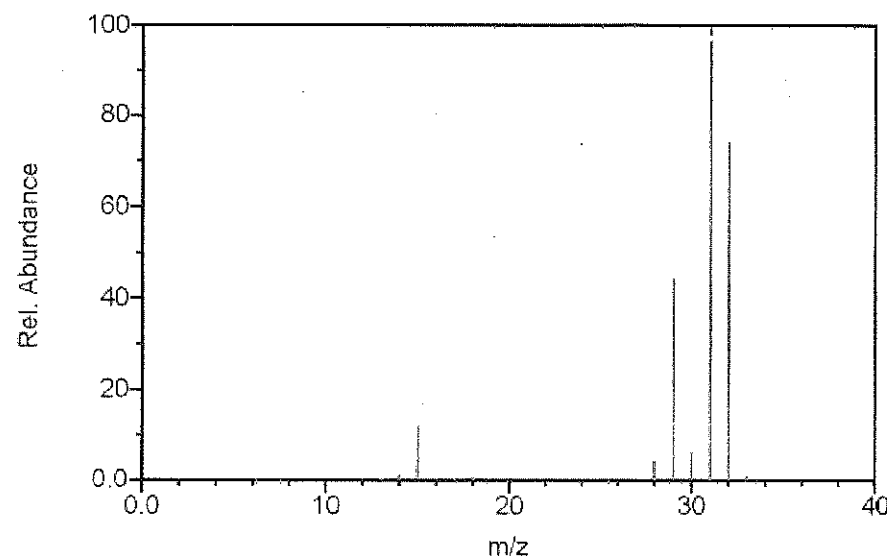


3. The diagram below shows the mass spectrum of methanol.



(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 the 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.

BINDURA UNIVERSITY OF SCIENCE EDUCATION

CHEMISTRY DEPARTMENT

DIPLOMA IN SCIENCE EDUCATION

DCH007/DC005 ANALYTICAL CHEMISTRY

TIME:

APR 2025

2 HOURS

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

1. (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 cm³ of water. If the organic compound is extracted with ether, show that the quantity extracted by two 25 cm³ portions of ether portions is larger than that extracted by one 50 cm³ portion.

(Partition coefficient = 4) [9 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, Cl₂(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]

7. The data below show 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) Using the data above, 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]

END OF QUESTION PAPER

[2 marks]

(d) With the aid of a fully labeled 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]

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

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

(b) 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	$\text{H}_2\text{NCH}(\text{CH}_3)\text{CO}_2\text{H}$
Aspartic acid	$\text{H}_2\text{NCH}(\text{CH}_2\text{CO}_2\text{H})\text{CO}_2\text{H}$
Serine	$\text{H}_2\text{NCH}(\text{CH}_2\text{OH})\text{CO}_2\text{H}$

(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 R_f values were affected by the Ag^+ ions. [4 marks]

(b) Draw a labeled TLC chromatogram that can be used to show that all the three amino acids in 6(a) 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]