Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	PHYSICAL CHEMISTRY
COURSE CODE	:	BWK 10103
PROGRAMME CODE	:	BWK
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 The reversible dissociation reaction of bromine monochloride follows the chemical equation below:

$$2BrCl_{(g)} \rightleftharpoons Br_{2\,(g)} + Cl_{2\,(g)}$$

At a temperature of 205 °C, the equilibrium constant (K_p) for this reaction was experimentally determined to be 0.143. If 1.34 mol of bromine and 1.34 mol of chlorine were introduced into an 11 L container, determine the concentration of bromine monochloride at equilibrium.

(14 marks)

Q2 The reaction between nitrogen gas and hydrogen gas to produce a gaseous product was conducted at temperature of 298 K. The enthalpy change (ΔH) of this reaction was determined to be -92.38 kJ. Approximate the change in internal energy (in kJ) for this reaction.

(6 marks)

Q3 The combustion of methane releases 890.47 kJ/mol of heat. If 12.00 g of methane were burned at 25 °C

(i) Calculate the Gibbs free energy (ΔG) to determine either the reaction is exergonic or endergonic. Given that the atomic mass for carbon and hydrogen is 12.0009 g/mol and 1.0078 g/mol respectively.

(7 marks)

(ii) With the aid of calculation briefly explain how changes in temperature could affect the spontaneity of this reaction.

(7 marks)

Q4 Estimate the mass of trisodium phosphate needed to produce a 15 mL aqueous solution with an ionic strength of 0.0600. The atomic mass of sodium, phosphorus and oxygen are 22.9897 g/mol, 30.9737 g/mol and 15.9990 g/mol respectively.

(6 marks)

Q5 A solution was prepared by dissolving 5 g of $C_{12}H_{10}$ and 7.50 g of $C_{10}H_8$ in 200 g of benzene. A chemist hypothesized that the freezing point of benzene shall decrease to 2.1989 °C as compared to its actual freezing point of 5.5000 °C. With the aid of calculation, explain the validity of the hypothesis when given that the freezing point depression constant of benzene is 5.12 °C/m while the atomic mass for carbon and hydrogen are 12.0090 g/mol and 1.0078 g/mol respectively.

(14 marks)

Q6 Lead (Pb) has the potential to displace silver (Ag) from its aqueous solution. Predict the Gibbs free energy (ΔG) of the reaction to classify if the reaction is spontaneous or in contrary. Given that the standard reduction potential (E^0) for lead and silver are -0.13 eV and 0.80 eV respectively.

(6 marks)

Q7 A saturated hydrocarbon with two carbon chain was heated at 599.60 °R. With the aid of **APPENDIX A** calculate the viscosity of this hydrocarbon.

(14 marks)

Q8 The root mean square speed of nitrogen gas molecules at a temperature of 300K is identical to root mean square speed of oxygen gas at an unknown temperature. Determine the unknown temperature given that the atomic mass of nitrogen and oxygen is approximately 14.007 g/mol and 15.999 g/mol respectively.

(6 marks)

- END OF QUESTIONS -

APPENDIX A

Table APPENDIX A: Sutherland's Constant and Gas Viscosity

Gas	Sutherland's Constant, K	Gas Viscosity (μ_0, cP)		
		t_o = 20 °C	t_o = 50 °C	t_o = 100 °C
Acetylene	320	0.0100	0.01111	0.0127
Air	113	0.0183	0.0198	0.0220
Ammonia	503	0.0099	0.0110	0.0129
Argon	148	0.0223	0.0242	0.0271
Benzene	300	0.0075	0.0081	0.0094
Butane	270	0.00742	0.00814	0.00932
Carbon dioxide	253	0.0147	0.0161	0.0184
Carbon monoxide	102	0.0174	0.0188	0.0209
Chlorine	345	0.0132	0.0145	0.0167
Ethane	252	0.00921	0.0101	0.0115
Ethylene	225	0.0100	0.0110	0.0126
Helium	72.9	0.0196	0.0210	0.0232
Hydrogen	66.8	0.0088	0.0094	0.0104
Hydrogen chloride	362	0.0144	0.0159	0.0183
Hydrogen sulphide	331	0.0124	0.0137	0.0159
Methane	169	0.0110	0.0120	0.0135
Nitric oxide	133	0.0175	0.0188	0.0210
Nitrogen	104.7	0.0189	0.0204	0.0228
Nitrous Oxide	263	0.0147	0.0161	0.0184
Oxygen	125	0.0203	0.0220	0.0246
Propane	150	0.00821	0.00896	0.0102
Propylene	250	0.00847	0.00934	0.0107
Steam	260	0.0097	0.0106	0.0124
Xenon	252	0.0228	0.0251	0.0288