Theory

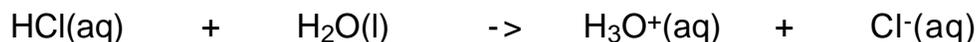
The **Arrhenius** definitions of acids and bases given earlier were found to be inadequate as they failed to explain several things, such as :

- NH_3 acts like a base when dissolved in water.
- H^+ ions are not found in an aqueous acidic solution.
- The nature of the solvent (usually water) is very important in determining the behavior of an acid.
- When a salt is added to water, the solution may be acidic, basic, or neutral.
- Some species are **amphiprotic**. These are substances that can act as a base or an acid. (e.g. water)

Brønsted and Lowry proposed a new definition of acids and bases that explained these discrepancies.

An **acid** is a proton (H^+) donor. A **base** is any species which is a proton acceptor.

Example : When HCl acid is added to water, it **was** believed that it produced H^+ ions. But it was later found that the HCl donated a proton to a water molecule forming a **hydronium** ion (H_3O^+) and a Cl^- ion. The equation is given below.

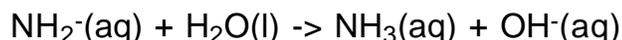


In the above example, according to Brønsted-Lowry theory, HCl is the acid and H_2O is the base. In this case, we don't have an equilibrium reaction. HCl is a very strong acid, so all of the HCl dissociates.

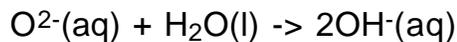


HCN is a weak acid. In this case, we have an equilibrium reaction. All of the HCN does not dissociate.

Example : $\text{KNH}_2(\text{s}) \rightarrow \text{K}^+(\text{aq}) + \text{NH}_2^-(\text{aq})$, K^+ is a spectator ion. That is, it does not contribute to the reaction.

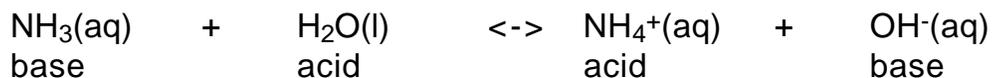


Example : $\text{Li}_2\text{O}(\text{s}) \rightarrow 2\text{Li}^+(\text{aq}) + \text{O}^{2-}(\text{aq})$, Li^+ is a spectator ion. So, we have :



In the above two examples, KNH_2 , and Li_2O are strong bases.

Example : When a base such as NH_3 (ammonia) is added to water we have the reaction :

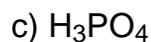
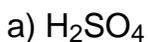


In this example NH_3 and NH_4^+ are called **conjugate acid-base pairs**.

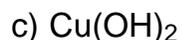
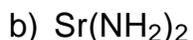
Also, there is an equilibrium because ammonia is a weak base.

Exercise 1) Give the Brønsted-Lowry definition of an acid and a base.

Exercise 2) Are the following strong or weak acids? Give the ionization equation. (See the acid strength table)

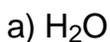


Exercise 3) Identify each of the following as a strong or weak base. (See previous notes on strong bases)



Exercise 4) Write the complete dissociation equation for the salt Potassium Carbonate. Show that it is a base. (Hint : K^+ is a spectator ion.)

Exercise 5) Give the conjugate acid for each of the following :



d) OH⁻

e) SO₄²⁻

f) CH₃OH

Exercise 6) Give the conjugate base for each of the following :

a) HF

b) H₃O⁺

c) NH₃

d) NH₄⁺

e) HPO₄²⁻

f) HSO₃⁻

Answers : 1) Acid - Proton donor, Base - Proton acceptor, 2)a) strong; H₂SO₄ -> H⁺ + HSO₄⁻, b) weak; HNO₂ <-> H⁺ + NO₂⁻, c) weak; H₃PO₄ <-> H⁺ + H₂PO₄⁻, 3)a) strong, b) strong, c) weak, 4) K₂CO₃ <-> 2K⁺ + CO₃²⁻; CO₃²⁻ + H₂O <-> HCO₃⁻ + OH⁻, 5)a) H₃O⁺, b) H₂CO₃, c) H₂PO₄⁻, d) H₂O, e) HSO₄⁻, f) CH₃OH₂⁺, 6) a) F⁻, b) H₂O, c) NH₂⁻, d) NH₃, e) PO₄³⁻, f) SO₃²⁻.