NATIONAL UNIVERSITY OF LESOTHO

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF PHARMACY

PHA 3401 : PHARMACEUTICAL ANALYSIS

FINAL EXAMINATION PAPER

JAN 2024 TIME; 3 HOURS 100 MARKS

INSTRUCTIONS

- **The paper consists of two sections (2); section A [40 MARKS] and section B [60 MARKS]**
- **Answer all the questions**
- **Begin every question on a NEW PAGE**
- **The paper consists seven (7) printed pages including the cover page**
    - **The statistics tables formulas and periodic table are attached in the last page of the paper**

1. DEFINATION OF TERMS: [10 marks]

a. Briefly define the following terms**: [**1 mark each**]**

I. Molality

II. Buffer

III. Partition coefficient

IV. Super saturated solution

b. Differentiate between the following terms: **[6 marks]**

I. Equivalence point vs end point [2 marks]

II. Precision vs accuracy [2 marks]

III. Quantitative analysis vs qualitative analysis [2 marks]

2. SOLUTIONS, CONCENTRATIONS AND UNITS [10 marks]

a. How would you prepare a 500-ml glucose solution which is 0.500 M from solid glucose given that the molar mass (Mr) glucose = 180.1554 g/mol? [4 marks]

b. How would you prepare a 500-ml glucose solution which is 0.250 M from a 0.500 M glucose solution? [4 marks]

c. Express 0.0125 mg/ml paracetamol in µg/ml [2 marks]

3. STATISTICS AND ERRORS [10 marks]

Acetylsalicylic acid is an NSAID used as an antiplatelet at 300mg in HTN patients. Its content in 300 mg tablet was determined by six repetitive measurements and the resultsare tabulated below.

Measurement No	Quantity/mg
1	300
2	290
3	301
4	299
5	296
6	295

I. Reject the outlying data if it is necessary using the Q-test. [4 marks]

II. Calculate the mean of the acetyl salicylic acid [1 marks]

III. Calculate the standard deviation. [1 mark]

IV. Calculate the confidence interval at 95 % confidence level. [2 marks]

V. Express your answer as the proper analytical result. [2 marks]

4. PHYSICOCHEMICAL PROPERTIES AND PARTITION COEFFICIENT [10 marks]

a. The equation below show addition of 0.1 M ammonium chloride (NH_4Cl) into water.

$$HCl + NH_3 \rightarrow NH_4Cl \rightarrow NH_4^+ + Cl^-$$
$$NH_4^+ + H_2O \leftrightarrow NH_3 + H_3O^+$$

If ammonia pkb = 9.25, calculate the pH of the solution [5 marks]

b. Domperidone (Neutral) is an antidopaminergic agent, used in treating nausea, vomiting, gastrointestinal problems and Parkinson's disease. The drug has a partition coefficient of 8 (P= 8) between ethanol and water.

If 3 x 10 ml of ethanol was used to extract the compound, what percentage of the compound would be extracted from 10 ml of water? [5 marks]

SECTION B **[60 marks]**

1. WEAK ACID- STRONG BASE TITRATION [20 marks]

a. What are some of the necessary requirements for a successful acid-base titration? [5 marks]

b. Indomethacin is an NSAIDS used for the treatment of pain. It is a weak acid with $K_a = 3.16 \times 10^{-5}$ and it can be assayed by acid base titration. 100.0 ml of a 0.030 M solution of indomethacin was titrated with 0.050 M NaOH.

I. Calculate the missing pH values and complete the table [3, 4, 4 marks respectively]

II. sketch a graph of pH versus volume of added base indicating all the regions [4 marks].

V_b (mL)	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00
pH		4.20	4.50	4.80	5.20		11.47	

2. COMPLEXIOMETRIC TITRATION [20 marks]

a. A 50.0-mL sample containing Ni^{2+} was treated with 25.0 mL of 0.0500 M EDTA to complex all the Ni^{2+}. The excess EDTA was then back-titrated, requiring 5.00 mL of 0.0500 M Zn^{2+}. What was the concentration of Ni^{2+} in the original solution? [5 marks]

b. 50.0 mL of a 0.0200 M metal M^{2+} solution and buffered at pH 9.00 is titrated with 0.020M EDTA. The value of log K for the complex MY^{2-} is 14.30 and αY^{4-} is 5.4×10^{-2}.

I. What is the effect of pH on αY^{4-}? [1 mark]

II. Explain any two methods to enhance complexiometric titrations selectivity [2 marks]

III. Calculate pM when missing volumes of the titrant are added [4,4,4 marks]

mL	0.00	25.0	49.9	50.0	50.1	55.0
pM	1.70		4.70		10.30	

3. REDOX TITRATION AND GRAVIMETRY ANALYSIS [20 marks]

a. Chlorine is a powerful oxidising agent used as a disinfectant. Analysis of chlorine in a 20.0ml sample was carried out as outlined below. The sample was acidified with glacial acetic acid to pH 3 – 4. Exactly 1 g of KI was added to the sample which was then titrated with 0.09298 M sodium thiosulphate, $Na_2S_2O_3$, until the yellow colour due to I^{3-} begins to disappear. 1 ml of starch indicator solution was then added and the titration was continued until the blue colour of the starch-I^{3-} complex disappeared.

The volume of the titrant needed to reach end point was 19.65 ml.

The thiosulphate reaction is given by: $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$

K =39.102g/mol, I= 126.904 g/mol, Cl =35.453 g/mol.

I. Is this an iodometric or iodimetric titration? [1 mark]

II. Why is starch indicator added towards the end of the titration? [2 mark]

III. Calculate the concentration of chlorine in the sample. [6 marks]

b. Epsom Salt, a common laxative, contains magnesium sulphate ($MgSO_4$.).

- A 0.710-g sample of Epsom salt was dissolved in 100 mL water in a 600 mL beaker, followed by 1.3 g each of ammonium dihydrogen phosphate and ammonium chloride.
- Once all solids were completely dissolved, 10% NH_3 (ammonia) was added dropwise with mixing until the solution became permanently turbid.
- The beaker was covered with a watch glass and brought to a gentle boil, with occasional replacement of water.
- After about forty-five minutes, a white, granular precipitate of magnesium ammonium phosphate ($MgNH_4PO_4$) had separated.
- More 10% ammonia was then added dropwise until no further turbidity was produced and the mixture smelled strongly of ammonia.
- The precipitate was let to settle, filtered, dried, ignited and cooled on a crucible in a desiccator, producing magnesium pyrophosphate ($Mg_2P_2O_7$).
- The following data was acquired:

  Mass of empty crucible: 10.820g.

  Mass of crucible plus ignited precipitate: 11.137g.

i. Why was more 10 % ammonia added even after precipitate formation? [1 mark]

ii. Calculate the mass of magnesium in the sample. [6 marks]

iii. Calculate the percentage composition of magnesium in Epsom salt. [2 marks]

iii. State two reasons why a special ashless filter paper is used in gravimetry. [2 marks]

STATISTICS TABLES AND FORMULAS

Table of critical values Q

N	Q_{crit} (CL:90%)	Q_{crit} (CL:95%)	Q_{crit} (CL:99%)
3	0.941	0.970	0.994
4	0.765	0.829	0.926
5	0.642	0.710	0.821
6	0.560	0.625	0.740
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568

Table of Student's t Values

Degrees of Freedom	Confidence level		
	90%	95%	99%
1	6.314	12.706	63.657
2	2.920	4.303	9.925
3	2.353	3.182	5.841
4	2.132	2.776	4.6004
5	2.015	2.571	4.032
6	1.943	2.447	3.707
7	1.895	2.365	3.500
8	1.860	2.306	3.355
9	1.833	2.262	3.250
10	1.812	2.228	3.169

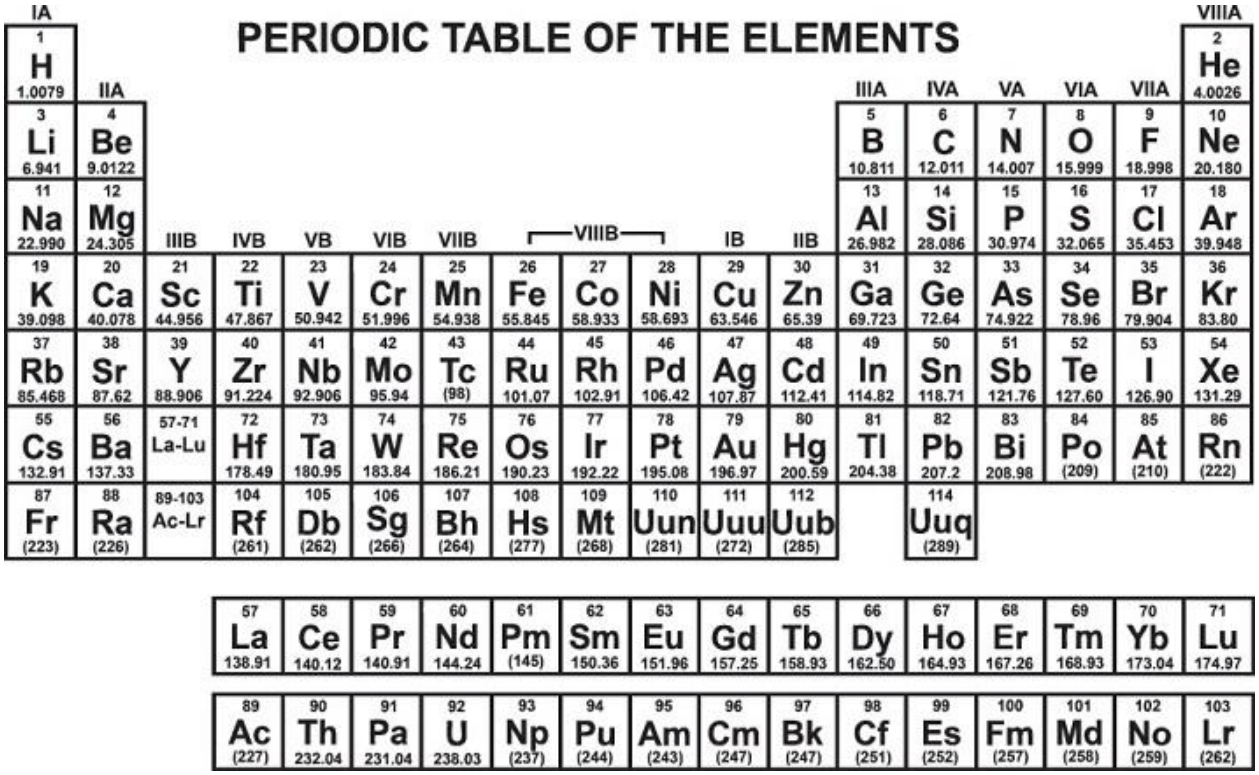
[Mean] $= \frac{x_1 + x_2 + x_3 \dots x_n}{\mathrm{n}} = \sum_i \frac{x_i}{n}$

[Confidence interval] $\boldsymbol{\mu = \bar{x} \pm \frac{t \cdot s}{\sqrt{n}}}$

[Standard deviation] : $\sqrt{\frac{\sum_{i=1}^{i=n}(x_i - \bar{x})^2}{n-1}}$

$Qcalculated = \frac{|xi - xcritical|}{|x1 - xcritical}$

APPENDIX 1


PERIODIC TABLE OF THE ELEMENTS
IA
IIA
IIIB
IVB
VB
VIB
VIIB
VIIIB
IB
IIB
IIIA
IVA
VA
VIA
VIIA
VIIIA
1 H 1.0079
2 He 4.0026
3 Li 6.941
4 Be 9.0122
5 B 10.811
6 C 12.011
7 N 14.007
8 O 15.999
9 F 18.998
10 Ne 20.180
11 Na 22.990
12 Mg 24.305
13 Al 26.982
14 Si 28.086
15 P 30.974
16 S 32.065
17 Cl 35.453
18 Ar 39.948
19 K 39.098
20 Ca 40.078
21 Sc 44.956
22 Ti 47.867
23 V 50.942
24 Cr 51.996
25 Mn 54.938
26 Fe 55.845
27 Co 58.933
28 Ni 58.693
29 Cu 63.546
30 Zn 65.39
31 Ga 69.723
32 Ge 72.64
33 As 74.922
34 Se 78.96
35 Br 79.904
36 Kr 83.80
37 Rb 85.468
38 Sr 87.62
39 Y 88.906
40 Zr 91.224
41 Nb 92.906
42 Mo 95.94
43 Tc (98)
44 Ru 101.07
45 Rh 102.91
46 Pd 106.42
47 Ag 107.87
48 Cd 112.41
49 In 114.82
50 Sn 118.71
51 Sb 121.76
52 Te 127.60
53 I 126.90
54 Xe 131.29
55 Cs 132.91
56 Ba 137.33
57-71 La-Lu
72 Hf 178.49
73 Ta 180.95
74 W 183.84
75 Re 186.21
76 Os 190.23
77 Ir 192.22
78 Pt 195.08
79 Au 196.97
80 Hg 200.59
81 Tl 204.38
82 Pb 207.2
83 Bi 208.98
84 Po (209)
85 At (210)
86 Rn (222)
87 Fr (223)
88 Ra (226)
89-103 Ac-Lr
104 Rf (261)
105 Db (262)
106 Sg (266)
107 Bh (264)
108 Hs (277)
109 Mt (268)
110 Uun (281)
111 Uuu (272)
112 Uub (285)
114 Uuq (289)
57 La 138.91
58 Ce 140.12
59 Pr 140.91
60 Nd 144.24
61 Pm (145)
62 Sm 150.36
63 Eu 151.96
64 Gd 157.25
65 Tb 158.93
66 Dy 162.50
67 Ho 164.93
68 Er 167.26
69 Tm 168.93
70 Yb 173.04
71 Lu 174.97
89 Ac (227)
90 Th 232.04
91 Pa 231.04
92 U 238.03
93 Np (237)
94 Pu (244)
95 Am (243)
96 Cm (247)
97 Bk (247)
98 Cf (251)
99 Es (252)
100 Fm (257)
101 Md (258)
102 No (259)
103 Lr (262)