

LEARNING OBJECTIVES – ELECTROCHEMICAL METHODS OF ANALYSIS

Thomas Wenzel, Bates College

Overall Unit

After completing this entire unit on electrochemical methods of analysis, a student will be able to:

1. Describe each of the electrochemical methods discussed in the unit.
2. Perform quantitative calculations for each of the methods if provided appropriate information or data.
3. Compare the advantages and disadvantages of the different electrochemical methods of analysis.
4. Select the best method from among those covered in the unit for a particular analysis and justify the choice.

Problem set titled “Electrochemistry”

After completing this problem set, a student will be able to:

1. Define the processes of oxidation and reduction.
2. Define the meaning of an oxidizing and reducing agent.
3. Describe what is meant by a half-reaction.

Problem set titled “Chemical Energy”

After completing this problem set, a student will be able to:

1. Relate chemical energy to electrochemical potential.
2. Relate the sign of the electrochemical potential to the direction of a reaction.
3. Define the standard state and explain why it is necessary to define a standard state.

Problem set titled “Electrochemical Cells”

After completing this problem set, a student will be able to:

1. Describe the components of an electrochemical cell, the purpose of each, and the process that occurs in each.
2. Write a shorthand notation for an electrochemical cell.
3. Describe the processes responsible for conduction of electricity in different part of an electrochemical cell.
4. Describe what it means for a reaction to be chemically and electrochemically irreversible.

Problem set titled “Use of the Nernst Equation”

After completing this problem set, a student will be able to:

1. Calculate the potential of an electrochemical cell under standard and non-standard state conditions.
2. Calculate the equilibrium constant for an electrochemical reaction.

Unit on Ion Selective Electrodes

After completing this problem set, a student will be able to:

1. Describe the functioning of an ion selective electrode.
2. Describe the limitations in the use of ion selective electrodes.

Problem set titled “Electrodeposition/Electrogravimetry”

After completing this problem set, a student will be able to:

1. Describe how the method of electrogravimetry is performed.
2. Determine if one species will interfere with another in electrogravimetry.

Problem set titled “Coulometry”

After completing this problem set, a student will be able to:

1. Describe how the method of coulometry is performed.
2. Compare the advantages and/or disadvantages of electrogravimetry and coulometry.

Problem set titled “Coulometric Titration”

After completing this problem set, a student will be able to:

1. Describe how a coulometric titration is performed.
2. Describe the advantages of a coulometric titration over a conventional redox titration.

Problem set titled “Amperometric Titration”

After completing this problem set, a student will be able to:

1. Describe the process of performing an amperometric titration.
2. Draw the resulting plot of current vs. titrant volume for different scenarios in an amperometric titration.

Problem set titled “Potentiometric Titration”

After completing this problem set, a student will be able to:

1. Calculate the potential at various stages of a potentiometric titration.

Problem set titled “Voltammetric Methods”

After completing this problem set, a student will be able to:

2. Describe how it is possible to eliminate electrostatic migration be eliminated in an electrochemical cell.
3. Describe why it is common to purge samples with an inert gas and conduct the analysis under an inert gas environment when performing voltammetry.

Problem set titled “Anodic Stripping Voltammetry”

After completing this problem set, a student will be able to:

5. Describe how anodic stripping voltammetry (ASV) is performed.
6. Draw the output of an ASV analysis if given the identity of metal species being analyzed.
7. Explain the advantages of ASV over methods such as electrogravimetry and coulometry.

Problem set titled “Linear Sweep Voltammetry”

After completing this problem set, a student will be able to:

1. Describe how linear sweep voltammetry (LSV) is performed.
2. Draw the output of an LSV analysis for samples that are stirred or not stirred if given the identity of the species being analyzed.
3. Explain how concentration and species identification is performed in LSV.
4. Explain how differential pulse LSV is performed.
5. Draw the output obtained from a differential pulse LSV analysis.
6. Explain the advantages of differential pulse LSV over LSV.

Problem set titled “Cyclic Voltammetry”

After completing this problem set, a student will be able to:

1. Describe how cyclic voltammetry (CV) is performed.
2. Draw an example of the output in CV for the analysis of reversible, chemical irreversible and electrochemically irreversible reactions.
3. Provide a reaction mechanism that would explain the output of a cyclic voltammogram.