Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	ANALYTICAL CHEMISTRY
COURSE CODE	:	DAK 12603
PROGRAMME CODE	:	DAK
EXAMINATION DATE	:	JANUARY/ FEBRUARY 2021
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND **TWO (2)** QUESTION IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

SECTION A

Q1 (a) The maximum permissible concentration of chloride in a municipal drinking water supply is 2.50×10^2 ppm of Cl^-. Exceeding the said limit will result in a distinctive salty taste making it unfavorable to be consumed. Calculate the equivalent molar concentration of the Cl^-.

(3 marks)

(b) A 500 ml of standard stock solution containing 2.370 g of $KMnO_4$ was readily prepared by the laboratory assistant. You are required to prepare **five (5)** working solutions of 0.600×10^{-4} M, 1.200×10^{-4} M, 2.4×10^{-4} M, 3.6×10^{-4} M and 5.0×10^{-4} M in 250 ml volumetric flasks.

(i) Calculate the volume of $KMnO_4$ standard stock solution required in order to prepare each of the working solutions. Complete and reconstruct **Table Q1(b)** in your answer sheet (Given MW of $KMnO_4$ 158.034 g/mol).

(14 marks)

(ii) Plot the graph of absorbance versus concentration of $KMnO_4$ working solutions. Based on the curve trend, draw a conclusion by referring to the equation on the calibration curve.

(5 marks)

(iii) A sample contains an unknown concentration of $KMnO_4$. Determine the concentration of $KMnO_4$ in the samples if the absorbance of the solution is 0.666.

(3 marks)

Q2 (a) Define and give **one (1)** example of molecular spectroscopy.

(3 marks)

(b) Answer the followings.

(i) Definition of electromagnetic spectrum

(2 marks)

(ii) Write the Beer's Law and state the units for each of the parameters.

(4 marks)

(c) **Table Q2(c)** shows the UV/Vis analysis for standard chemical A at **three (3)** different concentrations. Answer the following questions.

(i) Complete Table Q2(c) and reconstruct the table in your answer sheet together with the calculation steps involve.

(14 marks)

(ii) Determine the value of molar absorptivity, ε if the pathlength of the cuvette is 1cm.

(2 marks)

SECTION B

Q3 (a) Answer the followings.

(i) Definition of infrared spectroscopy.

(2 marks)

(ii) An unknown compound is analyzed using a Fourier Transform Infrared (FTIR) spectroscopy. A strong, sharp peak is observed at frequency of 1750 cm^{-1}. Identify the functional group present and draw its chemical structure.

(3 marks)

(b) Calculate the absorbance of an infrared (IR) peak with 25% of transmittance.

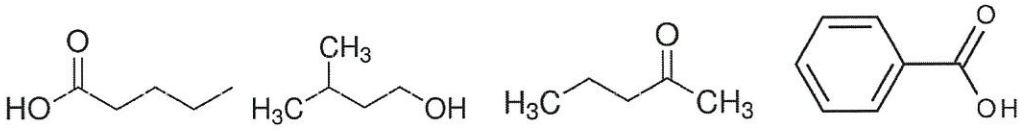
(4 marks)

(c) A block diagram of an FTIR spectrometer is shown in **Figure Q3(c).** Identify component (a), (b), (c), (d) and (e).

(5 marks)

(d) Match the given IR spectrum shown in **Figure Q3(d)** to one of the following compounds. Label at least **three (3)** absorbance bands (or absence thereof) with functional group in the IR that allow you to conclusively identify the compound.

(i) (ii) (iii) (iv)



(11 marks)

Q4 (a) Explain the followings.

(i) **Two (2)** major HPLC components and their functions

(4 marks)

(ii) Difference between HPLC and classical liquid chromatography

(2 marks)

(b) Calculate the number of theoretical plates, N and the plate height, H when the retention time is 15.20 minutes, half of the base width (given in minutes) is 0.55 minutes and the column length is 25 cm.

(6 marks)

(c) The polarity index of a mobile phase which consist of methanol and water is 7.5. Calculate the percentage (%) of methanol and water required to produce the mobile phase. Given the polarity index of methanol and water are 5.1 and 10.2, respectively.

(5 marks)

(d) Based on **Figure Q4(d)**, discuss the polarity of yellow and blue bands by using;

(i) Normal-phase HPLC mode

(4 marks)

(ii) Reversed phase HPLC mode

(4 marks)

Q5 (a) Explain the following terms that are used in chromatography.

(i) Mobile phase

(2 marks)

(ii) Stationary phase

(2 marks)

(b) Discuss **two (2)** types of chromatography.

(4 marks)

(c) Gas chromatography mass specttrometry (GCMS) is an analytical method that combines the features of gas chromatography and mass spectrometry. State the function of GC and MS.

(4 marks)

(d) Detectors are used to determine the presence and quantity of the analytes in a mixture. Discuss **two (2)** properties of an ideal detectors used for GC.

(4 marks)

(e) A GCMS instrumentation is shown in **Figure Q5(e).** Identify component (a), (b), (c), (d) and (e).

(5 marks)

(f) GCMS separation is mainly achieved using columns and temperature-controlled oven.

(i) State **two (2)** types of GC columns.

(2 marks)

(ii) Based on your answer in **Q5f (i)**, suggest and explain the most efficient column in terms of speed, quality and quantity of the separation process.

(2 marks)

-END OF QUESTIONS-

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Table 1 Q1(b) : The volume of $KMnO_4$ stock standard solution to be pipetted for each working standard solution concentration.

No	Concentration of $KMnO_4$ working solution (M)	Volume of $KMnO_4$ Stock Solution (ml)	Absorbance, A
1	0.00		0.000
2	0.600×10^{-4}		0.105
3	1.200×10^{-4}		0.212
4	2.4×10^{-4}		0.402
5	3.6×10^{-4}		0.597
6	5.0×10^{-4}		0.825

Table Q2(c) : UV/Vis analysis of samples

Absorbance at 454 nm	I	Io	T	Concentration (mol/L)
0		0.3		
0.15		0.3		
0.5		0.3		
1	0.03	0.3		0.04

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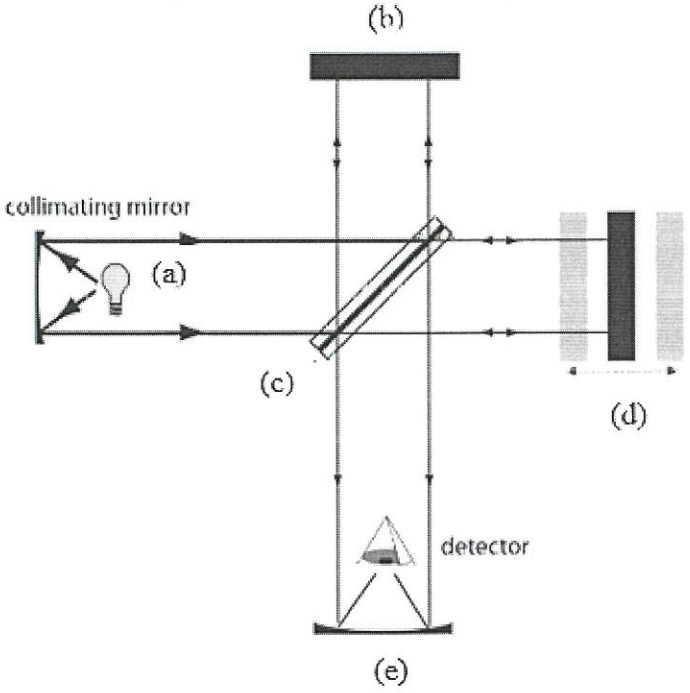

Figure Q3(c)

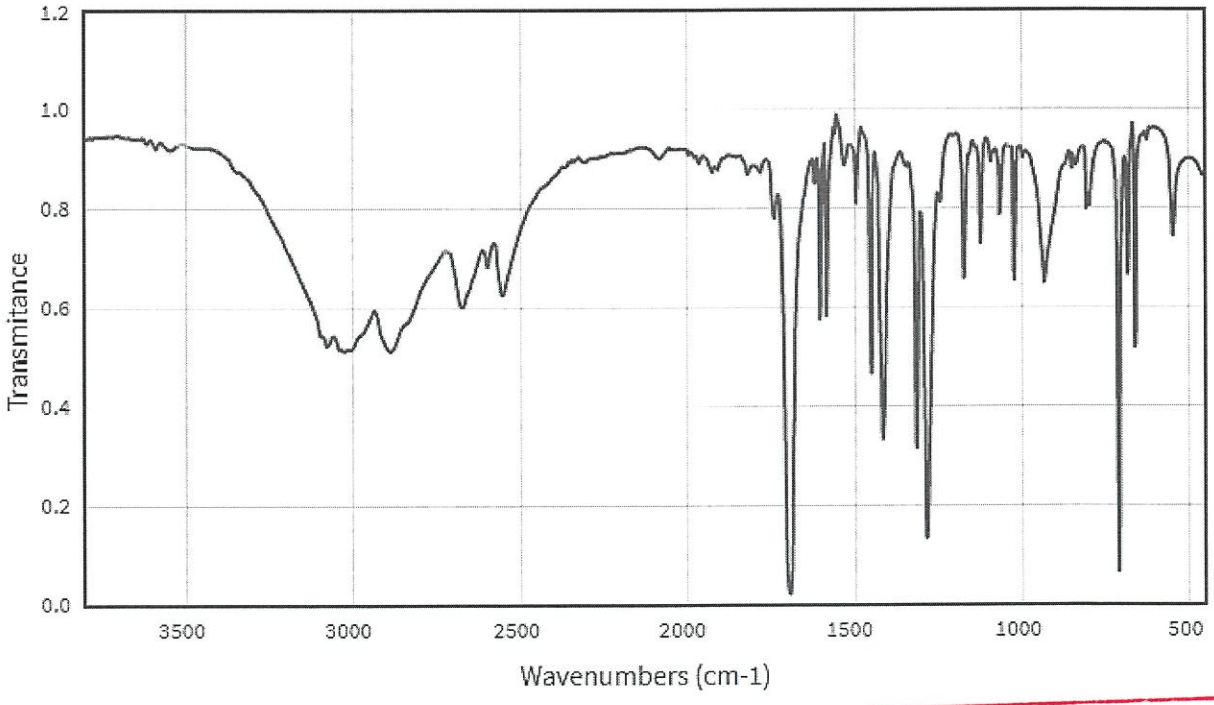

Figure Q3(d)

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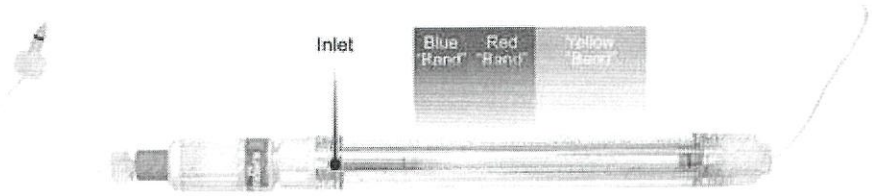

Figure Q4(d)

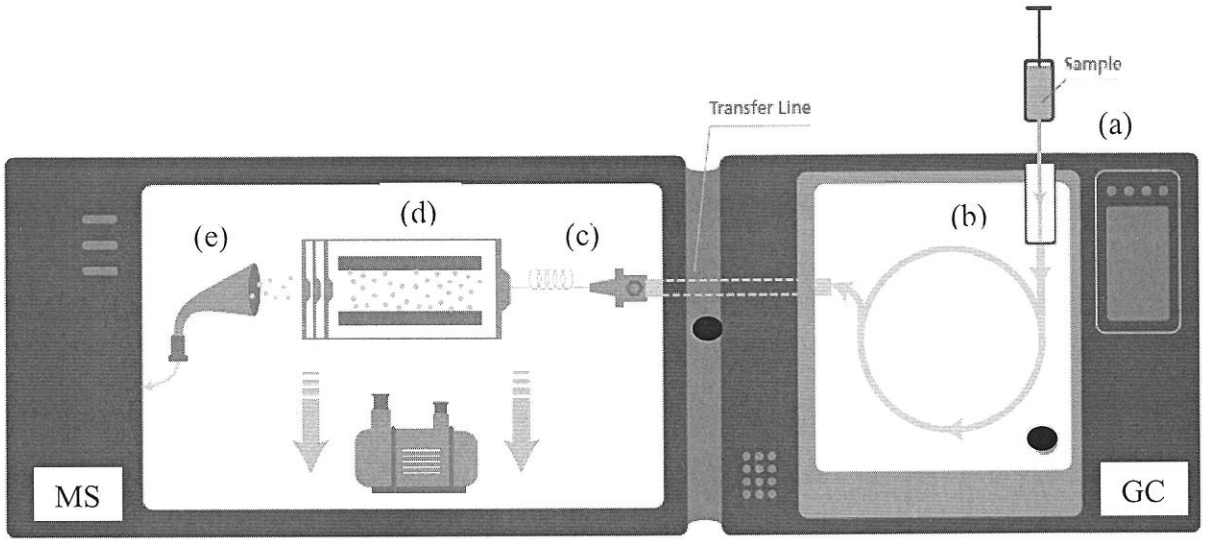

Figure Q5(e)