Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	ANALYTICAL CHEMISTRY
COURSE CODE	:	DAS 12403
PROGRAMME	:	DAU
EXAMINATION DATE	:	JUNE 2017
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	SECTION A) ANSWER **ALL** QUESTIONS SECTION B) ANSWER **THREE** (3) QUESTIONS ONLY

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THIS QUESTION PAPER CONSISTS OF **FIVE** (5) PAGES

SECTION A

Q1 (a) (i) Explain the terms quantitative and qualitative analysis in Analytical Chemistry. Give example for each term to differentiate the analysis.

(4 marks)

(ii) Selecting a method is one of the steps in quantitative analysis. Explain the factors need to be considered in the selection process.

(4 marks)

(b) Calculate the concentration of each following solutions.

(i) The molality of solution made by dissolving 25 g of NaCl (58.44 g/mol) into 2.0 L of distilled water. Assume the density of water d = 1.0 g/mL.

(4 marks)

(ii) The molarity of hydrochloric acid (HCl), if the following information written on the bottle:
Molar mass = 36.46 g/mol, Density = 1.18 g/ml, Weight percent = 37% (w/w)

(4 marks)

(c) (i) Differentiate the terms accuracy and precision.

(2 marks)

(ii) Ten (10) pH measurements were recorded for water sample collected from polluted lake. Draw the pattern of the data if the data obtained were high accuracy high precision, low accuracy high precision and low accuracy low precision.

(3 marks)

(iii) Determine the median, mean and standard deviation for the following pH data:
3.1, 3.2, 3.2, 3.5, 3.1, 3.5, 3.6, 3.4, 3.3, 3.4

(4 marks)

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SECTION B

Q2 (a) Define the following terms in titrimetric analysis.

(i) titration curve of strong acid and strong base
(ii) equivalence point and end point of a titration
(iii) indicator solution

(5 marks)

(b) (i) A 1.50 mL sample of a fairly concentrated hydrochloric acid solution is diluted to 250.00 mL with distilled water. A 20.00 mL sample of the diluted solution requires 22.50 mL of a 0.0125 M solution of $Ba(OH)_2$ to be titrated to the equivalence point. Determine the molarity of the original hydrochloric acid solution.

(5 marks)

(ii) A truck containing 2750 kg of a 5.0 M hydrochloric acid has been in an accident and is in danger of spilling its load. Determine the mass of $Ca(OH)_2$ should be sent to the scene in order to neutralize all of the acid in case the tank bursts. The density of the 5.0 M HCl solution is 1.05 g/mL.

(5 marks)

(c) A student was asked to determine the concentration of ammonia, a volatile substance, in a commercially available cloudy ammonia solution used for cleaning. The student pipetted 25.00 mL of the cloudy ammonia solution into a 250.0 mL conical flask. 50.00 mL of 0.100 M HCl solution was immediately added to the conical flask which reacted with the ammonia in solution. The excess (unreacted) HCl was then titrated with 0.050 M NaOH. 21.50 mL of NaOH solution was required. Calculate the concentration of the ammonia in the cloudy ammonia solution.

(10 marks)

Q3 (a) (i) Explain the difference between the transmittance and absorbance.

(2 marks)

(ii) State and explain the Beer Lambert's Law.

(3 marks)

(b) (i) A solution of a specific vitamin has a concentration of 5.23×10^{-7} M. The absorbance of the solution at 275 nm is 0.170. Determine the molar absorptivity of the vitamin at 275 nm. The cuvette used has a path length of 1.00 cm.

(4 marks)

(ii) The absorbance at 280 nm of a 1 mol/L solution of the enzyme trypsin in a 1 cm cuvette is 1.43. Determine the concentration of a solution of trypsin that has an absorbance of 1.50 in a 0.5 cm cuvette.

(4 marks)

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(c) A 1.00 ml aliquot of a solution was withdrawn from a solution in a 5 ml volumetric flask that contains a compound with a formula mass of 292.16 g/mol. The aliquot was placed in a 10 ml volumetric flask and diluted to the mark. The absorbance measured at 340 nm was 0.427 in a 1.000 cm cuvette. The molar absorptivity for this compound at 340 nm is 6130 M^{-1} cm^{-1}.

(i) Calculate the concentration of compound in the cuvette.

(4 marks)

(ii) Calculate the concentration of compound in the 5 ml volumetric flask.

(4 marks)

(iii) Determine the weight of compound (in mg) that were used to make the 5 ml solution.

(4 marks)

Q4 (a) Explain the following terms related to chromatography.

(i) mobile phase and stationary phase
(ii) retention time and theoretical plates
(iii) liquid chromatography and gas chromatography

(6 marks)

(i) Describe 2 (two) types of pumps used in high performance liquid chromatography (HPLC). Explain the advantages and disadvantages of each type.

(5 marks)

(ii) Discuss the components of a basic gas chromatography (GC) system.

(7 marks)

(c) Quantitative data were obtained by using methyl benzoate as internal standard. The following results in **Table 1** were obtained for calibration curve of cinnamaldehyde oil.

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Table 1

Concentration of cinnamaldehyde standard, ppm	Peak area of cinnamaldehyde/peak area of methyl benzoate
0.00	0.0
0.75	1.2
1.25	2.0
1.55	2.5
1.90	3.0
2.50	4.0

(i) Plot the calibration curve for cinnamaldehyde.

(ii) A sample containing cinnamaldehyde gave the peak area relative to the internal standard area of 2.6. Determine the concentration of cinnamaldehyde oil in the sample.

(7 marks)

Q5 (a) Briefly explain the basic experimental procedure for gravimetric analysis.

(5 marks)

(b) The percentage purity of powdered, impure magnesium sulfate, $MgSO_4$, was determined by gravimetric analysis. 32.50 g of the impure magnesium sulfate was dissolved in water and the solution was made up to 500.0 mL in a volumetric flask. Different volumes of 0.100 M $BaCl_{2(aq)}$ were added to six separate 20.00 mL samples of this solution. This precipitates the sulfate ions as barium sulfate. The equation for the reaction is

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

The precipitate from each sample is filtered, rinsed with de-ionised water and then dried to constant mass. The results of this analysis are shown in **Table 2.** Given atomic mass in $gmol^{-1}$: Ba (137.3), S (32.1), O (16 .0), Mg (24.3), Cl (35.5)

Table 2

Sample	1	2	3	4	5	6
Volume of $BaCl_2$ added (ml)	30.0	60.0	90.0	120.0	150.0	180.0
Mass of $BaSO_4$ (g)	0.704	1.41	2.00	2.00	2.00	2.00

(i) Plot the graph of mass of $BaSO_4$ precipitate versus volume of $BaCl_2$ added.

(4 marks)

(ii) Explain why it is necessary to rinse the precipitate with de-ionised water before drying.

(2 marks)

(iii) From **Q5b(i)**, analyse the graph and discuss on the graph obtained.

(4 marks)

(iv) Calculate the amount, in mole, of $SO_4^{2-}(aq)$ in the 500.0 mL volumetric flask.

(5 marks)

(v) Calculate the percentage, by mass, of magnesium sulfate in the powder.

(5 marks)

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-END OF QUESTIONS-