THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. Degree Programme / Stand alone courses 2006/2007
Level 5 – Continuous Assessment Test II

CHU 3129 – INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Duration: One and half-hours Date: 17th February 2006 from 11.30 a.m. to 1.00 p.m.

Reg. No. .....

Question No.	Marks
1	
2	
Total	
Percentage	

Instructions to candidates

*** Answer all questions.**
*** This question paper consists of two questions and five pages. Write down answers on this paper itself, attached sheets will not be graded.**

1.
(i) Define (in words) anode and cathode of a cell.

(10 marks)

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(ii) Standard reduction potentials for two half reactions are given below.

$$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)} \qquad E^\circ = 0.771\,V$$

$$Cd^{2+}_{(aq)} + 2e^- \rightarrow Cd_{(s)} \qquad E^\circ = -0.403V$$

Suppose you prepare a cell using these two electrodes. Determine the overall spontaneous cell reaction and the standard cell potential of the cell.

(20 marks)

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(iii) If you convert the cell mentioned in part (ii) into an electrolytic cell by supplying an external voltage, what would be the anode and what would be the cathode? What would be the overall reaction taking place?

(20 marks)

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(iv) What are the three electrodes used in constant potential coulometry?

(15 marks)

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2.

(i) In column chromatography, the retention factor for a component A, K'_A Is defined as follows.

$$K'_A = \frac{t_A - t_M}{t_M}$$

Define each term on the right hand side of the above equation.

(10 marks)

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(ii) Write down the equation for selectivity factor, α, for any two components A and B where B has a higher retention time than A. Define each term on the right hand side of the equation you write.

(08 marks)

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(iii) Suppose you use Thin Layer Chromatography to separate a mixture of three components of which one component is known to be ortho-nitro phenol. **Briefly explain** how do you identify the spot corresponding to ortho-nitro phenol. Draw a diagram of the developed TLC plate according to your explanation.

(17 marks)

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Answers

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(i) Anode is **always** (whether it is an electrochemical cell or an electrolytic cell) defined as the electrode where oxidation takes place. Cathode is **always** defined as the electrode where reduction takes place.

(ii) The electrode having higher reduction potential undergoes reduction. Hence the electrode potential of the cathode is 0.771 V. We also know that

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$E^\circ_{cell} = 0.771\ V - (-0.403\ V) = +1.174\ V$

Here the Cd electrode undergoes oxidation.

$$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)} \qquad E^\circ = 0.771\ V$$

$$Cd_{(s)} \rightarrow Cd^{2+}_{(aq)} + 2e^- \qquad E^\circ = -0.403 V$$

By multiplying first equation by 2 and adding to the second equation, we obtain the overall cell reaction which is given below.

$$2\ Fe^{3+}_{(aq)} + Cd_{(s)} \rightarrow 2\ Fe^{2+}_{(aq)} + Cd^{2+}_{(aq)}$$

(iii) If we convert the above cell into an electrolytic cell, the opposite (non-spontaneous) reaction will take place.

$$2\,Fe^{2+}_{(aq)} + Cd^{2+}_{(aq)} \rightarrow 2\,Fe^{3+}_{(aq)} + Cd_{(s)}$$

Cadmium ions will be reduced to cadmium (i.e. reduction). Hence Cd electrode is the cathode. Ferrous ions will be oxidized to ferric ions (i.e. oxidation). Hence Fe electrode is the anode.

(ii) In the case of metallic electrodes the analyte undergoes oxidation or reduction. Membrane electrodes work on an entirely different principle. The analyte is not subjected to oxidation or reduction. Instead the variable portion of the overall cell potential is a junction potential. The same ion is present on both sides of the membrane having different concentrations.

(iii)
(a) Working electrode, where the reaction of interest takes place.
(b) Reference electrode, usually a standard calomel electrode
(c) An auxiliary electrode.

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Address:.....

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