

Uva Wellassa University, Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Program
200 Level 1st Semester Examination July/August 2016
SCT 231-2 Physical Chemistry



Instructions to candidates

Number of questions: Four (04)
Answer all questions
Time allocation: Two (02) hours
Total marks allocated: 400
Scientific calculators are allowed

1. In aqueous medium Lead Chloride reacts with Potassium Oxalate yielding KCl, CO₂, Pb.

i. Write the balanced equation for the above reaction. (20 marks)

ii. Following data are obtained for three different sets of experiments.

Experiment No	Initial Concentration / mol L ⁻¹		Initial Rate of Reaction / mol L ⁻¹ min ⁻¹
	Lead Chloride	Potassium Oxalate	
1	0.104	0.15	1.800 X 10 ⁻⁵
2	0.105	0.30	7.200 X 10 ⁻⁵
3	0.052	0.31	3.500 X 10 ⁻⁵

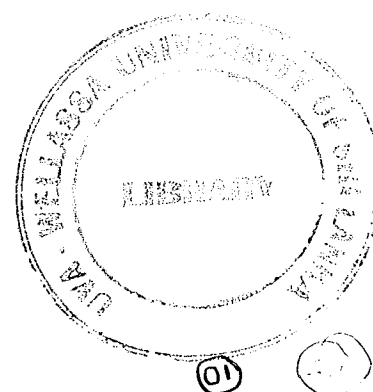
a. Write the equation for the rate (R) of total reaction using initial concentration of Lead Chloride and initial concentration of Potassium Oxalate. (16 marks)

b. Calculate the order of the reaction with respect to Lead Chloride (16 marks)

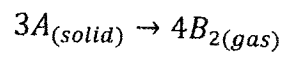
c. Calculate the order of the reaction with respect to Potassium Oxalate. (16 marks)

d. Calculate total order of the total reaction. (16 marks)

e. Calculate the rate constant of the reaction. (16 marks)



2. A certain reaction proceeds through time t as follows,



where A and B denote reactant and product.

Half-life of the reaction is 180 S. Rate constant of the reaction is $0.675 \text{ M}^{-1}\text{S}^{-1}$. How much reactant (A) will be left after a reaction time of 15 min?

(100 marks)

3.

i. Define the following terms.

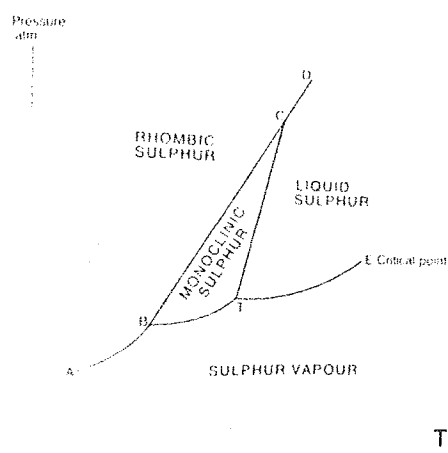
a. Melting point

(10 marks)

b. Critical point

(10 marks)

ii.



Using the above diagram, denote the following using the characters A to E and T

a. Sublimation curve for rhombic sulfur

b. Vapor pressure curve

c. Melting point curve for rhombic sulfur

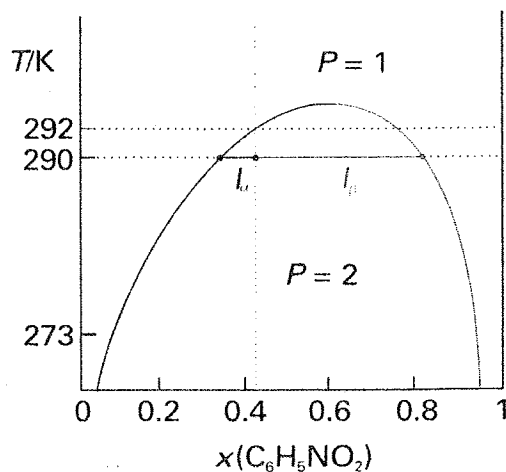
d. Critical point

e. How many triple points are there in the above diagram? (20 marks)

iii. Draw a schematic temperature-composition diagram for liquid-liquid equilibrium for a two-component system having a lower critical solution temperature. Name the axes.

(20 marks)

iv. A mixture of hexane (0.59 mol C_6H_{14}) and nitrobenzene (0.41 mol $C_6H_5NO_2$) was prepared at 290 K. The point $X=0.41$, $T=290$ K occurs in the two-phase region of the phase diagram. In the figure below, the horizontal tie line cuts the phase boundary at $X=0.35$ and $X=0.83$



Using the lever rule, find the number of moles of nitrobenzene in each phase at the point $X=0.41$, $T=290$ K (the point is shown above by the intersection of the dotted lines).

(20 marks)

v. a. Draw a schematic pressure-temperature (P-T) phase diagram for water. Circle the region that corresponds to the vapor pressure curve.

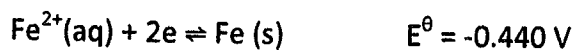
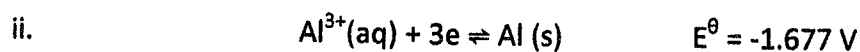
(10 marks)



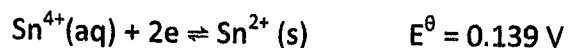
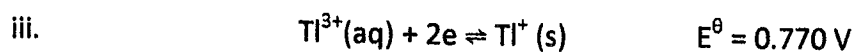
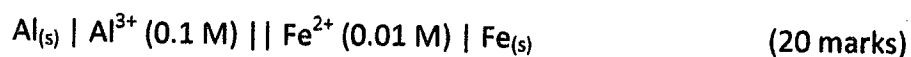
b. Using the P-T diagram you drew; explain the mechanism of a pressure cooker in making the cooking faster. (10 marks)

4. i. At 25°C, the molar conductivity of propanoic acid at infinite dilution (Λ_m^0) is 386.6 S cm² mol⁻¹. If its ionization constant (K_a) is 1.4×10^{-5} , calculate molar conductivity (Λ_m) of 0.05 M propanoic acid solution at 25°C. Assume that the degree of ionization, $\alpha \ll 1$.

(20 marks)



Find the cell potential for the following cell using the Nernst equation.



Consider the titration of 25.00 ml of 0.0100 M Sn²⁺ by 0.0500 M Tl³⁺ in 1 M HCl, using Pt and saturated calomel electrodes to find the endpoint. Potential of the calomel electrode is 0.241V.

a. Write the balanced redox equation for the above redox couple.

b. Using the stoichiometry of the redox equation, calculate the volume of Tl³⁺ solution needed to reach the endpoint.

c. Calculate the voltage reading (E) when 1.00 ml of Tl³⁺ is added.

d. Calculate the voltage reading (E) when 5.10 ml of Tl³⁺ is added. (60 marks)