UNIVERSITY OF KELANIYA – SRI LANKA

FACULTY OF SCIENCE

Bachelor of Science (Honours) Degree Examination – May/June 2023

ACADEMIC YEAR 2020/2021 - Semester II

Applied Chemistry

APCH 12622 – Basic Statistical Methods

No. of questions: Four (04) **No. of pages: Three (03)** **Duration: Two (02) hours**

Answer all the questions

Non-Programmable Calculators are allowed.

Statistical Tables will be provided.

1.

(a) Briefly explain the terms 'population', 'sample', 'parameter' and 'statistic' using a suitable real world example. (20 marks)

(b) Discuss the importance of statistics in the field of chemistry in brief. (10 marks)

(c) Concisely explain the prominence of a representative sample in a study. (10 marks)

(d) A researcher wants to find out the accuracy of the claim "Obesity can be observed in female students than male students in the University of ABC" and thought to assess it using the Body Mass Index (BMI) of students. Describe the way to carry out a proper statistical investigation to evaluate the aforementioned claim. (15 marks)

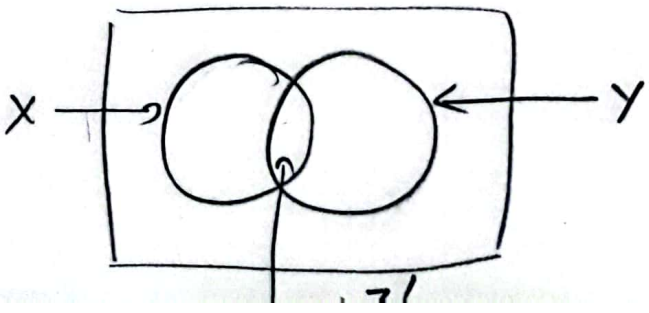
(e) Suppose we have the following information:

There is a 60 percent chance that it will rain today.
There is a 50 percent chance that it will rain tomorrow.
There is a 30 percent chance that it does not rain either day.

Find the following probabilities:

(i) The probability that it will rain today or tomorrow. (15 marks)
(ii) The probability that it will rain today and tomorrow. (15 marks)
(iii) The probability that it will rain today but not tomorrow. (15 marks)

P (AUB')



2. The below data are the percentages of ash content in 125 samples of coal discovered in close proximity:

Percentage of Ash content (%)	Number of samples
00-10	3
10-20	6
20-30	12
30-40	25
40-50	30
50-60	18
60-70	13
70-80	9
80-90	4
90-100	5

(a) Calculate the mean, median, mode and standard deviation of the distribution of percentages of ash content of coal. (40 marks)

(b) Find the inter quartile range of the above distribution. (30 marks)

(c) Draw a boxplot for the percentages of ash content of coal and interpret. (15 marks)

(d) Identify the shape of the percentages of ash content distribution using suitable method/s. (15 marks)

3.

(a) The gray wolf is a large canine native to Eurasia and North America. A gray wolf pup become mature or reach adulthood when they are 24 months old. Only one out of five wolf pups born in the wild survive to adulthood. Four wolf pups approximately having the same age are selected for a scientific study.

(i) Define a suitable random variable to model the number of wolf pups surviving to adulthood and identify its distribution. (10 marks)

(ii) Find the probability that all wolf pups survive to their adulthood. (05 marks)

(iii) On average how many wolf pups would survive until they reach adulthood? (05 marks)

(iv) Find the variance and standard deviation of the random variable. (10 marks)

(v) In order to make the scientific study successful at least 3 wolf pups should survive to their adulthood. What is the probability that researcher will finish a successful study? (10 marks)

(vi) Two other researchers are conducting the same study, under the same conditions independently from each other. What is the probability that out of these three researchers exactly two will be able to finish the research successfully? (10 marks)

(b) Assume that the velocity of N_2 gas molecules at 25 degrees Celsius are normally distributed with mean $450ms^{-1}$ and variance $100m^2s^{-2}$. S.D. = $\sqrt{100} = 10$

(i) Find the probability that a nitrogen molecule has velocity less than $440ms^{-1}$. (10 marks)

(ii) Find the probability that a nitrogen molecule has velocity between $430ms^{-1}$ and $460ms^{-1}$. (10 marks)

(iii) Find the 75^{th} percentile. (10 marks)

(iv) If exactly 25 nitrogen molecules were isolated, find the probability that the average velocity of these molecules is greater than $453ms^{-1}$. (10 marks)

(v) The molecules which have a velocity higher than $457ms^{-1}$ will tend to chemically react with an artificially created substance. If there are 1000 mols of N_2 gas inside this chamber how many mols of N_2 gas would you expect to react with this substance? $\bar{X}$ or X? (10 marks)

4.

(a) An experiment was conducted in order to calculate the average half-life time of Francium−221. A sample of twenty resulted in an average half-life of 4.84 minutes, with a sample standard deviation (s) of 0.24 minutes. Construct a 90% confidence interval for the true average half-life time, μ, for Francium−221. (40 marks)

(b) The maximum acceptable level of a certain toxic chemical in vegetables has been set at 50 parts per million (ppm). A consumer health group measured the level of the chemical in a random sample 45 tomatoes obtained from one producer to determine whether the mean level of the chemical in these tomatoes exceeds the recommended limit. The sample resulted in a mean, $\bar{x} = 51.5$ ppm. Assume that the population standard deviation $\sigma = 4.6$ ppm (You may assume that the chemical levels are normally distributed)

$n = 45$
$H_a = \mu > \mu_0$

(i) Determine the null and alternative hypotheses. (05 marks)

(ii) Classify the hypothesis test as two-tailed, left-tailed, or right-tailed. (05 marks)

(iii) Explain the meaning of a Type I error for the above hypothesis. (10 marks)

(iv) Test the above hypothesis at 1% significance level using critical value approach and give your conclusion. (20 marks)

(v) Test the above hypothesis at 5% significance level using p - value approach and give your conclusion. (20 marks)