

Homework #15-1: Problems pg. 669-670 #2, 4, 5, 6, 11, 15

2 Why must a Brønsted base have an atom containing a lone pair of electrons?

In order to bond with H^+ , there must be a pair of electrons available, which the base must provide.

4 Write the formulas of the conjugate bases of the following acids:

Recall that the conjugate base of a Brønsted acid is the species that remains when *one* proton has been removed from the acid.

- (a) HNO_2 : nitrite ion: NO_2^-
- (b) H_2SO_4 : hydrogen sulfate ion (formerly called bisulfate ion): HSO_4^-
- (c) H_2S : hydrogen sulfide ion (formerly called bisulfide ion): HS^-
- (d) HCN : cyanide ion: CN^-
- (e) $HCOOH$: formate ion: $HCOO^-$

5 Identify the conjugate acid-base pairs in each of the following reactions:

In general the components of the conjugate acid–base pair are on opposite sides of the reaction arrow. The base always has one fewer proton than the acid.

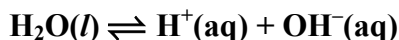
- (a) $CH_3COO^- + HCN \rightleftharpoons CH_3COOH + CN^-$
The conjugate acid–base pairs are (1) HCN (acid) and CN^- (base) and (2) CH_3COO^- (base) and CH_3COOH (acid).
- (b) $HCO_3^- + HCO_3^- \rightleftharpoons H_2CO_3 + CO_3^{2-}$
(1) HCO_3^- (acid) and CO_3^{2-} (base) and (2) HCO_3^- (base) and H_2CO_3 (acid).
- (c) $H_2PO_4^- + NH_3 \rightleftharpoons HPO_4^{2-} + NH_4^+$
(1) $H_2PO_4^-$ (acid) and HPO_4^{2-} (base) and (2) NH_3 (base) and NH_4^+ (acid).
- (d) $HClO + CH_3NH_2 \rightleftharpoons CH_3NH_3^+ + ClO^-$
(1) $HClO$ (acid) and ClO^- (base) and (2) CH_3NH_2 (base) and $CH_3NH_3^+$ (acid).
- (e) $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$
(1) H_2O (acid) and OH^- (base) and (2) CO_3^{2-} (base) and HCO_3^- (acid).

6 Write the formula for the conjugate acid of each of the following bases:

The conjugate acid of any base is just the base with a proton added.

- (a) HS^- : H_2S (b) HCO_3^- : H_2CO_3 (c) CO_3^{2-} : HCO_3^- (d) $H_2PO_4^-$: H_3PO_4
- (e) HPO_4^{2-} : $H_2PO_4^-$ (f) PO_4^{3-} : HPO_4^{2-} (g) HSO_4^- : H_2SO_4 (h) SO_4^{2-} : HSO_4^-
- (i) SO_3^{2-} : HSO_3^-

11 The ion-product constant for water is 1.0×10^{-14} at $25^\circ C$ and 3.8×10^{-14} at $40^\circ C$. Is the forward reaction process,



endothermic or exothermic?

Since K_w increases when T increases, this means that more products are formed, favoring the forward reaction. Since increased temperature always favors the endothermic process, the ionization of water must be endothermic, which is consistent with energy being required to break the O–H bond.

15 Calculate the concentration of OH^- in a $1.4 \times 10^{-3} M$ HCl solution,

$$[H^+] = 1.4 \times 10^{-3} M$$

$$[OH^-] = \frac{K_w}{[H^+]} = \frac{1.0 \times 10^{-14}}{1.4 \times 10^{-3}} = 7.1 \times 10^{-12} M$$