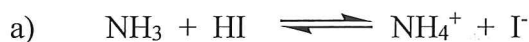


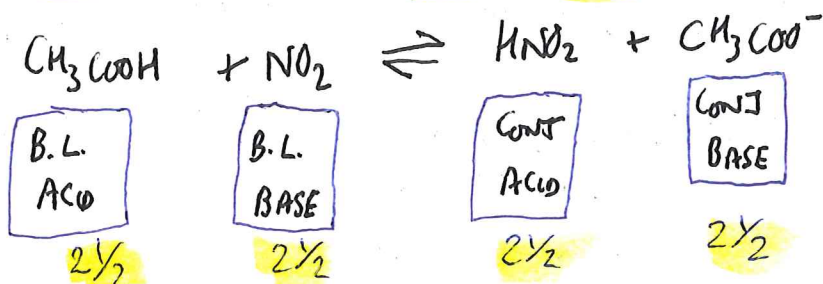
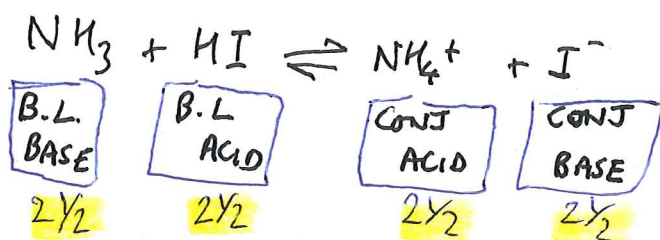
Chemical Principles Coursework

Please submit via Blackboard with answers for Monday 27th March 2017 to the questions provided. Please provide all workings for required questions and include units where appropriate.

1. Identify each reactant and product in the following reactions as acid, base or neither. Arrange the species in each reaction as conjugate acid/base pairs.



(20 marks)



2. Classify the following samples from most acidic to most basic.

Acidic

Basic

B, F, C, D, G, A, E

① for each in order

- a) Blood (pH 7.4)
 b) A 1 M solution of hydrochloric acid 0
 c) Tomatoes (pH 4.5)
 d) Milk (pH 6.5)
 e) A solution of sodium hydroxide at $0.100 \text{ mol.dm}^{-3}$ 13
 f) A solution B that has $[\text{H}_3\text{O}^+] = 8.2 \times 10^{-2} \text{ mol.dm}^{-3}$ = 1.08
 g) A neutral solution of water = 7

(20 marks)

2b) $\text{pH} = -\log_{10} [\text{H}^+(\text{aq})] \Rightarrow \text{pH} = -\log_{10} [1.0] \Rightarrow \text{pH} = 0$

e) $[\text{NaOH}] = 0.1 \text{ mol.dm}^{-3}$ $\therefore [\text{H}^+(\text{aq})] = \frac{k_w}{[\text{OH}^-]} = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{0.1 \text{ mol.dm}^{-3}}$
 $\therefore [\text{OH}^-(\text{aq})] = 0.1 \text{ mol.dm}^{-3}$ $\therefore [\text{H}^+(\text{aq})] = 10^{-13} \text{ mol.dm}^{-3}$

$\therefore \text{pH} = -\log [10^{-13}] = 13$

f) $[\text{H}^+(\text{aq})] = 8.2 \times 10^{-2} \text{ mol.dm}^{-3}$ $\therefore \text{pH} = -\log [8.2 \times 10^{-2}] = 1.08$

g) $\text{pH} = 7$

3. Complete the following table:

[H ₃ O ⁺] mol.dm ⁻³	3.6 x 10 ⁻³	2.77 x 10 ⁻¹²	3.98 x 10 ⁻¹¹	1.54 x 10 ⁻¹⁰	10 ⁻⁷
[OH ⁻] mol.dm ⁻³	2.77 x 10 ⁻¹²	3.6 x 10 ⁻³	2.51 x 10 ⁻⁴	6.3 x 10 ⁻⁵	10 ⁻⁷
pH	11.55 2.44	11.55	10.4	9.81	7.0

(20 marks)

Handwritten calculations for the table completion:

- For [H₃O⁺] = 3.6 x 10⁻³:

$$[OH^-] = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{3.6 \times 10^{-3} \text{ mol dm}^{-3}} = 2.77 \times 10^{-12} \text{ mol dm}^{-3}$$

$$pH = \frac{11.55}{2.44}$$

$$[H^+] = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{3.6 \times 10^{-3} \text{ mol dm}^{-3}}$$

$$[H^+] = 2.77 \times 10^{-12} \text{ mol dm}^{-3}$$

$$pH = 11.55$$
- For [H₃O⁺] = 2.77 x 10⁻¹²:

$$[H^+] = 10^{-pH} = 10^{-10.4} = 3.98 \times 10^{-11} \text{ mol dm}^{-3}$$

$$[OH^-] = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{3.98 \times 10^{-11} \text{ mol dm}^{-3}} = 2.51 \times 10^{-4} \text{ mol dm}^{-3}$$

$$pH = 10.4$$
- For [H₃O⁺] = 3.98 x 10⁻¹¹:

$$[H^+] = 10^{-pH} = 10^{-9.81} = 1.54 \times 10^{-10} \text{ mol dm}^{-3}$$

$$[OH^-] = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{1.54 \times 10^{-10} \text{ mol dm}^{-3}} = 6.3 \times 10^{-5} \text{ mol dm}^{-3}$$

$$pH = 9.81$$
- For [H₃O⁺] = 1.54 x 10⁻¹⁰:

$$[H^+] = 10^{-pH} = 10^{-7} = 10^{-7} \text{ mol dm}^{-3}$$

$$[OH^-] = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{10^{-7} \text{ mol dm}^{-3}} = 10^{-7} \text{ mol dm}^{-3}$$

$$pH = 7.0$$

4. Consider an aqueous solution of sodium hydroxide NaOH. What is the concentration [NaOH] in mol.dm⁻³ if the pH of the solution is 8.6?

(20 marks)

Handwritten solution for Question 4:

Step 1: Find [H⁺]
 $pH = -\log_{10} [H^+(aq)]$ so $[H^+(aq)] = 10^{-pH} = 10^{-8.6} = 2.51 \times 10^{-9} \text{ mol dm}^{-3}$

Step 2: Find [OH⁻] using K_w
 $[OH^-(aq)] = \frac{K_w}{[H^+(aq)]} = \frac{10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{2.51 \times 10^{-9} \text{ mol dm}^{-3}} = 3.98 \times 10^{-6} \text{ mol dm}^{-3}$

Step 3: Consider stoichiometry
 $NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$
 $\therefore [NaOH] = 3.98 \times 10^{-6} \text{ mol dm}^{-3}$

ANS = 3.98 x 10⁻⁶ mol dm⁻³

Calculate the pH of a solution of acetic acid where [CH₃COOH] = 0.05 mol.dm⁻³. (pK_a CH₃COOH/CH₃COO⁻ = 4.74)

(20 marks)

Handwritten solution for Question 5:

Step 1: write equation for dissociation and K_a
 $CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$

Step 2: from pK_a, find K_a
 $K_a = 10^{-pK_a} = 10^{-4.74} = 1.81 \times 10^{-5}$

Step 3: re-arrange step 1 K_a to find [H⁺]
 $\sqrt{K_a \times [CH_3COOH]} = [H^+]$
 $\sqrt{(1.81 \times 10^{-5}) \times 0.05} = [H^+] = 9.54 \times 10^{-4}$
 $pH = -\log [9.54 \times 10^{-4}] = 3.02$

ANS = 3.02