Year 12 Chemistry Mini-Assignment Term 1 Week 6

[31 marks]

Name: SOLUTIONS

Question 1

(1 mark)

HSO_4^- (aq) + H_2O(l) <===> H_3O^+ (aq) + SO_4^{2-} (aq)

In the equilibrium represented above, the species that act as bases include which of the following?

I. HSO_4^-
II. H_2O
III. SO_4^{2-}

(A) II only

(B) III only

(C) I and II

(D) I and III

(E) II and III

Question 2

(1 mark)

Which of the following is NOT a conjugate acid/base pair?

(A) H_3PO_4/HPO_4^{2-}
(B) H_2SO_4/HSO_4^-
(C) H_2CO_3/HCO_3^-
(D) NH_3/NH_2^-

Question 3

(1 mark)

The Brønsted–Lowry theory applies in both aqueous and non-aqueous systems.

The following reactions may take place in solvents other than water.

Which is NOT a Brønsted–Lowry reaction?

(A) $NH_4^+ + NH_2^- \rightleftharpoons 2NH_3$
(B) $CO_2 + OH^- \rightleftharpoons HCO_3^-$
(C) $HClO_4 + CH_3COOH \rightleftharpoons CH_3COOH_2^+ + ClO_4^-$
(D) $CH_3CH_2O^- + CH_3NH_3^+ \rightleftharpoons CH_3CH_2OH + CH_3NH_2$

Question 4

Define each of the following giving a *real* chemical equation to illustrate your definition.

(a) An Arrhenius base.

(2 marks)

A substance that produces OH^- in solution

$NaOH(s) \longrightarrow Na^+(aq) + OH^-(aq)$

(b) A Brønsted-Lowry base.

(2 marks)

A substance that accepts hydrogen ions

$NH_3(aq) + H^+(aq) \rightleftharpoons NH_4^+(aq)$

Brønsted-Lowry Base

Question 5

(a) Is acetic acid a non-electrolyte, a weak electrolyte or a strong electrolyte? Why?

(2 marks)

A weak electrolyte because it only partially ionises in solution

$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$

TWO ARROWS

(b) Is water a non-electrolyte, a weak electrolyte or a strong electrolyte? Why?

(2 marks)

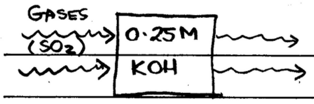
A weak electrolyte because it partially ionises

$2H_2O(l) \rightleftharpoons OH^-(aq) + H^+(aq)$

Question 6

It is suggested that SO_2 which contributes to acid rain, could be removed from a stream of waste gases by bubbling the gases through 0.25 M KOH, thereby producing K_2SO_3. Calculate the maximum mass of SO_2 that could be removed by 1000 L of the KOH solution?

(5 marks)



V = 1000 L

$n(KOH) = C \times V$
$= 0.25 \times 1000 = 250$ moles.

$SO_2(g) + H_2O(l) \longrightarrow H_2SO_3(aq)$
$H_2SO_3(aq) + 2KOH(aq) \longrightarrow 2H_2O(l) + K_2SO_3(aq)$
$\therefore SO_2(g) + 2KOH(aq) \longrightarrow K_2SO_3(aq) + H_2O(l)$

$n(SO_2) = \frac{n(KOH)}{2} = \frac{250}{2} = 125$ moles

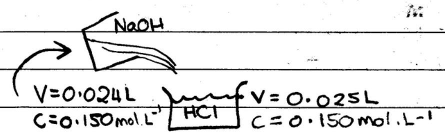
$m(SO_2) = n(SO_2) \times M(SO_2)$
$= 125 \times (32.06 + [2 \times 16.00])$
$= 8007.5$ g
$\therefore$ 8.00 kg

Question 7

24·0 mL of 0·150 mol L^{-1} NaOH is added to 25·0 mL of 0·150 mol L^{-1} HCl.

Calculate the pH of the final solution.

(7 marks)



$n(NaOH) = c \times V = 0.150 \times 0.024 = 3.6 \times 10^{-3}$ (1)
$n(HCl) = c \times V = 0.150 \times 0.025 = 3.75 \times 10^{-3}$ (1)

$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$
mole's reaction: 3.6×10^{-3} moles 3.6×10^{-3} moles (1)

But we have 3.75×10^{-3} moles HCl (1)
$\therefore$ HCl = ER

$n(HCl\ remaining) = 3.75 \times 10^{-3} - 3.6 \times 10^{-3}$
$= 1.50 \times 10^{-4}$ moles (1)

$c(HCl\ remaining) = \frac{n}{V} = \frac{1.50 \times 10^{-4}}{(0.024 + 0.025)}$ (1)
$= 3.061 \times 10^{-3}$ mol.L^{-1}
$= c(H^+)$

$pH = -\log[H^+] = -\log(3.061 \times 10^{-3})$
pH = 2.51 (1)

Question 8

0·300 g of solid NaOH was added to 1·00 L of $5{\cdot}00 \times 10^{-3}$ mol L^{-1} HNO_3.

(a) Which reactant was in excess? Explain your answer.

(5 marks)

$n(NaOH) = \frac{m}{M} = \frac{0.300}{23+16+1} = 7.5 \times 10^{-3}$ moles ①

$n(HNO_3) = C \times V = 5.00 \times 10^{-3} \times 1 = 5.00 \times 10^{-3}$ moles ①

$NaOH(aq) + HNO_3(aq) \longrightarrow NaNO_3(aq) + H_2O(l)$ ①

5.00×10^{-3} moles HNO_3 reacts with 5.00×10^{-3} moles NaOH. ①

But we have 7.5×10^{-3} mol of NaOH $> 5.00 \times 10^{-3}$ ①

∴ NaOH is excess reagent

(b) Assuming no volume change, what is the pH of the final solution?

(3 marks)

n(NaOH remaining) = n(NaOH in beginning) − n(NaOH reacting)

$= 7.5 \times 10^{-3} - 5.00 \times 10^{-3}$

2.5×10^{-3}

$c(NaOH) = n/V = \frac{2.5 \times 10^{-3}}{1} = 2.5 \times 10^{-3} M$

$= c(OH^-)$

$pOH = -\log[OH^-] = -\log(2.5 \times 10^{-3}) = 2.602$

$pH = 14 - pOH$

$= 14 - 2.602$

$= \underline{11.4}$