

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF FIRST SEMESTER EXAMINATIONS – JANUARY 2011
PHYSICAL CHEMISTRY FOR ENGINEERS – SCH 1120
TIME: (3) THREE HOURS

INSTRUCTIONS TO CANDIDATES

MATERIAL

Reduction potential tables, graph papers.

INSTRUCTIONS TO STUDENTS

Answer All questions in section A and Any Three questions in Section B.

Answer each question on a **FRESH** page.

$$R = 8.314 \text{ JK}^{-1}\text{mol}^{-1} = 0.08205 \text{ dm}^3 \text{ atm}^{-1} \text{ K}^{-1}\text{mol}^{-1}.$$

$$F = eN_A = 96\,485 \text{ C mol}^{-1}$$

$$1 \text{ atm} = 760 \text{ torr} = 760\text{mmHg} = 101\,325 \text{ Pa}$$

$$\ln x = 2.303 \log x$$

SECTION A *Answer ALL questions. Each question carries 10 marks*

1. (a) Name the two effects collectively known as the Retardation effects in strong electrolytes. Briefly describe one of them. [4 marks]
- (b) The limiting molar conductivities of KCl, KNO₃, and AgNO₃ at standard conditions are 149.9 S cm² mol⁻¹, 145.0 S cm² mol⁻¹, and 133.4 S cm² mol⁻¹, respectively. What is the limiting molar conductivity of AgCl at this temperature? [4 marks]
- (c) State the Kohlrausch's law of independent migration. [2 marks]

2. The conductivity of a 0.01 mol dm⁻³ aqueous solution of barium chloride [BaCl₂(aq)] at 25^oC is 0.2382 S m⁻¹ and the transport number of the chloride ions in this electrolyte is 0.5625. Calculate:
 - (a) The molar conductivity of barium chloride.
 - (b) The ionic conductivities of the barium and chloride ions
 - (c) The mobilities of the barium and chloride ions[10 marks]

3. (a) Compare and contrast physisorption and chemisorption? [6 marks]
- (b) State the *three* basic assumptions of the Langmuir's adsorption isotherm. [4 marks]

4. (a) Based on the knowledge that the disperse phase and the dispersion medium can be either solid, gas or liquid, complete the following table:

	Class of the disperse system	Disperse phase	Dispersion medium
1	Aerosol		
2	Foam		
3	Emulsion		
4	Sol		

[8 marks]

- (b) How can colloidal systems be further classified? [2 marks]

SECTION B

Answer ONLY THREE questions from this section.

5. (a) The cell $\text{Zn} | \text{Zn SO}_4(\text{aq}, a = 1) || \text{CuSO}_4(\text{aq}, a = 1) | \text{Cu}$ was set up in a laboratory experiment.

Calculate: (i) the e.m.f of the cell at standard conditions
(ii) the value of ΔG_r^\ominus for the cell reaction
(iii) the equilibrium constant for the cell reaction.

Which electrode is more positive, and which way do electrons flow?

[8 marks]

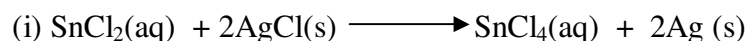
- (b) At 298K the standard redox potentials of the electrodes, $\text{Pt} | \text{Ce}^{4+}, \text{Ce}^{3+}$ and $\text{Pt} | \text{Fe}^{3+}, \text{Fe}^{2+}$, are 1.61V and 0.77V respectively. When these two electrodes are brought together the reaction comes to equilibrium. Write the spontaneous reaction and calculate the equilibrium constant.

[4 marks]

- (c) Name the *two* types of concentration cells and highlight the major difference between them. Give examples.

[4 marks]

- (c) Using electrode potentials, calculate the equilibrium constant for the following reactions at 25°C.



[4 marks]

6. The data below relates to the adsorption of carbon monoxide on charcoal at 273K. Confirm that they fit the Langmuir isotherm, and find:

(a) The constant k.

(b) The volume corresponding to complete coverage.

In each case V has been corrected to 1 atm

P/Torr	100	200	300	400	500	600	700
V/cm ³	10.3	19.3	27.3	34.1	40.0	45.5	48.0

The Langmuir's isotherm: $\Theta = kP/(1+kP)$ [20 marks]

7. (a) State the size range of colloidal particles. What kind of particles are above and below this range? [4 marks]

(b) State the *three* main sedimentation techniques that are used to evaluate the particle size of colloids in colloidal systems. [3 marks]

(c) What is Rayleigh scattering? [2 marks]

(d) Outline the formation of an electric double layer on the surface of a colloidal particle. State the prime role of the electric double layer and how this role is performed. [8 marks]

(e) What do you understand by the terms:

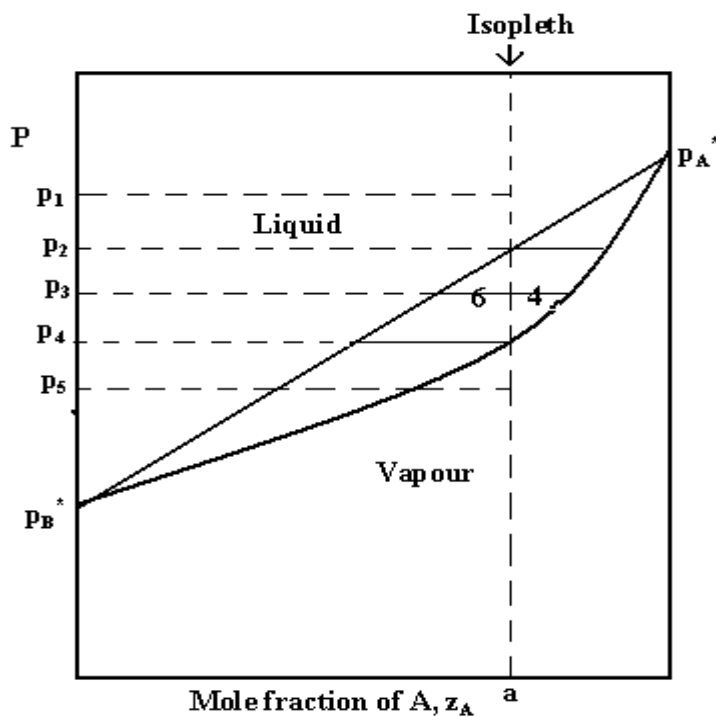
(i) aquasol,

(ii) alcosol, and

(iii) aerosol?

[3 marks]

8. (a) The figure below is a pressure – composition diagram a mixture of two volatile liquids A and B. Copy the diagram and use it as you describe in detail what will be observed when the pressure of a system of composition $z_A = a$ is reduced from P_1 to P_5 along the Isopleth. At each pressure indicated give the number of phases, the equilibrium composition of the phases (use notation of your choice), and the relative amounts of the phases. [10 marks]



- (b) Write the Phase rule and define each of the three variable terms in it. [8 marks]
- (c) What is a constituent in a system? [2 marks]

END OF QUESTION PAPER!!!