UNIVERSITY OF SWAZILAND

RESIT EXAMINATION – 2019, JULY

TITLE OF PAPER : Introductory Chemistry II

COURSE NUMBER : CHE152

TIME : Three Hours

INSTRUCTIONS :

Answer any Four questions (each question is 25 marks)

NB: Non-programmable electronic calculators may be used

A data sheet and a periodic table are attached

Useful data and equations:

1 atm = 760 Torr = 760 mmHg

1 atm = 101325 Pa

Arrhenius equation: $k = Ae^{-E_a/RT}$ or $lnk = lnA - \frac{E_a}{RT}$

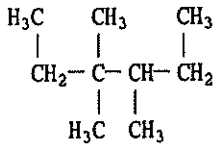
Van der Walls equation: $P = \frac{nRT}{V-nb} - \frac{n^2a}{V^2}$

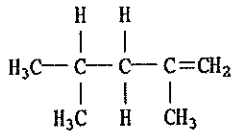
This Examination Paper Contains **Six** Printed Pages Including This Page

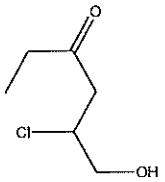
You are not supposed to open the paper until permission to do so has been grated by the Chief Invigilator.

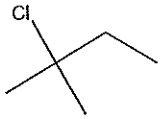
Question 1

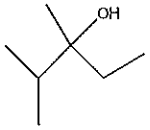
a. Name the following compounds: (15)

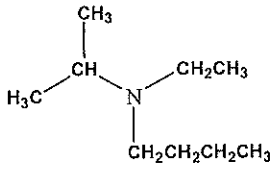
i. 

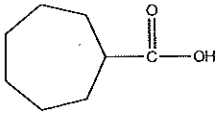
ii. 

iii. 

iv. 

v. 

vi. 

vii. 

viii. $CH_3(CH_2)_3CH_3$

b. Draw structured of the following compounds: (10)

i. 1,3-butadiene
ii. 3-bromo-2,3-dimethylpentanamine
iii. 3-methyl-5-hexenoic acid
iv. 1-iodo-1,3-dimethyl-2-pentanone
v. 2-ethoxy-3-bromoheptane

Question 2

a. Write the equilibrium-constant expression for the following reactions: (9)

i. $SO_2\,(g) + NO_2\,(g) \longrightarrow SO_2\,(g) + NO\,(g)$

ii. $(NH_4)_2Se\ (s) \longrightarrow 2NH_3\ (g) + H_2Se\ (g)$

iii. $2SO_2\ (g) + O_2\ (g) \longrightarrow 2SO_3\ (g)$

b. A solution formed by dissolving an antacid tablet has a pH of 9.18. Calculate $[OH^-]$. (6)

c. An aqueous solution of HNO_3 has a pH of 2.34.What is the concentration of the acid? (10)

Question 3

a. A 0.007500 m^3 volume of carbon dioxide was collected at 45.15°C and 121.59 kPa. The volume was then decreased by 75.00% while the temperature was halved. Calculate the new pressure in the container. (10)

b. Nitrous oxide can be formed by thermal decomposition of ammonium nitrate.

$$NH_4NO_{3(s)} \longrightarrow N_2O_{(g)} + 2H_2O_{(g)}$$

What mass of ammonium nitrate would be required to produce 115 L of H_2O at 2500 Torr and 75°C (10)

c. At 25°C, 0.300 moles of $CH_{4(g)}$, 0.200 mole of $H_{2(g)}$ and 0.400 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. (5)

Question 4

a. Nitrogen dioxide decomposes to nitric oxide and oxygen via the reaction:

$$2NO_2 \rightarrow 2NO + O_2$$

In a particular experiment at 300 °C, $[NO_2]$ drops from 0.0100 to 0.00650 M in 100 s. what is the rate of disappearance of NO_2 for this period in M/s (7)

b. What are the valid rate expressions for the reactions? (10)

i. $2\ ClO_2\ (aq) + 2\ OH^-\ (aq) \rightarrow ClO_3^-\ (aq) + ClO_2^-\ (aq) + H_2O\ (1)$ with respect to H_2O.

ii. $4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$ with respect to NH_3

iii. $2NO_2 \rightarrow 2NO + O_2$ with respect to NO

iv. $2N_2O_5\ (soln) \rightarrow 4NO_2\ (soln) + O_2\ (soln)$ with respect to NO_2

v. $Br_2\ (g) + 2NO\ (g) \rightarrow 2NOBr\ (g)$ with respect to Br_2

a. What are the overall reaction orders for the following reactions and what are the units of the rate constant for the rate law: (8)

i. $2N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$ Rate = $k[N_2O_5]$

ii. $CHCl_{3(g)} + Cl_{2(g)} \longrightarrow CCl_{4(g)} + HCl_{(g)}$ Rate = $k[CHCl_3][Cl_2]^{1/2}$

Question 5

a) Given the following standard enthalpy changes of formation, calculate the standard enthalpy change of combustion of silane, SiH_4 at 298 K:

(10)

$SiH_4(g) + 2O_{2(g)} \longrightarrow SiO_{2(g)} + 2H_2O_{(l)}$

Substance	$SiH_{4(g)}$	$SiO_{2(g)}$	$2H_2O_{(l)}$
$\Delta H°_f$ (KJ/mol)	+34.0	-910.9	-285.8

b) Beer contains both ethanol and glucose ($C_6H_{12}O_6$) in different proportions. These contribute to the total energy of beer.

i. Write balanced equations for the complete combustion of ethanol and glucose (5)

ii. Given that the standard enthalpy change of combustion for ethanol and glucose are -1370 kJ mol^{-1} and -3000 kJ mol^{-1} respectively, calculate the enthalpy change per gram for both glucose and ethanol. (10)

SI Units and Conversions

Unit	Symbol	SI units
Newton	N	$kg.m.s^{-2}$
Pascal	Pa	$kg.m^{-1}.s^{-2}$ or $N.m^{-2}$
Joule	J	$kg.m^{2}.s^{-2}$ or N.m or AVs
Watt	W	$kg.m^{2}.s^{-3}$ or $J.s^{-1}$
Coulomb	C	A.s
Volt	V	$kg.m^{2}.s^{-3}.A^{-1}$ or $J.C^{-1}$
Ohm	Ω	$kg.m^{2}.s^{-3}.A^{-2}$ 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	$8.314\ 51\ J.K^{-1}.mol^{-1}$ $8.314\ 51 \times 10^{-2}\ L.bar.K^{-1}.mol^{-1}$ $8.205\ 78 \times 10^{-2}\ L.atm.K^{-1}.mol^{-1}$ $62.364\ L.Torr.K^{-1}.mol^{-1}$
Avogadro constant	N_A	$6.022169 \times 10^{23}\ mol^{-1}$
Molar volume of an ideal gas at 0°C and 1 atm	V_m	$22.414\ dm^{3}$

UNIVERSITY OF SWAZILAND

Department of Chemistry

Atomic Number — Atomic Weight

1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac 227.03															

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (234)	96 Cm (247)	97 Bk 247	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)