NEUB Spring 2019 CHE101: Fundamentals of Chemistry Test 02**Set A**

Answer all the questions. Total Mark: 10 Total Time: 25 Minutes

1. The kinetics of the hydrolysis of the halogenoalkane RCH_2Cl with aqueous sodium hydroxide (where R is an alkyl group) was studied at 50 ºC. The following results were obtained:

Exp	$[RCH_2Cl]$	$[OH^-]$	Initial rate/ mol $dm^{-3}s^{-1}$
1	0.050	0.10	4.0×10^{-4}
2	0.15	0.10	1.2×10^{-3}
3	0.10	0.20	1.6×10^{-3}

   a. Deduce the order of reaction with respect to the halogenoalkane, RCH_2Cl, and with respect to the hydroxide ion, OH^-, giving reasons for your answers. [4]
   →Experiments 1&2, $[RCH_2Cl]\times3$, Rate×3 (1)
   ∴ first order with respect to $[RCH_2Cl]$ (1)
   Hypothetical experiment $[RCH_2Cl]=0.1$, (i.e. × 3) so rate is 8.0×10^{-4}
   Hypothetical experiment and experiment 3, $[OH^-]\times2$, Rate × 2 (1)
   ∴ first order with respect to $[OH^-]$ (1)

   b. Hence write the rate equation for the reaction. [1]
   → $\text{Rate} = k\,[R\text{–}CH_2\text{–}Cl]\,[OH^-]$ consequential on (i)

   c. Calculate the value of the rate constant with its units for this reaction at 50 ºC. [1]
   → Don't penalize for units

$$k = \frac{\text{rate}}{[RCH_2Cl][OH^-]} = \frac{4.0\times10^{-4}\,\text{mol dm}^{-3}\text{s}^{-1}}{0.050\times0.10\,\text{mol}^2\text{dm}^{-6}} = \quad 0.080 \ \textbf{(1)}\ \text{mol}^{-1}\ \text{dm}^3\ \text{s}^{-1}$$

2. Consider the following equation:

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

2.0 moles of SO_2 and 1.0 mole of O_2 were allowed to react in a vessel of volume 60 dm^3.At equilibrium 1.8 moles of SO_3 had formed and the pressure in the flask was 2 atm.

   a. Write the expression for K_c for this reaction [1]
   →$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$

   b. Calculate the value of K_c, with units. [3]
   →

	$2SO_2$	$+O_2$	$\rightleftharpoons$	$2SO_3$
Initial	2.0	1.0		0
Used/Produced	1.8	1.8/2		1.8
Equilibrium mole	0.2	0.1		1.8
Concentration	0.2/60	0.1/60		1.8/60
=	3.33×10^{-3}	1.67×10^{-3}		0.03

$$K_c = \frac{0.03^2}{(3.33\times10^{-3})^2 \times (1.67\times10^{-3})}$$
$$K_c = 4.86\times10^{-4}\ \text{mol}^{-1}\text{dm}^3$$

Marking guideline:
Finding equilibrium mole and concentration -2
Final answer with unit -1

NEUB Spring 2019 CHE101: Fundamentals of Chemistry Test 02**Set B**

Answer all the questions. Total Mark: 10 Total Time: 25 Minutes

1. In an experiment to determine the rate of the reaction between persulphate ions and iodide ions in aqueous solution the following data were obtained:

$$S_2O_8^{2-} + 2I^- \rightarrow 2SO_4^{2-} + I_2$$

Exp	$[S_2O_8^{2-}l]$	$[2I^-]$	Initial rate/ mol $dm^{-3}s^{-1}$
1	0.10	0.10	0.36
2	0.20	0.10	0.72
3	0.20	0.20	1.44

   a. Deduce the order of reaction with respect to each of the reagents and hence write the rate equation for the reaction. [3]

   →

   Working to show first order with respect to $[S_2O_8^{2}]$ **(1)**

   Working to show first order with respect to $[I^-]$ **(1)**

   overall equation **(1)**

   Consequential

   b. Calculate the rate constant including units. [1]

   →Don't penalize for units. $36\ dm^3 mol^{-1}s^{-1}$ (1)

   c. Suggest a suitable experimental technique that would enable you to determine the rate of the reaction given above. Give reasoning for your answer. [2]

   →Colorimetry / conductivity / remove samples and titrate with (standard) sodium thiosulphate solution **(1)**

   Proper reasoning (1)

2. Many industrial organic reactions produce hydrogen chloride as an additional product. This can be oxidized to chlorine by the Deacon process:

$$4HCl(g) + O_2(g) \rightleftharpoons 2CL_2(g) + 2H_2O(g)\ \Delta H = -115 KJmol^{-1}$$

0.800 mol of hydrogen chloride was mixed with 0.200 mol of oxygen in a vessel of volume 10.0 dm^3 in the presence of a copper(I) chloride catalyst at 400 ºC. At equilibrium it was found that the mixture contained 0.200 mol of hydrogen chloride.

   a. Write an expression for the equilibrium constant K_c. [1]

   →$K_C = \frac{[Cl_2]^2 \times [H_2O]^2}{[HCl]^4 \times [O_2]}$

   b. Calculate the value of K_c at 400 ºC. [3]

   →

$4HCl$	+	O_2	$2Cl_2$	+	$2H_2O$
equilibrium mols		0.20	0.050 **(1)**	0.30 and	0.30 **(1)**
[ ] eq ÷ 10 **(1)**		0.020	0.0050	0.030	0.030

$K_c = \frac{[0.030]^2 \times [0.030]^2}{[0.020]^4 \times [0.005]}$ = 1010 or 1012 or 1013 or 1012.5 ($mol^{-1}\ dm^3$) **(1)**