Warm-up 4/18

1. Define the terms *acid* and *base* according to the Brønsted-Lowry theory. Distinguish between a weak base and a strong base. State **one** example of a weak base.**(3)**

2. Weak acids in the environment may cause damage. Identify a weak acid in the environment **and** outline **one** of its effects. **(2)**

Acids on the Environment

- (ii) sulfurous acid/H_2SO_3;
  corrodes marble/limestone buildings/statues / leaching in soils / harms/kills plants;

  OR

  nitrous acid/HNO_2;

corrodes marble/limestone buildings/statues / leaching in soils / harms/kills plants;

- **OR**
- carbonic acid/H_2CO_3;
  corrodes marble/limestone buildings/statues / acidification of lakes;2
- *Do not allow oxides (e.g. CO_2 etc.).*
  Do not accept just corrodes or damages.

Additional Practice Problem

- Explain, using an equation, whether a solution of 0.10 mol dm^{-3} $FeCl_3(aq)$ would be acidic, alkaline or neutral.

- acidic;
  $[Fe(H_2O)_6]^{3+}$ $[Fe(H_2O)_5(OH)]^{2+} + H^+$ /
  $[Fe(H_2O)_6]^{3+} + H_2O$ $[Fe(H_2O)_5(OH)]^{2+} + H_3O^+$; 2
  Accept equations indicating the formation of
  $[Fe(H_2O)_4(OH)_2]^+$
  $[Fe(H_2O)_3(OH)_3]$
  $[Fe(H_2O)_2(OH)_4]^-$
  Do not penalize →.

18.1 CALCULATIONS INVOLVING ACIDS AND BASES

Write the equilibrium equation for the dissociation of water:

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

K_c = ?

K_w = dissociation constant of this equation

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

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

What happens as temperature increases?

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

Ex: $50^{o}C$ $[H+] = [OH-] = 3.05 \times 10^{-7}$

Decrease in temperature?

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

Pause for…Some key relationships

- $pH = -\log [H^+]$ $\quad [H^+] = 10^{-pH}$
- $pOH = -\log [OH^-]$ $\quad [OH^-] = 10^{-pOH}$
- $pK_w = -\log K_w$ $\quad K_w = 10^{-Kw}$
- $pK_a = -\log K_a$ $\quad K_a = 10^{-Ka}$
- $pK_b = -\log K_b$ $\quad K_b = 10^{-Kb}$
- @ **STP:** $[H^+] \times [OH^-] = 10^{-14}$

  $pH + pOH = pK_w = 14$

Pure water at 50ºC

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

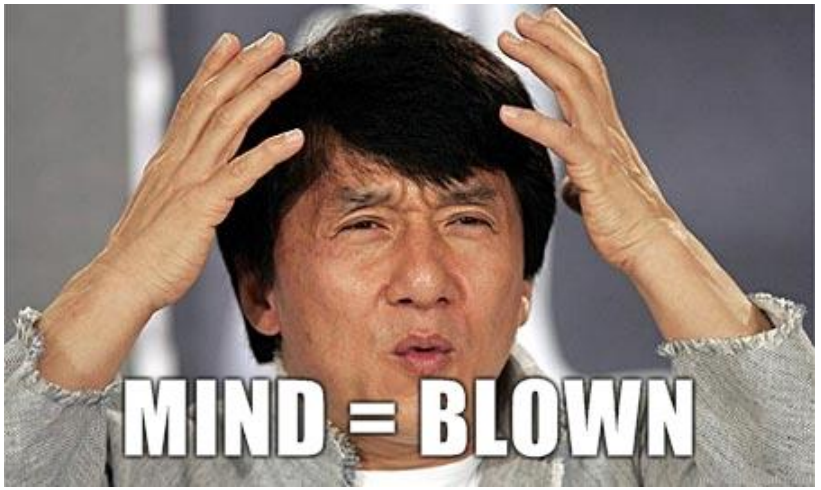
- 50ºC [H+] = [OH-] = 3.05×10^{-7}

- 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

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

Find:

[H+]

[OH-]

pH

pOH

Sample Problem #2

- At STP: [H+] = 0.001M

Find:

- pH
- pOH
- [OH-]

Homework – Grey Textbook!

- Pg. 711

16.30, 16.33, 16.39, 16.41

Warm-up 4/23

- 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).

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 Ka expression for ethanoic acid in an aqueous solution.

- $K_a = 1.74 \times 10^{-5}$ mol dm^{-3}
  - Does Ka 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
- $B + H_2O \rightleftharpoons BH^+ + OH^-$
- Write the K_b expression
- Write the equation for NH_3 in water.
- Write the Kb expression for this reaction.
- Strong bases = large K_b, small pK_b

Sample Problem

- Give the K_b expression for phenylamine.

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 @ STP

Sample Problem

- The Ka for the acid HX is 0.01. Find Kb for the conjugate base, X^- (@STP).

Sample Problem

- What is the value of pKb for:

- CH_3COO^- + H_2O ←→ CH_3COOH + OH^-

Sample Problem

- Ammonia pKb = 4.75
- Methylamine pKb = 3.34

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

18.1.5 determining relative strengths

- 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

- #1, 3, 4, 5, 6, 7, 10

- Be ready for a quiz on Monday!
- All of topic 8 and 18.1