

UNIVERSITY OF SWAZILAND
RE-SIT EXAMINATION – 2018, JULY

TITLE OF PAPER : Introductory Chemistry II

COURSE NUMBER : CHE 152

TIME : Three Hours

INSTRUCTIONS :

1. Answer all questions in Section A (Total 50 marks)
2. Answer any two questions in Section B (each question is 25 marks)

NB: Non-programmable electronic calculators may be used

A data sheet, a periodic table and answer sheet (for Section A) are attached

Useful data and equations:

$$1 \text{ atm} = 760 \text{ Torr} = 760 \text{ mmHg}$$

$$1 \text{ atm} = 101325 \text{ Pa}$$

$$\text{Arrhenius equation: } k = Ae^{-E_a/RT} \quad \text{or} \quad \ln k = \ln A - \frac{E_a}{RT}$$

$$\text{Van der Waals equation: } P = \frac{nRT}{V-nb} - \frac{n^2a}{V^2}$$

This Examination Paper Contains Twelve Printed Pages Including This Page

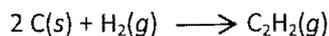
You are not supposed to open the paper until permission to do so has been granted by the Chief Invigilator.

Question 1

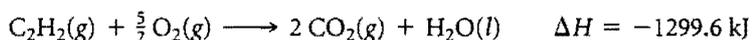
- a. Differentiate between effusion and diffusion of gas molecules. (5)
- b. At 25°C, 0.350 moles of CH_{4(g)}, 0.240 mole of H_{2(g)} and 0.500 mole of N_{2(g)} are contained in a 10.0 L flask. Evaluate the partial pressure (in atm), of each of the components of the gaseous mixture in the flask, and the overall pressure in the flask. (10)
- c. 8.0 grams of argon and 25.0 grams of neon are placed in a 1200.0 ml container at 25.0°C. Calculate the partial pressures of both gases. (10)

Question 2

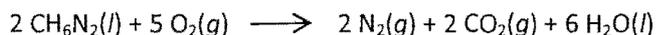
- a. Write the thermochemical equations that give values of the standard enthalpies of formation for the following: (10)
- Al₂O_{3(s)}
 - C₂H₅OH(l)
 - CH₆N_{2(l)}
 - C₆H₅OH(l)
 - CaCO_{3(s)}
- b. Calculate ΔH for the reaction (10)



given the following chemical equations and their respective enthalpy changes:



- c. The combustion of methylhydrazine (CH₆N₂), a liquid rocket fuel, produces N_{2(g)}, CO_{2(g)}, and H₂O(l):



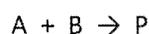
When 6.00 g of methylhydrazine is combusted in a bomb calorimeter, the temperature of the calorimeter increases from 25.00°C to 39.50°C. In a separate experiment the heat capacity of the calorimeter was measured to be 7.794 kJ/°C. Calculate the heat of reaction for the combustion of a mole of CH₆N₂. (5)

Question 3

- a. A household cleaning reagent has a hydroxide concentration of 0.0032 M. Calculate the [H₃O⁺], pH and pOH for this solution. (9)
- b. A student prepared a 0.10 M solution of formic acid (HCOOH) and found its pH at 25°C to be 2.38. Calculate K_a for formic acid at this temperature. (10)
- c. In a sample of lemon juice, [H⁺] = 3.8 × 10⁻⁴ M. What is the pH? (6)

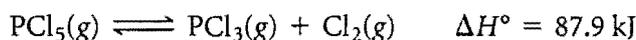
Question 4

- a. The data in the table below were obtained for the reaction: (9)



Experiment Number	[A] (M)	[B] (M)	Initial Rate (M/s)
1	0.273	0.763	2.83
2	0.273	1.526	2.83
3	0.819	0.763	25.47

- What is the order of the reaction in [A]
 - What is the order of the reaction in [B]
 - Write the rate law for the reaction.
 - What is the overall order of this reaction?
- b. For the reaction



in which direction will the equilibrium shift when

- $\text{Cl}_2(g)$ is added,
 - the temperature is increased,
 - the volume of the reaction system is increased,
 - $\text{PCl}_3(g)$ is removed? (8)
- c. If the rate of decomposition of N_2O_5 in the reaction $2 \text{N}_2\text{O}_5(g) \rightarrow 4 \text{NO}_2(g) + \text{O}_2(g)$ at a particular instant is $4.2 \times 10^{-7} \text{ M/s}$, what is the rate of appearance of
- NO_2 and
 - O_2 at that instant? (8)

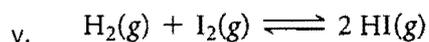
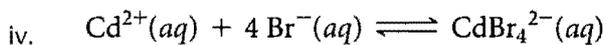
Question 5

- a. Draw the structures of the following compounds: (20)
- 2,4-dimethyl-1-pentene
 - 3-ethyl-2-methylpentane
 - 2,4-dichloro-2-pentyne
 - 2,5,6-trimethylnonane
 - 3-bromocyclohexanone
 - 2,4-dimethyl-hexanoic acid
 - 3-ethoxy-5-methyl-octanal
 - Methyl-cyclobutylamine
 - Isopropyl-butyl ether
 - 3-bromo-6-ethyl-4,4,5-trimethyl-8-nonanol
- b. Draw the structure and give the name of the product of the reaction of 4-ethyl-2-methyl-1-heptene with HBr. (5)

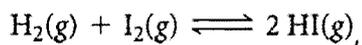
Question 6

- a. Write the equilibrium expression for K_c for the following reactions: (10)
- $2 \text{O}_3(g) \rightleftharpoons 3 \text{O}_2(g)$
 - $2 \text{NO}(g) + \text{Cl}_2(g) \rightleftharpoons 2 \text{NOCl}(g)$
 - $\text{Ag}^+(aq) + 2 \text{NH}_3(aq) \rightleftharpoons \text{Ag}(\text{NH}_3)_2^+(aq)$

iii.



b. For the reaction:



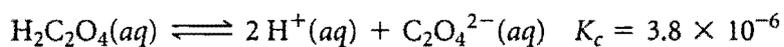
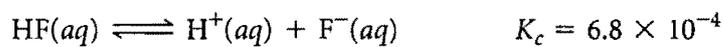
$K_p = 794$ at 298 K and $K_p = 55$ at 700 K. Is the formation of HI favoured more at the higher or lower temperature? (2)

c. After a mixture of hydrogen and nitrogen gases in a reaction vessel is allowed to attain equilibrium at 472°C, it was found to contain 7.38 atm H_2 , 2.46 atm N_2 , and 0.166 atm NH_3 .

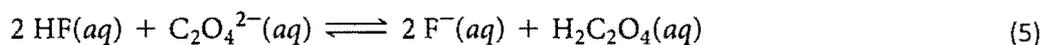
From these data, calculate the equilibrium constant K_p for the reaction



d. Given the reactions



Determine the value of K_c for the reaction



SI Units and Conversions

Unit	Symbol	SI units
Newton	N	kg.m.s^{-2}
Pascal	Pa	$\text{kg.m}^{-1}.\text{s}^{-2}$ or N.m^{-2}
Joule	J	$\text{kg.m}^2.\text{s}^{-2}$ or N.m or AVs
Watt	W	$\text{kg.m}^2.\text{s}^{-3}$ or J.s^{-1}
Coulomb	C	A.s
Volt	V	$\text{kg.m}^2.\text{s}^{-3}.\text{A}^{-1}$ or J.C^{-1}
Ohm	Ω	$\text{kg.m}^2.\text{s}^{-3}.\text{A}^{-2}$ or v.A^{-1}
Amp	A	1Cs^{-1}

Pressure Units and conversion factors

Pa	1 Pa = 1 N.m^{-2}
Bar	1 bar = 10^5 Pa
Atmosphere	1 atm = 101.325 kPa
Torr	760 Torr = 1 atm
	760 Torr = 760 mmHg = 101.325 kPa

General data and Fundamental Constants

Gas constant	R	8.314 51 $\text{J.K}^{-1}.\text{mol}^{-1}$ 8.314 51 $\times 10^{-2}$ $\text{L.bar.K}^{-1}.\text{mol}^{-1}$ 8.205 78 $\times 10^{-2}$ $\text{L.atm.K}^{-1}.\text{mol}^{-1}$ 62.364 $\text{L.Torr.K}^{-1}.\text{mol}^{-1}$
Avogadro constant	N_A	$6.022169 \times 10^{23} \text{ mol}^{-1}$
Molar volume of an ideal gas at 0°C and 1 atm	V_m	22.414 dm^3

