BINDURA UNIVERSITY OF SCIENCE EDUCATION

CHEMISTRY DEPARTMENT

DIPLOMA IN SCIENCE EDUCATION

DCH007/DC005 ANALYTICAL CHEMISTRY

TIME: **2 HOURS**

Answer **QUESTION ONE 1** and **FOUR (4) OTHERS.** Each question carries **20 marks.**

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1. The data below shows the masses of seven Zimbabwean $ 1 bond coins.

Coin	Mass (g)
1	3.081
2	3.094
3	3.107
4	3.056
5	3.112
6	3.174
7	3.198

(a) Calculate the following:

(i) the mean mass. [2 marks]

(ii) the standard deviation. [3 marks]

(iii) the variance. [3 marks]

(iv) the coefficient of variation. [2 marks]

(b) Describe in detail the steps taken when conducting a mass spectrometric analysis. [4 marks]

(c) What is the principle behind chromatography? [3 marks]

(d) What are the advantages of using HPLC over GLC? [3 marks]

SECTION A: Answer **TWO (2)** questions from this section.

2.

(a) What do you understand by the term relative atomic mass? [2 marks]

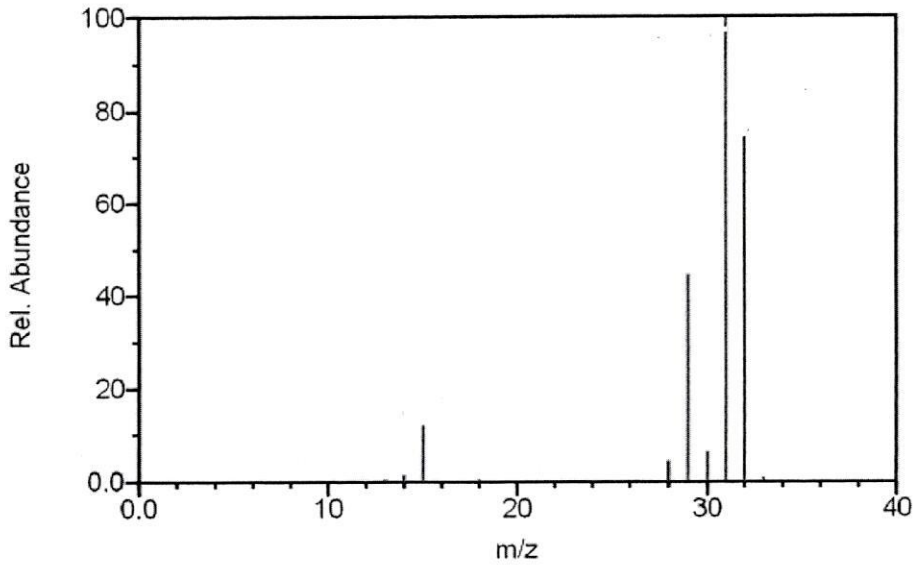
(b) Outline, with the aid of a labelled diagram, the use of the mass spectrometer in the determination of relative atomic masses. [7 marks]

(c) Naturally occurring gallium, Ga, is a mixture of two isotopes, gallium-69 and gallium-71. Use this information, together with the relative atomic mass of Gallium from the Data Booklet, to calculate the percentage abundance of each isotope.

[3 marks]

(d) The mass spectrum of chlorine, $Cl_{2(g)}$, consists of peaks at m/e values of 70, 72 and 74 of relative abundance 9:6:1. Explain these observations as fully as you can. [8 marks]

3. The diagram below shows the mass spectrum of methanol.



(a) Identify the fragments giving rise to the major peaks in the spectrum.

[6 marks]

(b) An analysis of the composition of a newly discovered element, Z, showed the following results.

Isotope	**Relative abundance (%)**
^{20}Z	90.91
^{21}Z	0.16
^{22}Z	8.93

On the mass spectrum of Z, the peak due to isotope ^{21}Z had a peak height of 20 mm.

(i) Deduce the heights of the other two peaks. [2 marks]

(ii) Draw a sketch of a mass spectrum of Z using these heights. [4 marks]

(iii) Calculate the relative atomic mass of Z. [4 marks]

(c) State any **two** common applications of mass spectrometry. [4 marks]

4. (a) Name **any 3** essential components of a mass spectrometer and give a function of each. [6 marks]

(b) What are the advantages of mass spectrometry as an analytical technique? [4 marks]

(c) Explain how separation of components is achieved in chromatography [2 marks]

(d) With the aid of a fully labelled diagram, describe the essential steps involved in performing thin layer chromatography. [8 marks]

SECTION B: Answer **TWO (2)** questions from this section.

5. (a) Describe the steps followed in performing an analytical procedure. [9 marks]

(b) Outline the principle of solvent extraction. [4 marks]

(c) What are the factors that affect the efficiency of solvent extraction? [3 marks]

(d) State the advantages of solid phase extraction over liquid-liquid extractions. [4 marks]

6. **(a)** A mixture of alanine, aspartic acid and serine was analysed by thin layer chromatography (TLC), with SiO_2 as a stationary phase. The TLC mobile phase was 95% ethanol and 5% H_2O.

Alanine	$H_2NCH(CH_3)CO_2H$
Aspartic acid	$H_2NCH(CH_2CO_2H)CO_2H$
Serine	$H_2NCH(CH_2OH)CO_2H$

(i) Deduce with reasons the amino acid with

1. the highest R_f value [3 marks]
2. the lowest R_f value [3 marks]

(ii) The stationary phase, adsorbed SiO_2, was mixed with silver ions, Ag^+.

State and explain how the magnitudes of the Rf values were affected by the Ag^+ ions. [4 marks]

(b) Draw a labelled TLC chromatogram that can be used to show that all the three amino acids were present in the analysed mixture. [4 marks]

(c) State **two** other applications of TLC. [2x2 marks]

(d) Give **two** advantages of TLC over paper chromatography? [2 marks]

7. **(a)** Distinguish between:

(i) Analyte and matrix. [3 marks]
(ii) Determinate error and indeterminate error. [3 marks]
(iii) Qualitative and quantitative analysis. [3 marks]

(b) What do you understand by the term 'partition coefficient? [2 marks]

(c) 20 g of an organic compound is dissolved in 100 cm^3 of water. If the organic compound is extracted with ether, show that the quantity extracted by two 25 cm^3 portions of ether portions is larger than that extracted by one 50 cm^3 portion.

(Partition coefficient = 4) [9 marks]

END OF QUESTION PAPER