



# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

PHYSICAL CHEMISTRY FOR CHEMICAL ENGINEERS

SCH 1120

Supplementary Examination Paper

July 2016

This examination paper consists of 3 pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Examiner's Name: Dr. S. Majoni**

## INSTRUCTIONS

1. Answer ALL questions
2. Each question carries 25 marks

## MARK ALLOCATION

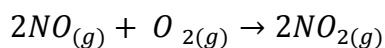
QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
<b>TOTAL</b>	<b>100</b>

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SCH 1120

1) The following data were collected for the rate of disappearance of NO in the reaction



Exp. No	[NO] molL <sup>-1</sup>	[O <sub>2</sub> ] molL <sup>-1</sup>	Initial rate (molL <sup>-1</sup> s <sup>-1</sup> )
1	0.0126	0.125	1.41 x 10 <sup>-2</sup>
2	0.0252	0.250	1.13 x 10 <sup>-1</sup>
3	0.0252	0.125	5.64 x 10 <sup>-2</sup>

i. Write rate equations for the zero, first, and second order reaction.

ii. Determine the rate law for the reaction.

iii. From the rate law, what is the overall order of reaction? [25 marks]

2) a) The equilibrium-constant expression for a reaction is given by:

$$K_c = \frac{[H_2O]^2[SO_2]^2}{[H_2S]^2[O_2]^3}$$

Write a balanced chemical equation corresponding to the expression [5 marks]

b) A solution has equal concentrations of NaCl and Cu(NO<sub>3</sub>)<sub>2</sub>, if the ionic strength of the solution is 0.015*m*, what are the concentrations of the four ionic species in solution? [5 marks]

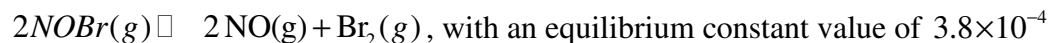
c) The mean activity coefficients of HBr in 5.0 and 20.0 mmol kg<sup>-1</sup> are 0.930 and 0.879, respectively. Consider a hydrogen electrode in HBr (aq) solution at 25 °C operating at 1bar. Calculate the change in the electrode potential when the molality of the acid solution is changed from 5.0 and 20.0 mmol kg<sup>-1</sup>. [8 marks]

d) Some mammoth bones found in Arizona were found by carbon-14 dating to be 11300 years old. Calculate the activity of carbon-14 in the bones at the time of analysis if the initial activity (at the time of death) was 15.3 disintegration per minute per gram. [7 marks]

3) a) A 100.0 L reaction vessel contains 2.5 mols of nitrogen dioxide which decomposes according to the following equation;  $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$   
At a temperature of 473 K, 6.0% of NO<sub>2</sub> decomposes, calculate the value of K<sub>c</sub> at 473 K. [8 marks]

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b) Gaseous NOBr decomposes according to the following equation;



at 298 K. Write the equilibrium expression, and for each of the following compositions determine whether the reaction is at equilibrium or not, if not at equilibrium decide which direction the reaction should go

i)  $[\text{NOBr}] = 0.072 \text{ M}$ ,  $[\text{Br}_2] = 0.0162 \text{ M}$ , and  $[\text{NO}] = 0.0162 \text{ M}$

ii)  $[\text{NOBr}] = 0.012 \text{ M}$ ,  $[\text{Br}_2] = 0.0045 \text{ M}$ , and  $[\text{NO}] = 0.0162 \text{ M}$

iii)  $[\text{NOBr}] = 0.012 \text{ M}$ ,  $[\text{Br}_2] = 0.023 \text{ M}$ , and  $[\text{NO}] = 0.01543 \text{ M}$

iv)  $[\text{NOBr}] = 0.043 \text{ M}$ ,  $[\text{Br}_2] = 0.011 \text{ M}$ , and  $[\text{NO}] = 0.018 \text{ M}$

[17 marks]