Ch. 15.3–15.5: pH; Strength of Acids and Bases; Begin Weak Acid Ionization Constants
Homework 15-2: Problems pg. 670-671 #13, 14, 18, 20, 25, 26, 29, 31, 33, 34, 35, 37

13 **The pH of a solution is 6.7. By this statement alone, can one conclude that the solution is acidic?**
Since the pH is 6.7, the solution is definitely acidic.
The pH can be zero. Example: if $[H^+] = 1$ M, then pH = 0
The pH can be negative. Example: If $[H^+] = 2$ M, then pH = –0.30

14 **Define pOH and write an equation relating pH and pOH.**
$pOH = -\log [OH^-]$ $pH + pOH = 14$

18 **Calculate the pH of the following solutions:**
(a) 2.8×10^{-4} *M* $Ba(OH)_2$:
$Ba(OH)_2$ is ionic and fully ionized in water. $\mathbf{Ba(OH)_2} \rightarrow Ba^{2+}\ (aq) + 2\ OH^-\ (aq)$
$[OH^-] = 2\ (\mathbf{2.8 \times 10^{-4}}\ \boldsymbol{M}) = 5.6 \times 10^{-4}\ M$

$$[H^+] = \frac{K_w}{[OH^-]} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-4}} = 1.8 \times 10^{-11}\ M$$

$$\mathbf{pH} = -\log[H^+] = -\log(1.8 \times 10^{-11}) = \mathbf{10.74}$$

(b) 5.2×10^{-4} *M* HNO_3:
Nitric acid is a strong acid, so 100 % ionized. Thus, $[H^+] = 5.2 \times 10^{-4}\ M$.

$$\mathbf{pH} = -\log[H^+] = -\log(5.2 \times 10^{-4}) = \mathbf{3.28}$$

20 **Calculate the $[H^+]$ for these solutions:**
(a) A solution whose pH= 5.20
$pH = -\log [H^+] = 5.20$; $\mathbf{[H^+]} = 10^{-pH} = 10^{-5.20} = \mathbf{6.3 \times 10^{-6}}\ \boldsymbol{M}$

(b) A solution whose pH = 16.00
$pH = -\log [H^+] = 16.00$; $\mathbf{[H^+]} = 10^{-pH} = 10^{-16.00} = \mathbf{1.0 \times 10^{-16}}\ \boldsymbol{M}$

(b) A solution whose OH^- concentration is 3.7×10^{-9} M

$$K_w = 1.0 \times 10^{-14} = [H^+][OH^-];\ \mathbf{[H^+]} = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{3.7 \times 10^{-9}} = \mathbf{2.7 \times 10^{-6}}\ \boldsymbol{M}$$

25 **How much NaOH (in grams) is needed to prepare 546 mL of solution with a pH of 10.00?**

$pOH = 14.00 - pH = 14.00 - 10.00 = 4.00$; $[OH^-] = 10^{-pOH} = 1.0 \times 10^{-4}\ M$

$[NaOH] = 1.0 \times 10^{-4}$ mol/L = $[OH^-]$ because 100% ionized, so we need to prepare 546 mL of 1.0×10^{-4} *M* NaOH.

$$\mathbf{?\ g\ NaOH} = 546\ \text{mL} \times \frac{1.0 \times 10^{-4}\ \text{mol NaOH}}{1000\ \text{mL soln}} \times \frac{40.00\ \text{g NaOH}}{1\ \text{mol NaOH}} = \mathbf{2.2 \times 10^{-3}\ g\ NaOH}$$

26 A solution is made by dissolving 18.4g of HCl in 662 mL of water. Calculate the pH of solution.

Molarity of the HCl solution is: $\dfrac{18.4 \text{ g HCl} \times \dfrac{1 \text{ mol HCl}}{36.46 \text{ g HCl}}}{662 \times 10^{-3} \text{ L}} = 0.762\ M$

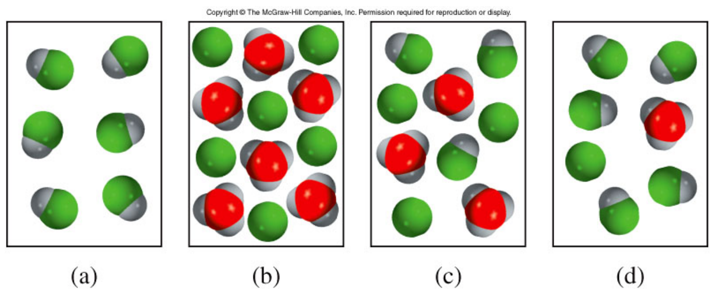
Since HCl is a very strong acid, [HCl] = [H^+], and **pH** = −log(0.762) = **0.118**

29 What are the strongest acid and strongest base that can exist in water?

The strongest acid that can exist in water is hydronium (H_3O^+)

The strongest base that can exist in water is hydroxide (OH^-)

31



Which diagram represents a strong acid? choice **(b)**. A strong acid, such as HCl, will be completely ionized,

Which diagram represents a weak acid? choice **(c)**. A weak acid will only ionize to a lesser extent compared to a strong acid.

Which diagram represents a very weak acid? Choice **(d)** is the best choice. A very weak acid will remain almost exclusively as the acid molecule in solution.

33 **(a)** HNO_3: strong acid,
(b) HF: weak acid,
(c) H_2SO_4 strong acid (first stage of ionization),
(d) HSO_4^-: weak acid,
(e) H_2CO_3: weak acid,
(f) HCO_3^-: weak acid,
(g) HCl: strong acid,
(h) HCN: weak acid,
(i) HNO_2: weak acid.

34 **(a)** LiOH: strong base
(b) CN^-: weak base
(c) H_2O: weak base
(d) ClO_4^-: weak base
(e) NH_2^-: strong base

35 **Have a 0.10M solution of the weak acid HA:** $HA \rightleftharpoons H^+ + A^-$

The maximum possible concentration of hydrogen ion in a 0.10 *M* solution of HA is 0.10 *M*. This is the case if HA is a strong acid. If HA is a weak acid, the hydrogen ion concentration is less than 0.10 *M*. The pH corresponding to 0.10 *M* $[H^+]$ is 1.00. (Why three digits?) For a smaller $[H^+]$ the pH is larger than 1.00 (why?).

(a) The pH = 1.00 False, the pH is greater than 1.00 ($[H^+] < 0.10$ *M*)
(b) $[H^+] >> [A^-]$ False, $[H^+] = [A^-]$
(c) $[H^+] = [A^-]$ True (see b)
(d) The pH is less than 1. False (see a)

37 **$F^-(aq) + H_2O(l) \rightleftharpoons HF(aq) + OH^-(aq)$ Predict the direction that predominates.**

Base acid conj acid conj base

The direction should favor formation of $F^-(aq)$ and $H_2O(l)$. Hydroxide ion is a stronger base than fluoride ion, and hydrofluoric acid is a stronger acid than water.