

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

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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

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

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 CO₂ to form a precipitate from a volume of 20L to a volume of 1L when CO₂ 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

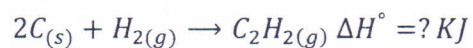
$$W = nRT \ln \left(\frac{V_i}{V_f} \right)$$
 (3 Marks)
- b) Argon gas at 1 atm expands reverse adiabatically to twice (2×) its initial volume. Calculate its final pressure given that $\gamma = 5 / 3$. (3 Marks)
- c) Differentiate between reversible and irreversible process (2 Marks)
- d) Show that at constant pressure, $q_p = \Delta U + P \cdot dV$ (2 Marks)
- e) What is an adiabatic process? Show that for an adiabatic process $\Delta U = 0$ (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)



Given the following thermochemical equations:

