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University Examinations 2023/2024

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE CHEMISTRY

SCH 3351: CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRIA

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

a) Define the following terms as used in thermodynamics

(i) System (2 marks)

(ii) Thermodynamics (2 marks)

(iii) Universe (2 marks)

(iv) Entropy (2 marks)

b) State the second law of thermodynamics (2 marks)

c) A piston of a gas initially has 500 joules of internal energy. 1000 joules of energy is added to the gas in the piston as heat and the internal energy increases to 6500 joules. How much work was done on or by the gas (3 marks)

d) Differentiate between the following terms

(i) Spontaneous and non-spontaneous processes (2 marks)

(ii) Adiabatic and isothermal processes (2 marks)

e) Calculate the change in entropy that occurs when 4.4g of Carbon IV oxide gas is allowed to expand isothermally and reversibly from an initial volume of $1.0dm^3$ to a final volume

of $10dm^3$ to a final volume of $10dm^3$ at 300k assuming the gas behave ideally. $R = 8.314 Jk^{-1}$ (4 marks)

f) Explain why kinetic energy decreases in adiabatic processes. (2 marks)

g) Classify the following properties as either intensive or extensive (3 marks)

(i) Mass

(ii) Viscosity

(iii) Volume of a solid

(iv) Temperature

(v) Pressure

(vi) Weight

h) State Roult's law (2 marks)

i) Explain briefly the meaning of the term state function (2 marks)

QUESTION TWO (20 MARKS)

a) Two moles of an ideal gas at STP are heated at constant volume to a temperature of 350k. determine the increase in entropy of the system given that $C_r = 12.47 Jk^{-1}$ (4 marks)

b) Write Gibb's-Helm holtz equation and define its terms (5 marks)

c) What are colligative properties (2 marks)

d) State four colligative properties (4 marks)

e) Given that

Compound	$S^{\theta}(JMol^{-1}k^{-1}$
H_2	130.68
Cl_2	223
HCl	187

Calculate Δs for the following reaction at 25ºC and comment on the values obtained (3 marks)

$$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$$

f) State phase rule (2 marks)

QUESTION THREE (20 MARKS)

a) Draw an illustration of a phase diagram of water and label all the parts (12 marks)

b) State the Henry's law (2 marks)

c) 0.5g of non-volatile organic compound (molecular weight 65) is dissolved in 100mL of CCl_4. If the vapour pressure of pure CCl_4 is 140mmHg, calculate the vapour pressure of the solution. Density of CCl_4 solution is $1.6gmL^{-1}$. (6 marks)

QUESTION FOUR (20 MARKS)

a) State the third law of thermodynamics (2 marks)

b) Draw and label a diabatic calorimeter and explain how the device is used to verify the third law of thermodynamics (10 marks)

c) Calculate ΔG when $11.21dm^3$ of a perfect gas at $0^\circ C$ and $760mmHg$ pressure expands isothermally until its pressure is $190mmHg$ (4 marks)

d) Calculate ΔG at 290k for the following reaction (4 marks)

$$2NO(g)+O_2(g) \longrightarrow 2NO_2(g)$$

Given that

$\Delta H = -120KJ$

$\Delta S = -150KJK^{-1}$