Solutions and Dilutions

Objective:

In this lab you will determine how to make and test solutions with different concentrations of sodium chloride. You will also compare the accuracy and precision of two chloride testing methods.

Procedure:

Part 1: Comparing accuracy and precision of two chloride testing methods: Waterproof SaltTestr Electrode vs. Quantab High-Range Chloride Titrator Strip

Fill a 100 mL beaker with 50 mL of the 0.08000M NaCl solution provided. Write down the actual NaCl solution concentration in your notebook.

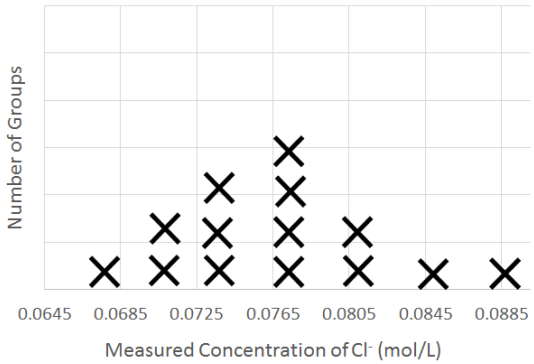
Part A:
Use the Quantab High-Range Chloride Titrator Strip to make one measurement of the concentration of the 0.08000 M NaCl solution.

Quantab High-Range Chloride Titrator Strip Directions:

1. Remove a titrator from the bottle and replace the cap immediately.
2. Insert the lower end of the titrator into the solution. Do not allow the solution to reach yellow completion band at top of titrator. (Quantab White portion is the top)
3. Immerse the bottom of the solution to completely saturate wick of titrator. Reaction is complete when yellow band turns black. This may take a couple of minutes.
4. Note where the tip of the white chloride peak falls on the numbered Quantab scale. This represents the Quantab unit value. Note that each graduation represents 0.2 units on the scale. The reading on the right would be 7.5.

Consult the Quantab High-Range Chloride Titrator Strip conversion chart at the end of the lab handout to determine the concentration of NaCl in mol/L. Record these values in your lab notebook as **Quantab strip Measured Molarity of 0.08000 M Stock Solution**

A histogram will be drawn on the whiteboard in the front of the classroom. Add your data to the histogram by drawing an **X** above the concentration value you measured with the Quantab High-Range Chloride Titrator Strip. The histogram should look something like this:



Ask a lab aide to check your values and then post your **Quantab strip Measured Molarity of 0.08000 M Stock Solution** value in the Google spreadsheet available on Moodle.

Part B:

Use the Waterproof SaltTestr Electrode to measure the concentration of the 0.08000M NaCl solution 10 times.

Waterproof SaltTestr Electrode Directions:

1. Rinse thoroughly with DI water and shake dry.
2. Turn the electrode on. When ready, the LCD screen should read 0.0 and the room temperature. In the upper left hand corner should be the word 'MEAS' to indicate the electrode is in measurement mode.
3. To measure a concentration, immerse the electrode in the sample and stir to release air bubbles. Allow the reading to stabilize for 30 seconds.
4. When you are finished rinse your volumetric flask well with deionized water.

Record the actual measured reading on SaltTestr display in your lab notebook. This reading is in $\frac{\text{grams NaCl}}{\text{L solution}}$.

Convert the concentration to molarity and record this value in your lab notebook as **SaltTestr Measured Molarity of 0.08000 M Stock Solution**.

Calculate the percent error: $\frac{\text{actual} - 0.0800}{0.0800} \times 100$

Ask a lab aide to check your values and then post your 10 **SaltTestr Measured Molarity of 0.08000 M Stock Solution** values in the Google spreadsheet available on Moodle.

Your molar results Quantab strip and SaltTestr Measured Molarity of 0.08000 M Stock Solution values must be posted to the Google spreadsheet before the end of the lab period.

Part 2: Preparing a solution of known concentration.

If the oldest person in you lab group has a birthday between January and April then calculate the mass of NaCl in grams needed to make 250.0 mL of 0.200M NaCl solution.

If the oldest person in you lab group has a birthday between May and August then calculate the mass of NaCl in grams needed to make 250.0 mL of 0.400M NaCl solution.

If the oldest person in you lab group has a birthday between September and December then calculate the mass of NaCl in grams needed to make 250.0 mL of 0.600M NaCl solution.

Place a weigh boat on the balance and zero it. Add the calculated mass of NaCl to the nearest 0.001 g. Carefully transfer the NaCl to a 250 mL volumetric flask and fill carefully to the mark with deionized water. With the flask plug in place, invert the flask 20 times to mix. Label this as your **stock NaCl solution**.

Pour the **stock NaCl solution** out of the volumetric flask into a 400 mL beaker and label it.

Part 3: Diluting your stock solution using $M_1V_1 = M_2V_2$

Calculate the concentration of NaCl in a solution you will make by diluting 10.0 mL of your **stock NaCl solution** to a total volume of 100.0 mL. For M_1, use the actual molarity of your stock **NaCl** solution based on the mass of NaCl you added in part 2. Using a 10 mL graduated pipet and pipet bulb, add 10.0 mL of your stock NaCl solution and dilute with DI water to the 100 mL mark on the volumetric flask. With the flask plug in place, invert 20 times to mix well and pour the solution into a small beaker. Label this solution as **cereal dilution #1** and write the molarity of NaCl you calculated.

Calculate the concentration of NaCl in a solution you will make by diluting 10.0 mL of your **cereal dilution #1** solution to a total volume of 100.0 mL. For M_1, use the actual molarity of your **cereal dilution #1** solution based on your calculation above. Label this solution as **cereal dilution #2** and write the molarity of NaCl you calculated.

Measure the chloride concentration in the stock NaCl, cereal dilution #1, and cereal dilution 2 using the Waterproof SaltTestr Electrode. Record your prepared NaCl concentrations and measured NaCl concentrations for the stock NaCl solution and cereal dilutions #1 & #2 in a table in your notebook.

Ask a lab aide to check your values and then post your three prepared NaCl concentrations and the three measured NaCl concentration values in the Google spreadsheet available on Moodle.

Questions:

1. Look at the Waterproof SaltTestr Electrode user manual and determine the range of the electrode. Does the range you measured in part 3 agree with this range?
2. Download the Google spreadsheet that contains the entire classes' measured NaCl solution values from part 1 of the lab. Calculate the mean, standard deviation, and standard error of the NaCl solutions concentrations the class measured using the Waterproof SaltTestr Electrode Directions. Calculate the mean, standard deviation, and standard error of the NaCl solutions concentrations the class measured using the Quantab High-Range Chloride Titrator Strip. Compare the mean and standard error for the two measurement methods.
    a. Which method is most accurate?
    b. Which method is most precise?
    c. Which is the least expensive?
3. Download the Google spreadsheet that contains the entire classes' measured NaCl solution values from part 3 of the lab. Graph the data. The "prepared NaCl concentration (moles/L)" should be the x-values and the "measured NaCl concentration (moles/L)" should be the y-values.
    a. What is the linear range of the Waterproof SaltTestr Electrode
    b. Does your measured linear range agree with the range provided in the manual?
4. Calculate the mass in grams of KNO_3 necessary to prepare 500.0 mL of 0.425 M KNO_3 solution.
5. You add 3.04 grams of KNO_3 to a beaker. To what volume must you dilute the solution to prepare a 0.400 M KNO_3 solution?
6. How many milliliters of 0.425 M KNO_3 solution must be diluted to prepare 50.0 mL of 0.085 M KNO_3 solution?
7. A 42.1 mL aliquot of 0.425 M KNO_3 solution is diluted to 3.67 liters. How many milligrams of KNO_3 are present in 25.0 mL of the dilute solution?

Quantab High-Range Chloride Titrator Strip Conversion Table

Quantab Value	mol NaCl / L
2.2	0.008141
2.3	0.008648
2.4	0.009155
2.5	0.009676
2.6	0.010197
2.7	0.010761
2.8	0.011324
2.9	0.011901
3	0.012479
3.1	0.013113
3.2	0.013746
3.3	0.014408
3.4	0.01507
3.5	0.015775
3.6	0.016479
3.7	0.017225
3.8	0.017972
3.9	0.018775
4	0.019577
4.1	0.020437
4.2	0.021296
4.3	0.022225
4.4	0.023155
4.5	0.024127

Quantab Value	mol NaCl / L
4.6	0.025099
4.7	0.026169
4.8	0.027239
4.9	0.02838
5	0.029521
5.1	0.030746
5.2	0.031972
5.3	0.03331
5.4	0.034648
5.5	0.036099
5.6	0.037549
5.7	0.039127
5.8	0.040704
5.9	0.042423
6	0.044141
6.1	0.046042
6.2	0.047944
6.3	0.050014
6.4	0.052085
6.5	0.05438
6.6	0.056676
6.7	0.059211
6.8	0.061746
6.9	0.064577

Quantab Value	mol NaCl / L
7	0.067408
7.1	0.070577
7.2	0.073746
7.3	0.07731
7.4	0.080873
7.5	0.084915
7.6	0.088958
7.7	0.093549
7.8	0.098141
7.9	0.103423
8	0.108704
8.1	0.114803
8.2	0.120901
8.3	0.128042
8.4	0.135183
8.5	0.143606
8.6	0.152028
8.7	0.162085
8.8	0.172141
8.8	0.172141