THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. Degree Programme / Stand alone courses in Chemistry
Level 5 –Continuous Assessment Test II– 2015 / 2016
CMU 3123/CME 5123 – Analytical Chemistry

Duration: One hour
Date and time: 14th May, 2016 from 4.00 p.m. to 5.00 p.m.

Reg. No……………………………………

Question number	Max. marks	marks
1	56	
2	44	
Total	100	

Instructions to students

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

1. (i) A mixture of $CaCO_3$ and CaO was analysed using Thermogravimetry. Only one decomposition was observed. It was between 600°C – 900°C and the weight was decreased from 150.6 mg to 106.6 mg. (C= 12.00g, O = 16.00 g, Ca = 40.00g)

(a) Draw and label the Thermo Gravimetric curve.

(b) Calculate the weight of CaO in the above mixture.

(22 marks)

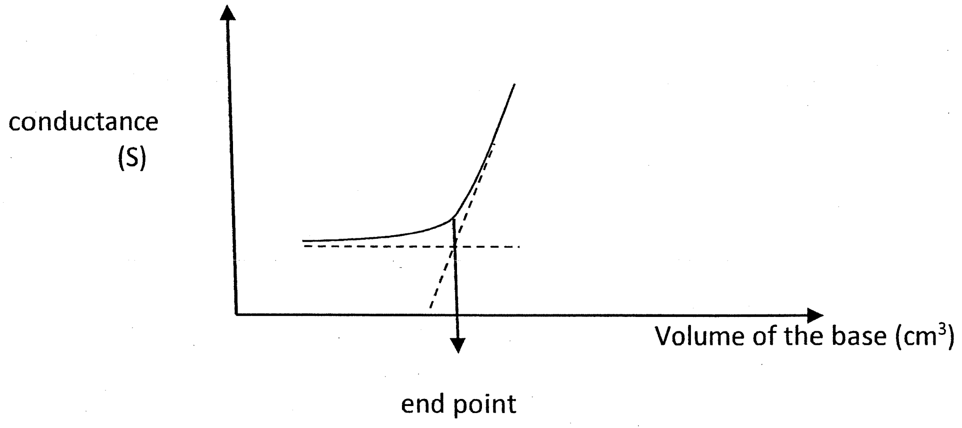
(ii) Name two components used in Atomic Absorption Spectrophotometer which are not used in UV-Visible spectrophotometer and explain the function of the two components.

(14 marks)

(iii) Give one major disadvantage and one major advantage of potentiometric titrations compared to classical titrations.

(06 marks)

(iv) The following conductometric titration curve is of an acid base titration. Comment whether the acid and the base are strong or weak and justify your answer.



(14 marks)

2. A 15.0 cm^3 sample of water containing M^{2+} (0.0500 M) was extracted with two 10.0 cm^3 portions of an organic chelating legend HL. HL undergoes partial dissociation in aqueous phase. M^{2+} forms ML complex with L^-.

(i) Write down the equation with chemical species to show the distribution ratio of the metal ion in the two phases.

(06 marks)

(ii) State one assumption that you made when writing down the equation for the distribution ratio in above 2. (i).

(04 marks)

(iii) If the distribution ratio of the metal in the two phases is 8.05, calculate the concentration of the metal ion that will be in the organic phase after extracting with two 10.0 cm^{3}portions of HL.

(19 marks)

(iv) What would you expect to observe if the above extraction was carried out at low pH? Give reasons for your answer.

(15 marks)

Name ……………………………………………………………

Address ……………………………………………………

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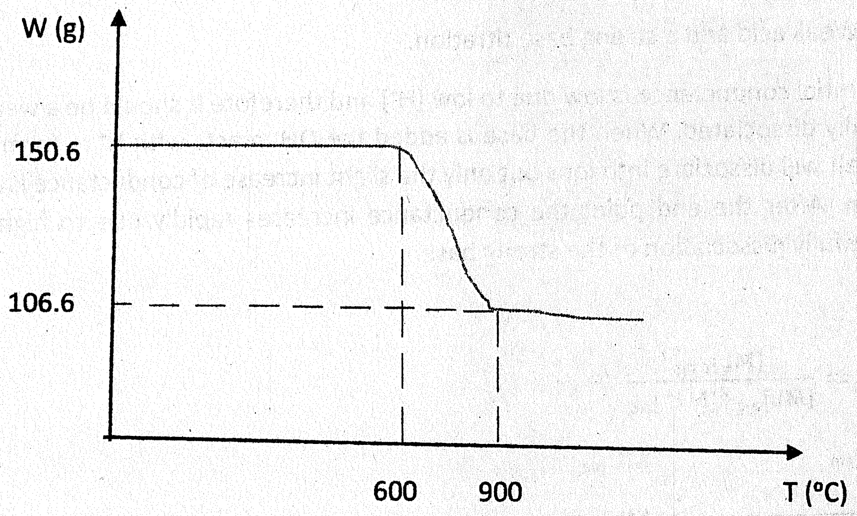
Answer Guide

(i)(a)



(b)

$$CaCO_3 \xrightarrow[\Delta]{} CaO + CO_2$$

Weight loss is due to CO_2.

Molecular weight of CO_2 = 44 g

Weight loss = 150.6 mg – 106.6 mg = 44 mg

Number of moles of CO_2 = $\frac{44\ \text{mg}}{44 \times 1000\ \text{mg}}$ = 1mmol

Number of moles of $CaCO_3$ in the mixture which had produced 1 mmol of CO_2 = 1mmol

Molecular weight of $CaCO_3$ = 100 g

Weight of $CaCO_3$ = 100 $\text{gmol}^{-1} \times 1 \times 10^{-3}$ mol = 0.1 g

Weight of the CaO = 150.6 mg – 100 mg = 50.6 mg

Or

Number of moles of new CaO produced with 1mmol of CO_2 = 1mmol

Molecular weight of CaO = 56 g

Weight of new CaO produced= 56 $\text{gmol}^{-1} \times 1 \times 10^{-3}$ mol = 56 mg

Weight of total CaO after heating (already present + produced)= 106.6 mg

Weight of the CaO that was present in the mixture= 106.6 mg – 56.0 mg = 50.6 mg

(ii)

- Hollow Cathode Lamp – The source of energy to provide the required λ_{max} of the analyte.
- Modulator – To help the detector to identify unabsorbed λ from emitted λ.
- Flame (Atomizer) – To provide energy to atomize the analyte.

(iii) Disadvantages – Time consuming, high cost

Advantages – Can titrate
- Coloured solutions.
- Solutions where indicators are not available.
- Solution of which $\Delta E^0 < 0.4$ V

(iv) You have to note that it is the base that is added from the burette and you have the acid in the flask.

It is a Weak acid and a strong base titration.

Reason – The initial conductance is low due to low $[H^+]$ and therefore it should be a weak acid which is partially dissociated. When the base is added the OH^- reacts with H^+ to form water and salt. The salt will dissociate into ions but only the slight increase of conductance is shown due to dilution. After the end point the conductance increases rapidly due to high $[OH^-]$ resulted by the fully dissociation of the strong base.

2.

(i) $D = \frac{[M]_{org}}{[M]_{aq}} = \frac{[ML]_{org}}{[ML]_{aq}+[M^{2+}]_{aq}}$

(ii) $M^{2+}_{(aq)} + L^{-}_{(aq)} \qquad ML_{(aq)}$

$$ML_{(aq)} \rightleftharpoons ML_{(org)}$$

- ML (Metal – Ligand complex) is only formed in aqueous medium.
- The only form of M^{2+} extracted into the organic phase is the ML_2 complex.
- Metal ion (M^{2+}) doesn't undergo any other side reactions.

(iii) $C_n = \left[\frac{V_{aq}}{DV_{org}+V_{aq}}\right]^n C_0$

C_n = Concentration in aqueous phase
C_0 = Initial concentration
D = Distribution ratio
V_{org} = Volume in organic phase
V_{aq} = Volume in aqueous phase

$$C_n = \left[\frac{15.0}{8.05 \times 10.0 + 15.0}\right]^2 0.0500 = 0.00123M$$

$C_{org} = C_0 - C_n = 0.0500\ M - 0.00123\ M = 0.04877\ M = 0.0488\ M$

(iv) $HL_{(aq)} \rightleftharpoons H^+_{(aq)} + L^-_{(aq)}$

$$M^{2+}_{(aq)} + L^-_{(aq)} \longrightarrow ML_{(aq)}$$

$$ML_{(aq)} \rightleftharpoons ML_{(org)}$$

At low pH, $[H^+]$ is high. Therefore, dissociation of HL is low, thus $[L^-]$ is decreased. Due to that reason, $[ML]_{(aq)}$ become less resulting decrease in $[ML]_{(org)}$. Therefore distribution ratio (D) will be decreased. So the concentration of ML remaining in the aqueous phase will be increased thus decreasing the amount extracted into the organic phase.

So at low pH the concentration of metal ion in the organic phase will be less.