MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY

SAN 101: LABORATORY PROCEDURES AND CLASSICAL ANALYSIS

DATE: **TIME:**

INSTRUCTIONS:

- Values of Student's t attached
- Periodic Table attached
- Section **A** is **compulsory**.
- Answer any **two** questions from section **B**.

SECTION A: COMPULSORY (30 MARKS)

QUESTION ONE

a) Differentiate between the following terms

i. Nucleation and particle growth. (2 marks)

ii. Determinate and indeterminate errors. (2 marks)

b) List three factors that one should consider when sampling. (3 marks)

c) A chemist adds 50 ml of a 4.0×10^{-4} M solution of $BaCl_2$ in water to 200 mL of 1.0×10^{-5} M Na_2SO_4 in water. Will a precipitate form under these conditions? Show your working. (4 marks)

d) An empty weighing bottle had a mass of 10.3 g. After the addition of water from 25-mL pipet, the mass was 35.2 g. If the lab temperature was 27°C, calculate the volume of water delivered by the pipet. Comment on your answer. (2 marks)

e) Using relevant examples,

i. Explain two safety features that exist in the chemistry laboratory at Machakos University. (2 marks)

ii. Briefly describe the steps that should be considered during an effective waste management process (6 marks)

f) A student measured the concentration of HCl in a solution by titrating with different indicators to find the end point.

	Indicator	Mean HCl Conc. (M)	Number of measurements
1	Bromothymol blue	0.09565 ± 0.00225	28
2	Methyl red	0.08686 ± 0.00098	18
3	Bromocresol green	0.08641 ± 0.00113	29

Is the difference between indicators 2 and 3 significant at 95% confidence level. (5 marks)

g) Formulate a SMART objective to describe the following broad scientific research areas:

i. Marijuana impaired driving. (2 marks)

ii. Hemoglobin concentration and fresh pork quality. (2 marks)

SECTION B: ANSWER ANY TWO (2) QUESTIONS (20 marks each)

QUESTION TWO (20 MARKS)

a) Briefly explain

i. The laboratory primary safety rule and your implied responsibility to make it work. (2 marks)

ii. The principles of operation of electronic and mechanical balances. (4 marks)

b) Karen Wetterhahn, was an expert in the biochemistry of metals and the first female professor of chemistry at Dartmouth College. Explain what lessons we can learn from her death that occurred in 1997. (2 marks)

c) Two group of students were carrying out an experiment using iodate ions and Lead nitrate respectively. Briefly explain how they should dispose their waste without causing any harm to the environment. (4 marks)

d) A student was given a transfer pipet that can hold up to a volume of 50 mL. Briefly explain how the pipet can be calibrated to minimize errors. (3 marks)

e) An analysis for disulfiram, $C_{10}H_{20}N_2S_4$, in Antabuse is carried out by oxidizing the sulfur to H_2SO_4 and titrating the H_2SO_4 with NaOH. If a 0.4613 g sample of Antabuse is taken through this procedure, requiring 34.85 mL of 0.02500 M NaOH to titrate the H_2SO_4, Calculate the %w/w disulfiram in the sample. (5 marks)

QUESTION THREE (20 MARKS)

a) A student was asked to measure the percent iron in a steel sample he believed was to be about 85% Fe by mass. The student dissolved four replicate samples in nitric acid and diluted them by mass to a concentration of 3 mg Fe L^{-1} for analysis by a relevant instrumental method such as Flame Atomic Absorption (FAA). The student began by dissolving 1.0000 g of steel and then diluted it to final volume of 50 mL. Then an aliquot of the solution was diluted to a final volume of 100 mL for analysis. Calculate the

i. Concentration (in mg L^{-1}) of the initial solution. (3 marks)

ii. Volume of the aliquot required to make the final solution for analysis. (2 marks)

b) A student weighed the volume of water delivered by an automatic pipette 10 times. The pipette was adjusted to deliver 4.50 mL. The mass of the water delivered was found to be 4.62±0.08 g. Assume the density of water is 1.00 g cm^{-1}.

i. Differentiate between random and systematic error. (2 marks)

ii. Do you observe evidence of random error and systematic errors in the measurement described above? If yes, state the magnitude of the errors. (4 marks)

iii. List four ways one could use to asses a method for systematic error. (4 marks)

c) Using relevant example, explain the meaning of standard reference materials and their importance in analytical chemistry. (5 marks)

QUESTION FOUR (20 MARKS)

a) Megan prepared a 0.250 M NH_3 solution by diluting 8.45 (±0.04) mL of 28.0 (±0.5) wt% NH_3 [density = 0.899 (±0.003) g/mL] up to 500.0 (±0.2) mL.

i. Differentiate between absolute and relative uncertainty. (2 marks)

ii. Find the uncertainty in 0.250 M. The molecular mass of NH_3, 17.0305 g/mol, has negligible uncertainty relative to other uncertainties in this problem. (5 marks)

b) A 50.00 mL portion of HCl solution required 29.71 mL of 0.01963 M $Ba(OH)_2$ to reach an end point with bromocresol green indicator.

i. Explain the difference between end point and equivalence point. (2 marks)

ii. Write a balanced equation for the reaction and calculate the molar concentration of the HCl. (4 marks)

c) 0.470 g of sample containing sodium carbonate was treated with 50 mL of 0.1 M HCl. The excess HCl was back titrated using 0.1 M standardized NaOH where 20 mL of NaOH was used.

i. List four characteristics of a titration reaction. (2 marks)

ii. Calculate the % of sodium carbonate in the sample given that the molecular weight of sodium carbonate is 105.99 g. (5 marks)

QUESTION FIVE (20 MARKS)

a) Differentiate between the following terms

i. Standard reference materials and calibration curves. (2 marks)

ii. Random sampling and statistical sampling. (2 marks)

iii. Gravimetric and titrimetric methods. (1 mark)

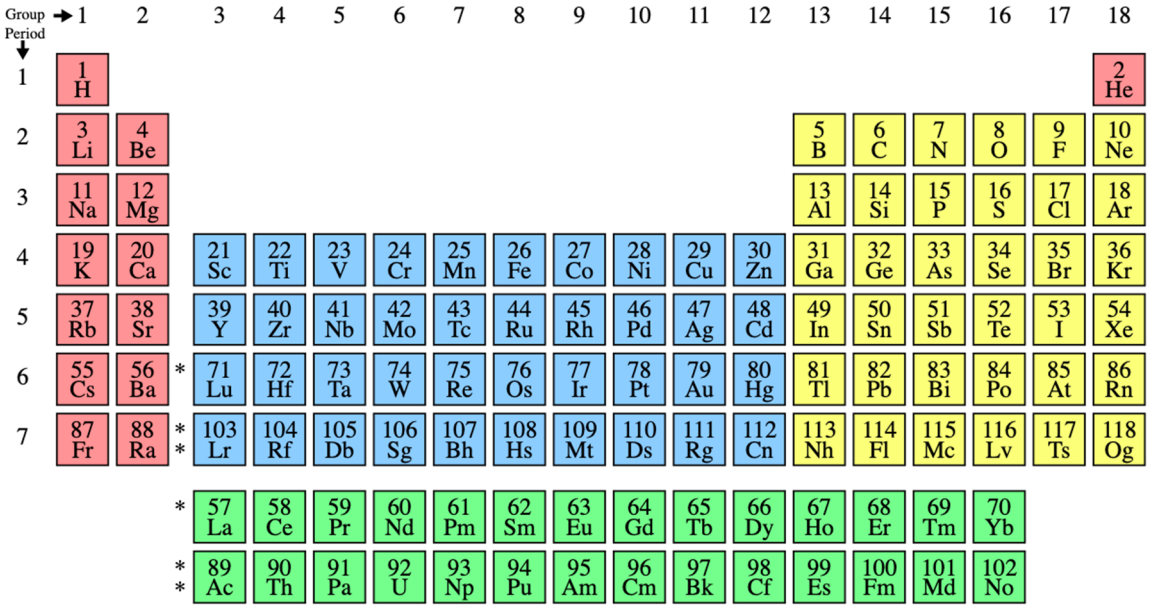
b) For analysis of mercury (Hg) in fish, the following data was obtained:

Trial	Hg (ppb)
1	5.4
2	5.1
3	4.2
4	4.7
5	5.6

Determine the mean concentration and express the uncertainty in the concentration in terms of standard deviation, standard error and the 95% confidence limit. (5 marks)

c) One of the requirements for BSc. Analytical chemistry program is that students must do a project in their fourth year of study. Using a relevant example, explain how you will apply the steps of chemical analysis to achieve this requirement. (10 marks)

Periodic Table



Values of Student's t

	Confidence level (%)						
Degrees of freedom	**50**	**90**	**95**	**98**	**99**	**99.5**	**99.9**
1	1.000	6.314	12.706	31.821	63.656	127.321	636.578
2	0.816	2.920	4.303	6.965	9.925	14.089	31.598
3	0.765	2.353	3.182	4.541	5.841	7.453	12.924
4	0.741	2.132	2.776	3.747	4.604	5.598	8.610
5	0.727	2.015	2.571	3.365	4.032	4.773	6.869
6	0.718	1.943	2.447	3.143	3.707	4.317	5.959
7	0.711	1.895	2.365	2.998	3.500	4.029	5.408
8	0.706	1.860	2.306	2.896	3.355	3.832	5.041
9	0.703	1.833	2.262	2.821	3.250	3.690	4.781
10	0.700	1.812	2.228	2.764	3.169	3.581	4.587
15	0.691	1.753	2.131	2.602	2.947	3.252	4.073
20	0.687	1.725	2.086	2.528	2.845	3.153	3.850
25	0.684	1.708	2.060	2.485	2.787	3.078	3.725
30	0.683	1.697	2.042	2.457	2.750	3.030	3.646
40	0.681	1.684	2.021	2.423	2.704	2.971	3.551
60	0.679	1.671	2.000	2.390	2.660	2.915	3.460
120	0.677	1.658	1.980	2.358	2.617	2.860	3.373
∞	0.674	1.645	1.960	2.326	2.576	2.807	3.291