

# MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING  
CHEMICAL AND PROCESSING ENGINEERING  
ANALYTICAL CHEMISTRY  
CODE: HCHE 222  
SESSIONAL EXAMINATIONS  
APRIL-MAY 2021  
EXAMINER: MR M MAPOSA  
DURATION: 3 HOURS

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## *INSTRUCTIONS*

1. *Answer all questions*
2. *Each question carries 25 marks*
3. *Total marks 100*

**ADDITIONAL MATERIAL**  
*Periodic table*  
*t-Table*

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## QUESTION 1

(a) An investigation was done to determine calcium content in parts per million in a sample of food. The following results were obtained:

6.8, 6.7, 7.2, 6.9, 6.4, 6.5, 6.3, 6.7, 7.1

- i) Find the mean, mode, range and median of the data
- ii) Calculate the standard deviation [8 marks]

(b) Method 1 and Method 2 have performance parameters given in Table 1.

Table 1

Method	Mean(ppm)	Standard deviation (ppm)
1	6.7	0.8
2	8.2	1.2

Is there any statistically significant difference between these two methods?  
[5 marks]

(c) Distinguish between

- i) random error and systematic error
- ii) classical methods and instrumental methods of analysis
- iii) sample and analyte [12 marks]

## QUESTION 2

(a) Quantitative determination of chloride ions in an unknown can be done using Volhard method or Mohr method. Give a description of each of the techniques, highlighting the reagents used, procedure, indicator used and the conditions under which each method would be more suitable.

[10 marks]

(b) Volhard method is an example of back titration method.

- i) What do you understand by the term back titration?

ii) Under what circumstances would back titration be preferred instead of direct titration? [5 marks]

c) Explain the need for the following practices during an analysis

i) Taking repeated readings

ii) Calibrating the instruments [4 marks]

d) Distinguish between standard addition method and calibration curve method during instrumental analysis [6 marks]

### QUESTION 3

a) Write brief notes on the following terms

i) Le Chatelier's principle

ii) Equilibrium constant

iii) Acid dissociation constant

iv) pH curve

v) Buffer solution [10 marks]

b) Define the following terms as used in analytical laboratory (i) risk (ii) hazard (iii) exposure. How would one mitigate against these? [5 marks]

c) A 50.0 mL aliquot of city drinking water was treated with a small amount of an ammonia – ammonium chloride buffer to bring the pH to 10. After the addition of Calmagite indicator the solution required 10.50 mL of  $5.0 \times 10^{-3}$  M EDTA for titration.

i) Calculate the hydroxide ion concentration in the solution at pH 10.

ii) Explain why alkaline pH mediums are required during EDTA titrations.

iii) Calculate pCa when only 5.25 ml of EDTA solution was added

iv) Calculate the hardness of city water in **mol dm<sup>-3</sup>** calcium carbonate.

[10 marks]

#### QUESTION 4

- a) i) Briefly describe the term gravimetric analysis
- ii) State the four types of gravimetric analysis
- iii) Give any **two** advantages and **one** disadvantage of gravimetric analysis

[9 marks]

- b) A certain barium halide exists as the hydrated salt  $\text{BaX}_2 \cdot 2\text{H}_2\text{O}$ , where X is the halogen. The barium content of the salt can be determined by gravimetric methods. A sample of the halide of mass 0.277 g was dissolved in  $200 \text{ cm}^3$  of water and excess sulfuric acid added. The mixture was then heated and held at boiling for 45 minutes. The barium sulfate precipitate was filtered off, washed and dried. Mass of precipitate obtained = 0.265 g.

- i. Calculate the percentage barium content in the salt
- ii. ii) Determine the identity of X. [7 marks]

- c) Briefly describe the following methods of analysis

- i. High Performance Liquid Chromatography (**HPLC**)
- ii. Atomic Absorption Spectroscopy (**AAS**)

- d) UV- VIS spectroscopy (**UV-VIS**) [9 marks]

**END OF EXAM**

