Warm-up 4/24

1. Black coffee has a pH of 5 and toothpaste has a pH of 8. Identify which is more acidic **and** deduce how many times the $[H^+]$ is greater in the more acidic product. (2)

2. A student has equal volumes of 1.0 mol dm^{-3} sodium hydroxide and ammonia solutions.
Which statement about the solutions is correct?

A. Sodium hydroxide has a lower electrical conductivity than ammonia.

B. Sodium hydroxide has a higher hydrogen ion concentration than ammonia.

C. Sodium hydroxide has a higher pH than ammonia.

D. Sodium hydroxide has a higher hydroxide ion concentration than ammonia.

18.1 Lewis Acids and Bases

- Definitions?
  - Lewis Acid = lone pair acceptor
  - Lewis Base = lone pair donor

  - Use curly arrows to show Lewis Acid/Base Reaction between Ammonia and Boron trifluoride.
    - Type of bonding?

Other applications of Lewis Acids and Bases

- Formation of complex ions.
  - EX: $Co^{2+} + 6\ H_2O$
  - Nucleophiles in SN reactions = Lewis _______________
  - Electrophiles (addition reactions) = Lewis ______________

18.2 CALCULATIONS INVOLVING ACIDS AND BASES

Write the equilibrium equation for the dissociation of water:

$H_2O_{(l)} \longleftrightarrow H^+_{(aq)} + OH^-_{(aq)}$ $\Delta H = +\ 57$ kJ/mol

$K_c = ?$

K_w = dissociation constant of this equation

At 298K: [OH-] = [H+] = 1.00×10^{-7} units?

$K_w = (1.00 \times 10^{-7}) \times (1.00 \times 10^{-7}) =$ **1.00×10^{-14}**

Pause for…Some key relationships

- $pH = -\log [H^+]$ — $[H^+] = 10^{-pH}$
- $pOH = -\log [OH^-]$ — $[OH^-] = 10^{-pOH}$
- $pK_w = -\log K_w$ — $K_w = 10^{-pKw}$
- $pK_a = -\log K_a$ — $K_a = 10^{-pKa}$
- $pK_b = -\log K_b$ — $K_b = 10^{-pKb}$
- **@ 298K:** $[H^+] \times [OH^-] = 10^{-14}$

  $pH + pOH = pK_w = 14$

What happens as temperature increases?

- Higher temperature = shifts to right
- More H+
- Lower pH

Ex: 50°C

$[H+] = [OH-] = 3.05 \times 10^{-7}$

Decrease in temperature?

$$H_2O_{(l)} \longleftrightarrow H^+_{(aq)} + OH^-_{(aq)} \quad \Delta H = +57 \text{ kJ/mol}$$

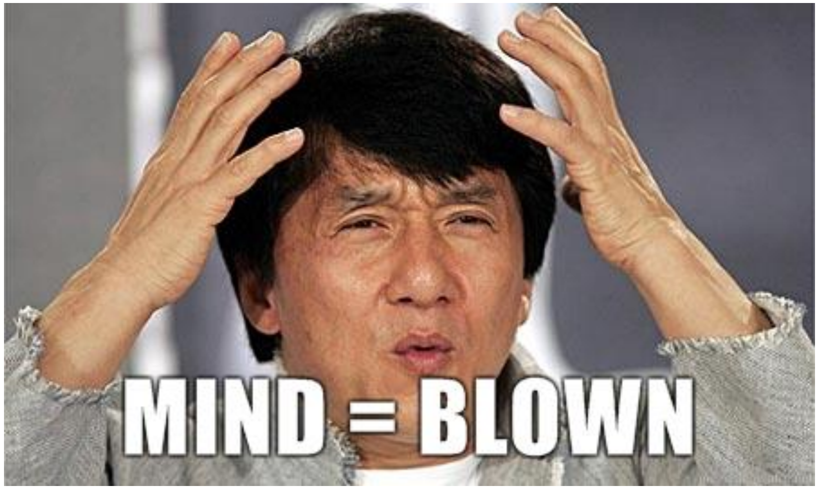
Pure water at 50^oc

pH of 7 is neutral for a pure water solution only at 25^oC!

- 50^oC [H+] = [OH-] = 3.05×10^{-7}
- pH = ?
- 6.5
- But this is pure water….What is this telling us about acidity basicity?

Neutral solutions?

- [H+] = [OH-]
- Acidic: [H+] > [OH-]
- Basic: [H+] < [OH-]



Sample Problem #1

- $K_w = 5.48 \times 10^{-14}\ M^2$ @ 50^oC

Find:

[H+]

[OH-]

pH

pOH

Sample Problem #2

- At 298K: [H+] = 0.001M

Find:

- pH
- pOH
- [OH-]

Book Problems-To Be Turned in

- Pg. 410-412

7, 11

Grey Textbook problems

Warm-up 4/26

- Determine the pH of the solution resulting when 100 cm^3 of 0.50 mol dm^{-3} $HCl(aq)$ is mixed with 200 cm^3 of 0.10 mol dm^{-3} $NaOH(aq)$. **(5 pts)**

- $n(HCl) = (0.100 \times 0.50) = 0.050$ (mol);
  $n(NaOH) = (0.200 \times 0.10) = 0.020$ (mol);
  $n(HCl)_{remaining} = (0.050 - 0.020) = 0.030$ (mol);
  $[HCl] = \; = 0.10$ (mol dm^{-3});
  pH = 1.0;   5
  *Award **[2 max]** for just pH = 1.0 without working.*

HW Problems

- Energy Quiz Revisions (for both)
  - UNdroppable UNLESS you complete revisions/talk with me about understanding the material

Important Note

- Value of K_w at different temperatures are given in Data booklet (Table 23).

18.1.4 Weak Acids and Bases

- State an equation of any weak acid or base in water.

<u>Weak Acid:</u>

$$HA_{(aq)} \rightleftharpoons H^{+}(aq) + A^{-}(aq)$$

$K_a = [H+][A-]/[HA]$

How does K_a relate to strength?

Ethanoic Acid

- Write the equation and K_a expression for ethanoic acid in an aqueous solution.

- Ka = 1.74×10^{-5} mol dm^{-3}
  - Does K_a change with temperature?
- $pK_a = -\log K_a$
  - 4.76

- Similar relationship as pH and concentration.
- Larger Ka = stronger acid
- Smaller pKa = stronger acid

Weak Bases

- Always need to show with water in the equation (but not Kc expression)
- $B + H_2O \rightleftharpoons BH^+ + OH^-$

- Write the K_b expression

- Write the equation for NH_3 in water.

- Write the K_b expression for this reaction.
- Strong bases = large K_b, small pK_b

18.1.5-solving problems

- $K_a \times K_b = K_w$ ***Works for conjugate acid/base pairs**

- Why? Derivation
- **Write out K_a and K_b expressions for the dissociations of generic weak acid (HA) and weak base (A^-)**

- Remember pKa + pKb = pKw = 14 @ 298K

Sample Problem

- Calculate the base dissociation constant K_b at 298 K for a 0.00100 M solution of the base 1-phenylmethanamine. The pH of the solution is 10.17.
  - Also: Draw the molecular structure of this base

Sample Problem

- The K_a for the acid HX is 0.01. Find K_b for the conjugate base, X^- (@298K).

Sample Problem

- What is the value of pK_b for:

- $CH_3COO^- + H_2O \longleftrightarrow CH_3COOH + OH^-$

Sample Problem

- Ammonia $pK_b = 4.75$
- Methylamine $pK_b = 3.34$

- Which conjugate acid of the above base is the strongest?
- Show its dissociation in water and give a value for pKa.

Determining relative strengths

- 1) Complete the following table 2)Rank these 1 M acids, weakest 1st

	pKa	Ka	pH	[H+]
HA	4			
HB		10^{-6}		
HC			4	
HD				10^{-5}

Rank these bases, weakest first

	pKb	Kb
methylamine	3.34	
dimethylamine	3.27	
Trimethylamine	4.20	

- Explain this trend, discussing relative dissociation of these bases

Bookwork – alternative text

- All of them are highly recommended.
- 8-10 if nothing else!