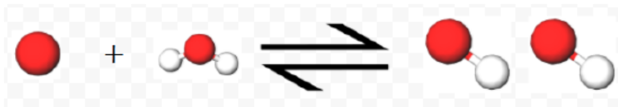
# 11.8: Bases

Bases have characteristics opposite those of acids, and bases can be neutralized by acids. Therefore it is logical, in the Brönsted-Lowry scheme, to define a *base* as a *proton acceptor*, that is, a species which can incorporate an extra proton into its molecular or ionic structure. For example, when barium oxide, BaO, dissolves in water, oxide ions accept protons from water molecules according to the equation

$$BaO + H_2O \rightarrow Ba^{2+} + 2OH^-$$

$$O^{2-} + H_2O \rightarrow OH^- + OH^-$$



The added proton transforms the oxide ion, into a hydroxide ion. Removal of a proton from a water molecule leaves behind a hydroxide ion also, accounting for the $OH^-$ on the right side of the equation. Since it can accept protons, barium oxide (or, more specifically, oxide ion) serves as a base. When a base is added to water, its molecules or ions accept protons from water molecules, producing hydroxide ions.

Thus the general properties of solutions of bases are due to the presence of hydroxide ions [$OH^-$(*aq*)]. Any aqueous solution which contains a concentration of hydroxide ions greater than the $1.00 \times 10^{-7}$ mol/L characteristic of pure water is said to be **basic**. Unlike the hydronium ion, which forms very few solid compounds, hydroxide ions are often present in solid crystal lattices (like NaOH, seen below). Therefore it is possible to raise the hydroxide-ion concentration above $1.00 \times 10^{-7}$ mol/L by dissolving compounds such as NaOH, KOH, or $Ba(OH)_2$.

Figure 11.8.1 NaOH, a strong base, is a solid crystal until dissolved in water.

Hydroxide ions can accept protons from water molecules, but of course such a proton transfer has no net effect because the hydroxide ion itself becomes a water molecule:

$$HOH + OH^- \rightarrow HO^- + HOH \tag{1}$$

Nevertheless, the hydroxide ion fits the Brönsted-Lowry definition of a base as a proton acceptor.

### Example 11.8.1 : Proton Transfer Equation

Write a balanced equation to describe the proton transfer which occurs when the base sodium hydride, NaH, is added to water.

**Solution** NaH consists of $Na^+$ and $H^-$ ions. Since positive ions repel protons, the $H^-$ ion is the only likely base. Again it may be useful to use two hypothetical steps: (l) donation of a proton by an $H_2O$ molecule, and (2) acceptance of a proton by the base. As in Example 11.6, we can then sum the steps

$HOH \rightarrow \cancel{H^+} + OH^-$ step 1 $H^- + \cancel{H^+} \rightarrow H_2$ step 2

$H^- + H_2O \rightarrow H_2 + OH^-$ overall

Note that adding a proton to $H^-$ balances the excess electron of that ion, producing a neutral $H_2$ molecule. Note also that charges balance in all equations.