Camosun College
Department of Chemistry and Geoscience
Course Outline: Chemistry 224
Fall 2002

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Texts: The required text for the course is:
" Modern Analytical Chemistry" by D. Harvey.
There is also a laboratory manual / study guide. All students must have both items and they can be obtained from the bookstore.

In addition, there will be some texts held on reserve in the library specifically for students registered in this course. You can sign them out at the front desk on a 72 hour loan.
All students must have their own pair of safety glasses with them in laboratory. If you normally wear glasses you do not require a second pair.

Assessment: The final grade in the course will be assigned on the basis of the following components:

First examination	20%
Second examination	20%
Final examination	35%
Laboratory reports	25%

Grades: The following percentages refer to the composite total obtained at the end of the course.

A range	85% to 100%
B range	70% to 84%
C range	60% to 69%
D range	50% to 59%
F range	<50%

N.B. In order to pass the course, students must obtain passing grades in both the lecture and the laboratory portions of the course.

Course outline

Illustrations for each type of analysis will be drawn from case studies in clinical and environmental chemistry, food and drugs, geology and oceanography as well as materials science.

Elementary statistics: The topics examined will include:-

The mean, median and mode for populations and large samples
Central limit theorem
Normal distribution of errors
Confidence intervals for populations and large samples
Sources of error in chemical analysis
The problems of small data sets
Q test for rejection of data

Classical methods: The techniques examined will include:-

Gravimetric analysis
Complexation titrations
Acid-base equilibria

The language of analytical chemistry will be introduced and will include definitions of:-

Accuracy and precision
Analyte and matrix
Determination and measurement
Techniques and methods
Procedures and protocols

Spectroscopy: The techniques examined will include:-

Absorption and transmission spectroscopy.
The Beer Lambert law and its limitations: Analysis of mixtures
Use of complexing agents to produce strongly absorbing species for ultra violet / visible spectroscopy.
Conversion of data
Atomic absorption and emission spectroscopy.
Use of flames and furnaces to atomize the sample
Nephelometry and turbidity
X ray and ultra violet fluorescence

Electrochemistry: The techniques examined will include:

Ion selective electrodes,
Potentiometric titrations and redox reactions
Polarography
Coulometry

Radiochemistry: The techniques examined will include:
Isotope production
Neutron activation analysis
Isotope dilution analysis

Mass spectrometry: Topics will include:

Types and limitations of various mass spectrometers
Peak matching and the use of on-line data banks
Isotope ratios and geological dating.

Separation methods: The techniques examined will include:

Solvent extraction
Sublimation
Distillation
Ion exchange,
Gas-liquid chromatography,
G.C. / M.S. and H.P.L.C.

Data collection: The topics will include:

Signal to noise ratio and the benefits of multiple scans.
Pulsed F.T. methods vs continuous wave systems
Analog to digital conversion
Export of data files
Use of a spreadsheet (Excel)

Statistics of sampling: The topics will include:

Construction of a significance test
Null point hypothesis and the alternative hypothesis
One and two tailed tests
Comparison of two sample means
The paired t test

Chemistry 224
Learning Outcomes

At the end of this course, the student will possess an enhanced ability to:

Statistics I

- Use the procedures of elementary statistics to calculate mean, median, mode, variance and standard deviation for a series of replicate analyses.
- Utilize the properties of the standard error curve to estimate the population mean from analysis of a small sample.
- Apply the Dixon Q test to reject or retain a suspect result.
- Graph data using the least squares procedure.
- To carry out these procedures using a calculator and the EXCEL spread sheet.

Classical analysis

- Perform well characterized gravimetric and titrimetric analyses and obtain data that falls within the established margins of error for the method.
- Report the data with an estimate of the margin of error.

Spectroscopy

- Account for the behaviour of radiation passing through a solution and origins of the
- Beer-Lambert law.
- Apply this law to determine the concentration of absorbing species in isolation and in mixtures.
- Operate a U.V. / Visible spectrophotometer and report the results in terms of absorbance and % transmission.
- Operate an atomic absorption spectrophotometer to determine the levels of various metals in sediments.
- Understand the limits of Beer-Lambert law and apply the appropriate corrections.
- Use internal and external standards to calibrate the procedure.
- Obtain emission spectra from samples containing alkali metals and alkaline earth metals and estimate the concentrations of these metal ions in solution.
- Using data obtained from other laboratories, estimate the concentration of colloidal material in a sample by light scattering techniques.

Radioactivity

- Distinguish between the major modes of radioactive decay
- Distinguish between the activity of the sample and the dose received by the absorber.
- Describe the major methods of isotope production.
- Operate a Geiger counter and use it to estimate the radioactive content in heterogeneous rock samples
- Utilize the data collected from archeological sites to estimate the age of fossils and artifacts via carbon and argon dating techniques.
- Predict the irradiation time required to produce a radioactive isotope in sufficient concentration to perform an analysis by the neutron activation method.

- Estimate the levels of trace metals in alloys and biological samples, from data collected elsewhere, by means of the neutron activation technique.
- Understand and apply the principle of chemical exchange in estimating the concentration of one species in a mixture by means of the isotope dilution technique.

Electrochemistry

- Identify and describe the mode of operation for the four major types of electrode
- Describe and use combination electrodes
- Explain the differences in potential between the various standard reference electrodes.
- To carry out a redox analysis, plot the data and explain the shape of the curve.
- Construct an ion selective electrode and use it to monitor the concentration of that particular ion in solution.
- Explain the importance of pH and total ionic strength in the operation of an ion selective electrode.
- Distinguish between constant current and constant potential coulometry.
- Calculate the moles of metal ions removed from solution in both types of experiment
- Distinguish between normal and pulsed polarography
- Determine the half wave potentials for various ions from a polarogram.
- Identify the ions present by means of their reduction potentials.
- Analyze a polarogram obtained from a mixture of metal ions and determine which ions are present and in what concentration.

Describe the use of these resins in water treatment

Methods of separation

- Chose solvent combinations which allow the components of a mixture to separate from each other on the basis of differing solubility in different phases.
- Use the distribution coefficient to calculate the number of extractions that must be done to achieve a given level of decontamination.
- Purify molecular compounds by sublimation
- Distinguish between ideal and non-ideal solutions
- Distinguish between simple and fractional distillation
- Calculate the number of theoretical plates required to give a specific level of enrichment
  Describe the synthesis of anion and cation exchangers
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- Predict the elution sequence for a mixture based upon the formation constant of each adsorbed species.
- Distinguish between packed columns and capillary columns
- Explain the significance of the retention volume and retention time for a given component in a mixture
- Predict the effects of using a temperature program on the elution pattern of the components.
- Distinguish between normal and reverse phase chromatography
- Distinguish between isocratic and gradient elution in H.P.L.C.

Data collection

- Calculate the improvement in the signal to noise ratio from the number of scans obtained.

- Distinguish between the Fourier transform and continuous wave methods of recording data.
- Explain the process of analogue to digital conversion.

Statistics II

- Construct a null point hypothesis and the alternative hypothesis for a given set of data
- Use one and two tailed significance tests to reject or retain a null point hypothesis.
- Compare two sample means by means of a significance test
- Use a paired t test to compare two different methods of analysis for the same sample of compound.

Summary of learning outcomes

At the end of this course, the student will possess an enhanced ability to:

Statistics I	Define and calculate the mean, median, mode, variance and standard deviation for a series of replicate analyses. Estimate the population mean from analysis of a small number of trials. Test for the rejection or retention of suspect data. Explain and use the least squares procedure to graph experimental data.
Classical analysis:	Describe and explain the procedures for gravimetric and titrimetric analyses: obtain data that falls within the established margins of error for the methods.
Spectroscopy	Derive and apply the Beer-Lambert law and use internal and external standards to ensure the validity of the analysis. Distinguish between absorption, emission, fluorescence and phosphorescence. Obtain absorption and emission spectra from various sources and perform a complete quantitative analysis on the samples provided. Explain and use light scattering techniques to estimate the turbidity of solutions.
Radioactivity	Distinguish between the major modes of radioactive decay and between the activity of the sample and the dose received by the absorber. Estimate the age of fossils and artifacts via carbon and argon dating techniques and the concentrations of trace materials using neutron activation and isotope dilution techniques.
Electrochemistry	Identify and describe the mode of operation for the four major types of electrode. Distinguish between constant current and constant potential coulometry and use them to estimate the concentrations of particular ions in solution. Distinguish between normal and pulsed polarography and analyze polarograms obtained from mixtures of metal ions.
Separation methods	Describe, explain and apply the techniques of solvent extraction, sublimation, distillation and the major forms of chromatography to the separation of a mixture.
Data collection	Discuss the basis for improvements in the signal to noise ratio of a measurement. Distinguish between the Fourier transform and continuous wave methods of recording data. Explain the process of analogue to digital conversion.
Statistics II	Construct a null point hypothesis; use one or two tailed significance tests to reject or retain the hypothesis. Use a paired t test to compare two different methods of analysis for the same sample.

Place of analytical chemistry

Methods elimination of errors

Silver nitrate / halide determinations Richards

Tolerance

Balances and volumetric glassware

Instrumentation

Examples mss / molecular weight moles of AgCl 0.3461 g / 143.3209
= 0.002414861
=0.002415 moles