Altamonte Springs
SCIENCE
INCUBATOR

Name: _____

Date: _____

Understanding Analytical Chemistry
(Weighing, Mixing, Measuring and Evaluating)

High School Environmental Science | AP Module 1 | Environmental Lab

NGSSS Big Ideas:

This module is a laboratory-based group activity involving: weighing potassium nitrate and mixing it with deionized water to make a stock standard, diluting the stock standard to make a series of calibration standards, measuring the nitrate concentration using ion-selective electrode methodology, and statistical analysis using linear equation, slope of a line, standard deviation, precision and accuracy

Benchmark Code & Description:

G.K12.5.3.3a—Identify appropriate technology to achieve a project goal. Use analytical balance to weigh chemicals.

SC.912.P.8.9—Apply the mole concept and the law of conservation of mass to calculate quantities of chemicals participating in reactions.

SC.912.P.12.12—Explain how various factors, such as concentration, temperature, and presence of a catalyst affect the rate of a chemical reaction.

MAFS.912.S—ID.3.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of date.

MAFS.912.N-Q.1.3—Choose a level of accuracy appropriate to limitation on measurement when reporting quantities.

MAFS.912.S-ID.2.6—Represent data on two quantitative variable on a scatter plot, and describe how the variables are related: use functions fitted to data to solve problems in the context of the data (emphasize linear and exponential models), assess the fit of a function by plotting and analyzing residuals, and fit a linear function for a scatter plot that suggests a linear association.

SC.912.N.1.2—Describe and explain what characterizes science & its methods.

SC.912.N.1.Pa.2—Recognize a process used in science to solve problems, such as observing, following procedures, and recognizing results.

LEARNING GOALS/OBJECTIVES

- Describe the relationships between volume and the amount of solute to solution concentration.
- Explain how solution concentration will change by adding or removing: water, solute, and/or solution.
- Design a procedure for creating a solution of a given concentration.
- Describe the relationship between the solution concentration and the electrochemical response.
- Collect and evaluate data to interpret the line of best fit and the y-intercept.
- Measure solutions and plot their response in the appropriate significant figures.
- Use a best fit calibration to graph a line and evaluate all points that are not used in the best fit in terms of accuracy and precision.

PREREQUISITES

Review:

- Procedures
- Laboratory Safety
- Vocabulary List

VOCABULARY

See vocabulary sheet.

HANDS-ON ACTIVITIES

- Use analytical balance to weigh chemicals.
- Use laboratory equipment to make solutions.
- Use electrochemical methodology to measure solutions.

Provided Materials:

- Clipboard
- Procedure Handouts
- Lab Coat and Safety Classes

Career Options: Chemist (Bachelor's Degree), Scientist (Bachelor's Degree), Microbiologist (Bachelor's Degree)

Lesson Steps:

1. Students are provided lab coats and safety glasses to wear.
2. As students are suiting up, we will present safety instructions and an overview of the module.

3. Students are provided a clipboard with handouts covering the procedures they will learn.
4. Students are guided to the laboratory.
5. Students are taught how to use an analytical balance. Each student will begin to make a stock standard by weighing 0.07222 grams of potassium nitrate, transferring the sodium nitrate to a 100 mL graduated cylinder and recording any observations.
6. Students are taught how to properly use a graduated cylinder, the techniques of mixing a solution, how to calculate the concentration of a standard, and how to use dilution to get the desired concentration. Each student will finish making their stock standard by filling their graduated cylinder with deionized water to the 100mL mark and record any observations. A calibration standard will be made by diluting the stock standard using the instructions on their handout to get a specific concentration. Using a clean 100mL graduated cylinder; pour the defined aliquot of the stock standard into the graduated cylinder, fill it to 100mL mark with deionized water and record any observations.
7. Students are taught how to collect data using an ion-selective electrode.
8. Students will be taught statistical quality control. The calibration standard measurements are displayed on a large screen monitor. A calibration curve is calculated using the best fit line. The remaining data points will be used to calculate standard deviation, precision and accuracy. A discussion involving student observations will focus on what the data means in terms of quality control.

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Environmental Laboratory AP Environmental Science Vocabulary List

Accuracy—A measure of how close the result is to the actual correct value.

Aliquot—Portion of a solution.

Analytical Balance—A devise designed for accurately weighing small amounts.

Aqueous—Made from, with, or by water.

Calibration Curve—A method for determining the concentration of a substance in an unknown sample by comparing the unknown to a set of standard samples of known concentrations.

Calibration Standard—A solution made by diluting a stock standard to a concentration usable in a calibration range.

Calibration Weights—Commercially standardized metal weights used to check the accuracy of the balance.

Concentration—The amount of a component in a given volume.

Correlation Coefficient—A number or function that indicates the degree of correlation between two sets of data that is equal to their covariance divided by the product of their standard deviations.

Deionized Water—Water which has had all of the minerals and other non-water molecules removed.

Electrode—A devise that detects the electrical response of a sample.

Graduated Cylinder—Laboratory equipment used to measure the volume of a liquid.

Homogeneous Sample—A sample in which the composition of ingredients is the same throughout the sample. A solution of salt dissolved in water would be homogeneous. Sand mixed in water would not be homogeneous.

Ion—An atom or group of atoms that has a positive or negative electric charge from losing or gaining one or more electrons.

Linear Equation—An algebraic equation in which each term is either a constant or the product of a constant and a single variable.

Precision—A measure of the amount of variability from one reading to the next of the same sample.

Slope of a Line—Is a number that describes both the direction and steepness of the line.

Standard Deviation—A calculation the measures the amount of variation from the average.

Stock Standard—A solution made at a high concentration from which calibration standards are made.

Variability—Refers to how close a set of data is to each other. It is unusual to obtain exactly the same reading twice from the same sample.

Volume—An amount of something.

Weighing Paper—A non-stick paper placed in a balance to weigh a solid on and transfer to a container.

y-Intercept—Where a horizontal axis represented by variable (x) and a vertical axis represented by variable (y), a y-intercept is a point where the graph of a function intersects with the y-axis.

Zero or Tare—When you zero of tare a balance, you are setting the display on the balance to read zero weight.

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DATA RECORD

Procedure:

1. Weigh 0.0722 grams of Potassium Nitrate.

   Observations (ex: 0.07222???): _____

   _____

   _____

2. Transfer the Potassium Nitrate to a 100 mL graduated cylinder and bring to volume with DI water to make a 100 mg/L Stock Standard.

   Observations (ex: Spill???, Meniscus???): _____

   _____

   _____

   Calculate the volume needed from your 100 mg/L Stock Standard to make your _____ mg/L Calibration Standard in a 100 mL graduated cylinder.

   Initial Concentration (C_I) x Initial Volume (V_I) = Final Concentration (C_F) x Final Volume (V_F)

   $C_I \times V_I = C_F \times V_F$

   Solve for Initial Volume: $V_I = (C_F \times V_F)/C_I$

   _____

3. Pour _____ mL of the Stock Standard into a 100 mL graduated cylinder and bring to volume with DI water and invert several times.

   Observations (ex: Spill???, Meniscus???): _____

   _____

   _____

4. Pour the Calibration Standard into a beaker and measure using an ion-selective electrode.

5. Use observations to discuss Statistical Quality Control using best-fit linear calibration and applying standard deviation, precision and accuracy to the outliers.