



MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND SEMESTER SPECIAL EXAMINATION FOR THE DIPLOMA IN
EDUCATION (SCIENCE)

SCH 0201: CHEMICAL KINETICS AND THERMODYNAMICS

DATE: 18th Oct 2017

TIME: 11:00 -1:00 am

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **Two** questions from section **B** (each 20 marks).

Section A - Compulsory.

1. a. Which of the following are extensive properties and which are intensive properties.

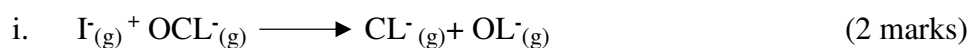
(5 marks)

- i. Viscosity
- ii. eight
- iii. Mass
- iv. Volume of a solid
- v. Pressure

- b. i. Define adiabatic change. (2 marks)

- ii. Two Moles of an ideal monatomic gas at 300k are compressed adiabatically to one quarter of the original volume. What is the temperature of the gas after compression? (4 marks)

- c. Write the rate expressions for each of the following reactions



- d. i. Explain the factors that affect chemical reactions (5 marks)

- ii. Consider the reaction $4\text{PH}_3 \longrightarrow \text{P}_{4(\text{g})} + 6\text{H}_2\text{O}_{(\text{g})}$ at a particular point during the reaction, molecular hydrogen is being formed at the rate 0.168m/s

- iii. At what rate is P_4 being formed (3 marks)

- iv. At what rate is PH_3 being consumed (2 marks)

- e. i. Define isothermal change. (1 mark)

- ii. 0.1 mole of an ideal gas is expanded isothermally at 273k from 3dm^3 to 5dm^3 . Determine the energy (q) absorbed from the surrounding. (4 marks)

SECTION B: (ANSWER ANY 2 (TWO) QUESTIONS)

2.

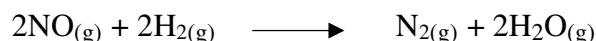
- a. The decomposition of hydrogen peroxide is 1st Order



The K is $1.8 \times 10^5 \text{ s}^{-1}$ at 20°C. If the starting concentration of H_2O_2 is 0.75M determine.

- The concentration of H_2O_2 remaining after 2hrs 30mins. (5 marks)
 - How long will it take for H_2O_2 concentration to drop to 0.1 M. (5 marks)
- b.
- Define the term half-life. (2 marks)
 - The decomposition of Ethane to Methyl radicals is a 1st Order reaction with rate constant of $5.36 \times 10^{-4} \text{ s}^{-1}$ at 700°C. Calculate the half-life of the reactions in seconds. (5 marks)
 - State the methods of determining rate law from experimental data. (3 marks)

3. a. The gas reaction of NO with H_2 at 1280 °C is

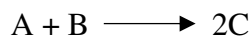


From the table below determine.

EXP	$[\text{NO}]_0(\text{M})$	$[\text{H}_2]_0(\text{M})$	Initial Rate M/Min
1	5.0×10^{-3}	2×10^{-3}	1.3×10^{-5}
2	1.0×10^{-2}	2×10^{-3}	5×10^{-5}
3	1.0×10^{-2}	4×10^{-3}	1×10^{-4}

- Rate Law. (2 marks)
- Rate constant. (3 marks)
- Overall order of the reaction. (2 marks)
- Rate of reaction when $[\text{NO}]$ is $4.8 \times 10^{-3}\text{M}$ and $[\text{H}_2] = 6.2 \times 10^{-3}\text{M}$. (3 marks)

b. For the following reaction, $\text{Rate} = K[A]^2$ and $K = 1.3 \times 10^{-2} \text{ M}^{-1} \text{ S}^{-1}$



Use this information to fill in the missing table entries. (7 marks)

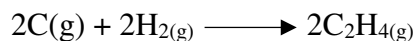
Exp	[A] ₀ M	[B] ₀ M	Initial Rate M/Min
1	0.013	0.25	2.2×10^{-6}
2	0.026	0.25	_____
3	_____	0.5	2.2×10^{-6}

c. Name three major orders of chemical reactions. (3 marks)

4. a. Define each of the following terms as used in thermodynamics. (5 marks)

- i. System
- ii. Surrounding
- iii. Open System
- iv. State Function
- v. Closed System

b. Calculate the entropy change for the reaction. (5 marks)



Given the following standard entropies at 25°C in units $\text{JK}^{-1} \text{ mole}^{-1}$

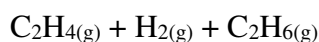
C _(graphite)	5.7
H ₂	131.2
C ₂ H ₄	221.0

- c. The enthalpy of transmission from rhombic to monoclinic Sulphur at the transition temperature of 95.6°C is 0.361 KJ/mole. Determine the entropy of transition. (4 marks)
- d. 2 moles of an ideal gas at 10 atmospheres and 23°C are expanded isothermally to a pressure of 1 atmosphere. Determine the work done. (4 marks)
- e. Differentiate between extensive properties and intensive properties. (2 marks)

5. a.

- i. State Hess's law of constant heat summation (2 marks)

- ii. Calculate the enthalpy of the reaction (4 marks)

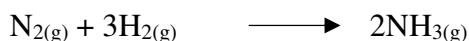


At 298K from the following data.

- i. $\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$ $\Delta H = -1395\text{KJ}$
- ii. $\text{C}_2\text{H}_6(\text{g}) + 7/2\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{g})$ $\Delta H = -1550\text{KJ}$
- iii. $\text{H}_2(\text{g}) + 1/2\text{O}_2(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{g})$ $\Delta H = -243\text{KJ}$

- b. i. Derive the Kirchhoff's equation (5 marks)

- ii. For the reaction



The value of ΔH°_{298} is -92.29 kJ at 25°C. The molar heat capacities at constant pressure of Nitrogen, hydrogen and ammonia are given as:

$$C_{\text{H}_2} = (29.038 - 0.0836 \times 10^{-3}T + 20.097 \times 10^{-7}T^2) \text{ JK}^{-1}$$

$$C_{\text{N}_2} = (26.957 + 5.906 \times 10^{-3}T - 3.373 \times 10^{-7}T^2) \text{ JK}^{-1}$$

$$C_{\text{NH}_3} = (25.870 + 32.968 \times 10^{-3}T - 30.430 \times 10^{-7}T^2) \text{ JK}^{-1}$$

Calculate the standard enthalpy of reaction at 125°C. (5 marks)

- c. When one mole of liquid benzene was completely burnt in oxygen to form liquid water and CO₂ gas $\Delta H = -3250\text{kJ}$ at 298K. Calculate the enthalpy of reaction at constant volume at the same temperature. (4 marks)