THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. Degree Programme / Stand alone courses in Chemistry
Level 5 –Continuous Assessment Test 1– 2014 / 2015

CMU 3123/CME 5123 – Analytical Chemistry

Duration: One hour
Date and time: 08th February, 2015 from 9.00 a.m. to 10.00 a.m.

Reg. No.....

Question number	Max. marks	marks
1	50	
2	50	
Total		

Instructions to students

Answer all questions in the spaces given. Additional sheets will not be marked.

(1). A random sample of an industrial effluent (100.0 cm^3) was subjected to gravimetric analysis in order to determine the amount of Cu^{2+}. When 100.0 cm^3 of X^{2-} (0.001 M) was added to the sample, the precipitate CuX just started to form. After completion of precipitation, the weight of the precipitate obtained was 0.1910 g (Cu = 63.5, X= 32.0).

(a) State three essential properties that CuX should have in order to determine the amount of Cu^{2+} using gravimetry.

(09 marks)

(b) Calculate the solubility product of CuX.

(16 marks)

(c) Zn^{2+} was also present in the effluent in similar concentration to Cu^{2+} and forms the precipitate ZnX. However, selective precipitation of Cu^{2+} and Zn^{2+} was possible having the precipitation of CuX first. Comment on the solubility product of ZnX compared to the solubility product of CuX.

(10 marks)

(d) One student stated that since the sensitivity of the method gravimetry is low, the accuracy of results is poor.

(a) Define the term "sensitivity" with respect to methods of analysis.

(b) What is meant by "accuracy"?

(c) Suggest one way of improving accuracy in the above analysis.

(15 marks)

(2) (a) Compare acid- base titrations and redox titrations with respect to feasibility, selectivity and titration curves.

(30 marks)

(b) What is the difference between the formal potential and the standard potential of a reaction?

(06 marks)

(c) Calculate the concentration of Mg^{2+} in a solution prepared by adding 50.0 cm^3 of 0.500 M Mg^{2+} into a 50.0 cm^3 solution of 0.500 M EDTA. State all the assumptions you made in the calculation.

(K_{MgY} = 3.2 x 10^8 mol^{-1} dm^3, $\alpha_{Mg^{2+}}$ = 0.4)

(14 marks)

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CMU 3123 – ANALYTICAL CHEMISTRY - Level 5 — 2014/2015

Assignment Test I - ANSWER GUIDE

1. (a)Requirements of a precipitate to be analyzed using gravimetry:
   1. It should have a very low solubility.
   2. Should be able to wash and filter easily.
   3. Should be able to obtain in pure form.

(b) You are adding X^{-2} solution to a Cu^{+2} solution.

$$K_{sp} = [Cu^{+2}][X^{-2}] \longrightarrow (1)$$

The amount of Cu+2 that was already present at the time of precipitation = Amount of Cu in CuX

Molecular weight of CuX = 95.5 $gmol^{-1}$

Therefore, Cu in 0.1910g of CuX $= \frac{1\ mol\ X\ 0.1910}{95.5} = 0.002\ mol$

Total Volume = 200 cm^3

Concentration of Cu^{+2} $= \frac{0.002\ mol\ X\ 1000}{200} = 0.01\ M$

When 0.001M 100ml of X^{-2} was added only the precipitate started to form indicating that it was the time that the solubility product just exceeded the ionic product.

Concentration of X^{-2} in the solution at that time $= \frac{0.001\ x\ 100\ x\ 1000}{1000\ x\ 200} = 0.0005\ M$

By substituting equation (1)

Ksp = 0.01 x 0.0005 = $5 \times 10^{-6}\ mol^2dm^{-6}$

(c) Since Cux was precipitated first, Ksp of ZnX is higher than Ksp of CuX.

For selective precipitation (with similar concentration of ions),

$$\frac{K_{sp1}}{K_{sp2}} > 10^4$$

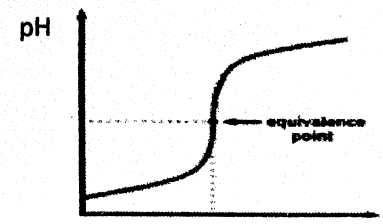
Therefore, for selective precipitation ZnX and CuX, Ksp of ZnX should be 10^4 times (or more) higher than Ksp of Cux.

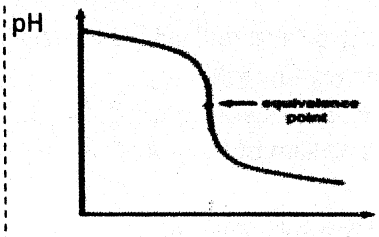
(d) (a) Sensitivity – Change of response for a unit change in the amount of sample.
(b) Accuracy - Closeness of a result to the true or accepted value.
(c) We can use one of the methods below:–
   1. Corrections
   2. Blank determination
   3. Compensation
   4. Method of standard addition

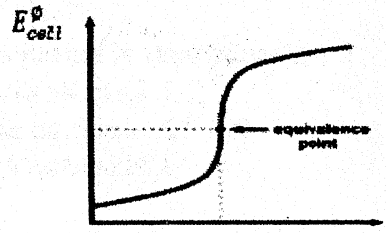
2.(a)

Acid-Base	Redox
Feasibility $\Delta G = -RTlnK$; ΔG should be negative & high.	$\Delta G = -nFE$; ΔG should be negative & high.
Selectivity If only, $\frac{K_{a1}}{K_{a2}} > 10^4$	If only, $E^{\emptyset}_{cell} - E^{\emptyset}_{cell2} \geq 0.4V$

Titration Curves







If the potential of the titrant< titrand, the shape of the curve would be the other way round.

(b)

Standard Potential – potential in standard (specified) conditions
Formal Potential – potential in the actual conditions.

(c)

Mg^{+2} + EDTA $\longrightarrow$ MgEDTA

Mg^{+2} : EDTA = 1 : 1

The amount of MgEDTA formed = $\frac{0.5\ X\ 50}{1000} = 25\ x\ 10^{-3}\ mol$

Concentration of MgEDTA = $\frac{25\ x\ 10^{-3}\ x\ 10^{3}}{100} = 0.25\ M$

At equilibrium,

Mg^{+2} + EDTA $\rightleftharpoons$ MgEDTA

x x 0.25M – x

$K_{Mg'y'} = K_{Mgy} . \alpha_{Mg} . \alpha_{y^{4-}}$ = 3.2 x 10^8 x 0.4 x 1 = 1.28 x 10^8 $mol^{-1}dm^3$

Assumption $\alpha_{y^{4-}} = 1$

$K_{Mg'y'} = \frac{[MgEDTA]}{[Mg^{+2}]'.[y]'} = \frac{0.25-x}{x^2}$, $0.25 - x \approx 0.25$ *since* $x \lll\lll 0.25\ M$

$1.28 \times 10^8 = \frac{0.25}{X^2}$

$x = \sqrt{\frac{0.25}{1.28 \times 10^8}} = 4.419\ x\ 10^{-5}\ M$