CHE 103e

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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2017 /2018 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: CHE 103e

COURSE TITLE: INTRODUCTION TO THERMODYNAMICS AND KINETICS

DATE: 27TH APRIL, 2018 **TIME: 9AM – 12.00 NOON**

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 5 PRINTED PAGES **PLEASE TURN OVER**

CHE 103e: INTRODUCTION TO THERMODYNAMICS AND KINETICS

STREAM: BED (Science) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer **ALL** questions from section A and any **THREE** from section B.*

ii. *Use the following physical constants where applicable:*

Physical Constants

$R=0.08206$ atm $L\,K^{-1}\,mol^{-1}$ or $R=8.314\,J\,K^{-1}\,mol^{-1}$, Molar Mass of $N_2=28g$, $1^{o}C=273K$

SECTION A (24 MARKS)

Question One

a) Define the following terms:
   i. Chemical equilibrium (1 Mark)
   ii. Intensive property (1 Mark)
   iii. State Function (1 Mark)
   iv. Half-life (1 Mark)
   v. Rate law (1 Mark)

b) Differentiate between an ideal and a real gas. (1 Mark)

c) State the four main features of the ideal gas kinetic molecular theory. (2 Marks)

d) Fifty grams of N_2 occupies a volume of 750mL at 298.15 K. Assuming the gas behaves ideally, calculate the pressure of the gas in atm. (3 Marks)

e) Define the van der Waals equation and explain what it takes into consideration. (1 Mark)

Question Two

a) A neon-dioxygen mixture contains 70.6 g dioxygen and 167.5 g neon. If pressure of the mixture of gases in the cylinder is 25 bar. What is the partial pressure of dioxygen and neon in the mixture? (3 Marks)

b) Explain how the compression factor varies with pressure and temperature and describe how it reveals information about intermolecular interactions in real

gases. (2 Marks)

c) What is chemical kinetics? (1 Mark)

d) State Le Chatelier's Principle. (2 Marks)

e) The half-life of a radioactive isotope A is 1997 years. How long does it take for a sample of A to decay to 25% of its original radioactivity? (3 Marks)

f) What is activation energy? (1 Mark)

SECTION B

Question Three

a) For a reaction between A and B, experiments with different initial concentrations of A and B were carried out. The results were as follows:

	Initial Concentration	Initial Concentration	Initial Rate
1	0.01	0.02	0.0005
2	0.02	0.02	0.0010
3	0.01	0.04	0.0020

i. What is the order of reaction with respect to A and B? (3 Marks)

ii. Calculate the rate constant using results of experiment 1. (1 Mark)

iii. What is the rate equation for the reaction? (1 Mark)

b) Derive the integrated rate equation for a second order reaction and plot the graph. (3 Marks)

c) List two methods that can be used to measure the rate of a chemical reaction. (2 Marks)

d) List the factors that affect the rate of a chemical reaction. (2 Marks)

Question Four

a) Define the first law of thermodynamics. (1 Mark)

b) Show that for an adiabatic process, $\Delta U=0$. (2 Marks)

c) Define enthalpy. What does increase in the enthalpy of a system mean? (2 Marks)

d) Show that heat change at constant pressure (q_p) is given as $\Delta H = q_P$(3 Marks)

e) Prove that enthalpy, H is a state function (2 Marks)

f) Calculate the minimum work done at 25 °C on 2 moles of CO_2 to form a precipitate from a volume of 20L to a volume of 1L when CO_2 is considered as a perfect gas. (2 Marks)

Question Five

a) Give the rate law for the 0 order, 1st order and 2nd order reactions. (2 Marks)

b) What is the effect of temperature on activation energy? (2 Marks)

c) Define the Arrhenius equation and show how activation energy is determined graphically (3 Marks)

d) Using the Boltzmann distribution, show the distribution of molecular energies in a gas. (2 Marks)

e) What is the difference between a homogeneous and heterogeneous catalyst? (1 Mark)

f) Give four characteristics of a catalyst. (2 Marks)

Question Six

a) Show that work done in a reversible isothermal work is given by

$$W = nRT \ln\left(\frac{V_i}{V_f}\right)$$ (3 Marks)

b) Argon gas at 1 atm expands reverse adiabatically to twice (2×) its initial volume. Calculate its final pressure given that $y = 5 / 3$. (3 Marks)

c) Differentiate between reversible and irreversible process (2 Marks)

d) Show that at constant pressure, $q_p = \Delta U + P.dV$ (2 Marks)

e) What is an adiabatic process? Show that for an adiabatic process ΔU = 0 (2 Marks)

Question Seven

a) Define the following terms:

i. Standard enthalpy of combustion (ΔH_c^θ) (1 Mark)

ii. Standard reaction enthalpy (ΔH_r^θ)(1 Mark)

b) Show graphically the difference between an endothermic and exothermic reaction. (1 Mark)

c) State the laws of thermochemistry. (2 Marks)

d) State Hess law. (1 Mark)

e) Calculate the enthalpy for this reaction: (6 Marks)

$2C_{(s)} + H_{2(g)} \longrightarrow C_2H_{2(g)}\ \Delta H^{\circ} = ?\ KJ$

Given the following thermochemical equations:

$C_2H_{2(g)} + {}^{5}/_{2}\ O_{2(g)} \longrightarrow 2CO_{2(g)} + H_2O_{(l)}\ \Delta H^{\circ} = -1299.5\ kJ$

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}\ \Delta H^{\circ} = -393.5\ kJ$

$H_{2(g)} + {}^{1}/_{2}\ O_{2(g)} \longrightarrow H_2O_{(l)}\ \Delta H^{\circ} = -285.8\ kJ$

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