# THE OPEN UNIVERSITY OF SRI LANKA
## B.Sc. Degree Programme / Stand alone course – Level 4
## CHU 2125/CHE 4125 – Analytical Chemistry - 2011/2012
## Assignment Test II

Duration: One and half-hours

22nd September 2011- 4.00 p.m. to 5.30 p.m.

Index No.

| | No. | Marks |
|---|---|---|
| Unanswered/more than one answer | | |
| Wrong Answers | | |
| Correct Answers | | |
| Total | | |

**PART I (MCQ)**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 1 | 2 | 3 | 4 | 5 | 2. | 1 | 2 | 3 | 4 | 5 | 3. | 1 | 2 | 3 | 4 | 5 |
| 4. | 1 | 2 | 3 | 4 | 5 | 5. | 1 | 2 | 3 | 4 | 5 | 6. | 1 | 2 | 3 | 4 | 5 |
| 7. | 1 | 2 | 3 | 4 | 5 | 8. | 1 | 2 | 3 | 4 | 5 | 9. | 1 | 2 | 3 | 4 | 5 |
| 10. | 1 | 2 | 3 | 4 | 5 | 11. | 1 | 2 | 3 | 4 | 5 | 12. | 1 | 2 | 3 | 4 | 5 |
| 13. | 1 | 2 | 3 | 4 | 5 | 14. | 1 | 2 | 3 | 4 | 5 | 15. | 1 | 2 | 3 | 4 | 5 |
| 16. | 1 | 2 | 3 | 4 | 5 | 17. | 1 | 2 | 3 | 4 | 5 | 18. | 1 | 2 | 3 | 4 | 5 |
| 19. | 1 | 2 | 3 | 4 | 5 | 20. | 1 | 2 | 3 | 4 | 5 | | | | | | |

(2 marks x 20= 40 marks)

| Question | | Marks |
|---|---|---|
| Part I (MCQ) | | |
| Part II | Q1 | |
| | Q2 | |
| Total | | |

## PART I

1. According to Phase rule: $P + F = C + 2$, the number of degrees of freedom (F) at the triple point of water is
   (1) F= 1-1+2 (2) F= 2-3+2 (3) F= 1-2+2 (4) 2-1+2 (5) F= 1-3+2

2. What is the number of degrees of freedom for a system in which methanol vapour is in equilibrium with liquid methanol?
   (1) 0 (2) 1 (3) 3 (4) 4 (5) 5

3. At a particular temperature, the mole fraction of 'X' in the vapour phase is 0.25, while that in the liquid phase is 0.50. The mole fraction of 'Y' in the vapour phase is 0.75, while that in the liquid phase is 0.50. The relative volatility, $\alpha$ is
   (1) 1.5 (2) 0.33 (3) 3.0 (4) 0.67 (5) 0.5

4. A binary mixture of A and B with a mole fraction of 0.66 with respect to A, boils at 88°C under 1atm. The vapor pressures of pure A and B at this temperature are 1.26 and 0.5 atm respectively. What is the relative volatility of A with respect to B?
   (1) 2.52 (2) 0.4 (3) 1.94 (4) 0.52 (5) 0.6

5. A solution of 0.1 g of $I_2$ in 50.0 $cm^3$ of aqueous solution is extracted with 25.00 $cm^3$ chloroform. Calculate the percentage of $I_2$ extracted. ($K_D$= 85)
   (1) 97.7 (2) 99.9 (3) 85.5 (4) 90.0 (5) 85.5

6. 1 g of benzoic acid ($K_a = 6.5 \times 10^{-5}$) originally dissolved in 50.0 $cm^3$ of water is equilibrated with 50.0 $cm^3$ of ether at pH 6. Distribution coefficient, $K_D$ of benzoic acid between ether and water is 10. Benzoic acid is in one form in ether. The distribution ratio, $D_C$ is
   (1) 0.09 (2) 0.12 (3) 0.15 (4) 0.17 (5) 0.20

7. An aqueous solution containing 1.0 mg of tetracyclin in 100.0 $cm^3$ water is extracted with 10.0 $cm^3$ portion of ether. After equilibration, the ether contained 0.95 mg of tetracyclin only. The distribution coefficient $K_D$ of tetracyclin is
   (1) 10 (2) 19 (3) 190 (4) 95 (5) 5

Questions 8-9 is based on the equation $f_n = \left[\frac{V_w}{V_w + D_C V_o}\right]^n$ for the fraction of the solute remained after the $n^{th}$ extraction.

8. 'A' is dissolved in 50 $cm^3$ of aqueous layer and it is extracted to 50 $cm^3$ of ether. $D_C$ is given as 5. Calculate the fraction of solute remained after the $4^{th}$ extraction using the equation:
   (1) 1/6 (2) 1/36 (3) 1/216 (4) 1/1296 (5) 1/7776

9. 1 g of compound 'X' dissolved in 10.0 $cm^3$ of water will be recovered by extracting into an organic solvent. Given that $D_C$= 9.0, how many times the extraction needs to be carried out with 10.0 $cm^3$ portion of organic solvent at a time to achieve 99.99% extraction?
   (1) 1 (2) 2 (3) 3 (4) 4 (5) 5

10. Some of the factors affecting solvent extraction are
    a) densities of solvents b) viscosities of solvents c) type of extracting agent
    d) Miscibilities of the solvents.

The answer is

1) a) and b) only 2) b) and c) only 3) c) and d) only
4) a) and d) only 5) All of the above.

11. A light beam has a wave length of 0.085 microns. What is the energy of a photon in joules? ($c = 3x10^8$ m $s^{-1}$; $h = 6.63x10^{-34}$ J s)
(1) $2.18 \times 10^{-19}$ (2) $2.50 \times 10^{-19}$ (3) $2.23 \times 10^{-25}$ (4) $2.34 \times 10^{-18}$ (5) $2.45 \times 10^{-24}$

12. In UV-Visible spectrophotometer, radiant power of the incident light is 80 and two thirds of it is absorbed by the sample. What is the percentage of transmittance?
(1) 66.67 (2) 33.33 (3) 80.50 (4) 40.87 (5) 50.58

13. If 25% of the light is transmitted through a sample at a particular wavelength, calculate the corresponding absorbance at that wavelength.
(1) 0.25 (2) 0.75 (3) 0.60 (4) 0.40 (5) 0.50

14. A compound has a molar absorptivity of 1000 $dm^3$ $mol^{-1}$ $cm^{-1}$ at 300 nm. A sample containing this compound has an absorbance of 0.2 at 300 nm in a 1 cm cuvette. What is the concentration (mol $dm^{-3}$) of the compound in the sample?
(1) 0.2 (2) 0.02 (3) 0.002 (4) 0.0002 (5) 2.0

15. An ointment which prevents penetration of uv light through human skin, has an absorbance of 0.60 at 300nm. What is the percentage of uv light absorbed by the ointment?
(1) 60 (2) 40 (3) 25 (4) 75 (5) 50

16. Which of the following is **not** a type of interference present in Atomic Absorption Spectrophotometry (AAS)?
(1) physical interference (2) chemical interference (3) solvent interference
(4) interference by ionization (5) spectral interference

17. The SI unit of the term $\frac{RT}{nF}$ is
(1) J (2) $JK^{-1}$ (3) J $mol^{-1}$ (4) V (5) CV

18. The function of a salt bridge is to
(a) replenish salt lost due to evaporation (b) complete the electrical circuit
(c) make sure the system is electrically neutral (d) bridge the gap between the two solutions
The answer is
(1) (a) and (b) only (2) (b) and (c) only (3) (c) and (d) only (4) (d) and (a) only
(5) (a), (b) and (c) only

19. Which of the following represents the unit Seimen of conductance?
(1) A $kg^{-1}$ $m^{-2}$ $s^3$ (2) $A^2$ $kg^{-1}$ $m^{-2}$ $s^3$ (3) $A^2$ $kg^{-1}$ $m^{-1}$ $s^3$
(4) $A^2$ $kg^{-1}$ $m^{-2}$ $s^2$ (5) $A^2$ $kg^{-1}$ $m^{-2}$ $s^{-1}$

20. In pH measurements using a combined electrode, the cell voltage using a buffer solution of pH z is 'x'. If the cell voltage using an unknown buffer is 'y', the pH of the unknown buffer is
1) $\frac{y-x}{59.14} + z$ 2) $\frac{x-y}{59.14} + z$ 3) $\frac{z-x}{59.14} + y$ 4) $\frac{z-y}{59.14} + x$ 5) $\frac{y-x}{59.14}$

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## PART II (Structured type)

1. (i) Explain the terms, 'resonance line' and 'monochromatic light'.

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(ii) Identify the main function(s) of the Hollow Cathode Lamp (HCL).

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(iii) Distinguish between 'selectivity'and 'sensitivity' in relation to Atomic Absorption Spectrophotometer (AAS).

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(iv) Write the advantages of AAS.

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(30 marks)

2. (i) Compare the chemical principles involved in potentiometry and conductometry.

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(ii) Write down the electrode reaction for the calomel electrode and hence write the expression for its electrode potential in terms of the standard electrode potential and the concentration term.

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(iii) Sketch the conductometric titration curve for the titration: strong acid vs. weak base. Indicate the equivalence point.

(iv) A student measured the conductance (G) of 0.100 mol $dm^{-3}$ aqueous solution of KCl in a conductivity cell as $9.9 \times 10^{-3}$ S at 27 $^{0}$C. Given the conductivity ($\kappa$) of 0.100 mol $dm^{-3}$ KCl at 27 $^{0}$C as 0.01337 S $cm^{-1}$, calculate the cell constant of the cell.

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(30 marks)

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Answer Guide

# CHU 2125/CHE 4125 – Analytical Chemistry – 2011/2012
## Assignment Test II

## PART I (MCQ)

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|---|---|---|---|---|
| 1) 5 | 2) 2 | 3) 3 | 4) 1 | 5) 1 |
| 6) 3 | 7) 3 | 8) 4 | 9) 4 | 10) 5 |
| 11) 4 | 12) 2 | 13) 3 | 14) 4 | 15) 4 |
| 16) 3 | 17) 4 | 18) 2 | 19) 2 | 20) 1 |

## PART II (Structured type)

1. (i) Resonance Line : The best wave length of light suitable for absorption by an atom.

Monochromatic Light : Light made out of only one wave length.

(ii)
1. Act as the radiation source for AAS
2. Produce the resonance wavelength characteristic to the particular element to be analyzed.

(iii) Here, the cathode of HCL is made up of the same element that is going to be analyzed. Therefore, this is highly selective.
It has a very low detection limit and minute quantities can be detected.
So Highly sensitive method.

(iv)
1. High accuracy due to specific method for each metal
2. Freedom from interference from other constituents
3. Since free metal atom in the flame are detected
4. High sensitivity is obtained
5. The detection limit is low. (highly selective)

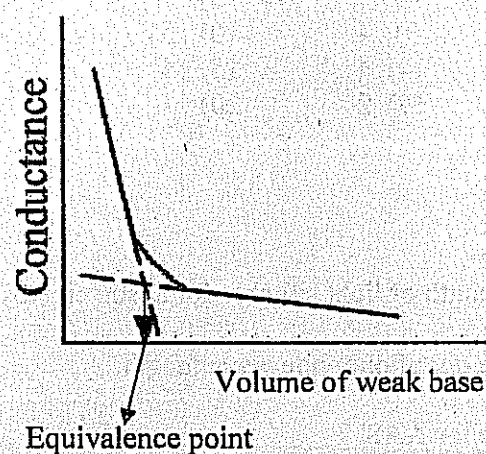
2.(i)

| **Potentiometry** | **Conductometry** |
|---|---|
| Electrons are involved | Ions are conducting |
| Measurement of the Potential difference between two points on an electric circuit | Measurement of the Conductance, Conductivity or electrical resistance of an electrolyte solution |

(ii) $Hg_2Cl_{2\,(s)} + 2e \longrightarrow 2\,Hg_{(l)} + 2\,Cl^-_{(aq)}$

$$E_{Hg^+/Hg} = E^{\theta}_{Hg^+/Hg} - \frac{RT}{2F}\ln\left[Cl^-\right]^2_{(aq)}$$

(iii)




(iv) $G = \kappa\left(\frac{a}{l}\right)$

$$\text{Cell constant} = \left(\frac{l}{a}\right) = \frac{K}{G} = \frac{0.01337\ S\ cm^{-1}}{9.9\times10^{-3}\ S}$$

$$= 135.05\ m^{-1}$$

$$\approx 130\ m^{-1}$$