

NEUB Spring 2019 CHE101: Fundamentals of Chemistry Test 02Set 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°C . The following results were obtained:

Exp	$[\text{RCH}_2\text{Cl}]$	$[\text{OH}^-]$	Initial rate/ $\text{mol dm}^{-3}\text{s}^{-1}$
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, $[\text{RCH}_2\text{Cl}] \times 3$, Rate $\times 3$ (1)

∴ first order with respect to $[\text{RCH}_2\text{Cl}]$ (1)

Hypothetical experiment $[\text{RCH}_2\text{Cl}] = 0.1$, (i.e. $\times 3$) so rate is 8.0×10^{-4}

Hypothetical experiment and experiment 3, $[\text{OH}^-] \times 2$, Rate $\times 2$ (1)

∴ first order with respect to $[\text{OH}^-]$ (1)

- b. Hence write the rate equation for the reaction. [1]

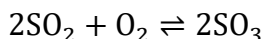
→ $\text{Rate} = k [\text{R-CH}_2\text{-Cl}] [\text{OH}^-]$ consequential on (i)

- c. Calculate the value of the rate constant with its units for this reaction at 50°C . [1]

→ Don't penalize for units

$$k = \frac{\text{rate}}{[\text{RCH}_2\text{Cl}][\text{OH}^-]} = \frac{4.0 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}}{0.050 \times 0.10 \text{ mol}^2 \text{ dm}^{-6}} = 0.080 \text{ (1) mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$$

2. Consider the following equation:



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]

$$\rightarrow K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]}$$

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

→

	2SO_2	$+\text{O}_2$	\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

$$K_c = \frac{0.03^2}{(3.33 \times 10^{-3})^2 \times (1.67 \times 10^{-3})}$$

$$K_c = 4.86 \times 10^{-4} \text{ mol}^{-1} \text{ dm}^3$$

Marking guideline:

Finding equilibrium mole and concentration -2

Final answer with unit -1

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

$$\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \rightarrow 2\text{SO}_4^{2-} + \text{I}_2$$

Exp	$[\text{S}_2\text{O}_8^{2-}]$	$[\text{I}^-]$	Initial rate/ $\text{mol dm}^{-3}\text{s}^{-1}$
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 $[\text{S}_2\text{O}_8^{2-}]$ (1)

Working to show first order with respect to $[\text{I}^-]$ (1)

overall equation (1)

Consequential

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

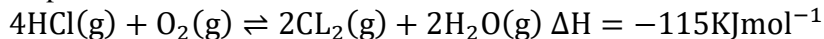
→Don't penalize for units. $36 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ (1)

- 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:



0.800 mol of hydrogen chloride was mixed with 0.200 mol of oxygen in a vessel of volume 10.0 dm³ in the presence of a copper(I) chloride catalyst at 400 °C. 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]

$$\rightarrow K_c = \frac{[\text{Cl}_2]^2 \times [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 \times [\text{O}_2]}$$

- b. Calculate the value of K_c at 400 °C. [3]

→

4HCl	+	O ₂	2Cl ₂	+	2H ₂ O
equilibrium mols		0.20	0.050 (1)	0.30	and 0.30 (1)
[] eq ÷ 10 (1)		0.020	0.0050	0.030	0.030

$$K_c = \frac{[0.030]^2 \times [0.030]^2}{[0.020]^4 \times [0.005]} = 1010 \text{ or } 1012 \text{ or } 1013 \text{ or } 1012.5$$

(mol⁻¹ dm³) (1)