Name: ____

Lab Instructor:____________________________________

PREPARATION FOR CHEMISTRY LAB: FLUORIDE IN WATER

On these problems, the solvent is water and the solution is sufficiently dilute so that the density of the solution is the same as the density of water, 1.00 g/mL. You may assume that the definition, **ppm = (mg solute)/(L solution)**, can be used. That is, if a solution is 15 ppm, there are 15 mg of solute in 1 liter of solution

1. How many milligrams of fluoride are present in 74.3 L of a solution that has a fluoride concentration of 4.62 ppm?

2. Calculate the concentration, in ppm, of a solution prepared by dissolving 0.804 grams of sodium fluoride in enough water to prepare 2.34 L of solution.

FLUORIDE IN WATER

INTRODUCTION

This week you will use colorimetry to measure the fluoride concentration in water samples.

Fluoride is used at very low levels in some municipal water supplies and in toothpastes to help prevent dental decay and as a treatment for osteoporosis. Fluoride ions are colorless (i.e., do not absorb light in the visible region) in aqueous solutions and therefore cannot be measured directly by absorbance. However, if we react the fluoride ions with a highly colored complex of zirconium ions and a dye (represented as **ZrIn)** we can indirectly get an accurate measurement of the fluoride concentration. The following simplified reaction represents the reaction of the ZrIn complex and fluoride ions:

$$\underset{\text{(red)}}{ZrIn} + F^- \rightarrow \underset{\text{(colorless)}}{ZrF + In^-}$$

When fluoride is added to a solution containing ZrIn, it reacts according to the above equation. **This reaction causes the absorbance of the solution to decrease with increasing fluoride concentration**; this is the expected behavior since you are removing the absorbing species by the addition of the fluoride.

THE "**PARTS PER MILLION**" (ppm) UNIT

When we use percent, we are actually working with parts per hundred (parts) and use the % symbol rather than pph.

When we are able to detect fairly small quantities of solutes in solution, it is often more convenient to use parts per million, ppm, rather than percent.

For liquid solutions, ppm is usually based on mass: a 1 ppm solution contains 1 g of solute per 10^6 grams of solution. Or, for dilute aqueous solutions, 1 ppm = 1 mg (solute)/L (solution).

For example, a 20 ppm aqueous NaCl solution contains 20 mg of NaCl per liter of solution.

PROCEDURE

Since the fluoride concentration in our water samples ranges from 0 to 3 ppm, great care will be needed in pipeting and measuring. Also, glassware has to be scrupulously clean. Your results depend on it. Data that are less than 95% correlated will not be accepted.

1. The LabQuest Colorimeter needs to be powered for about 5 minutes before using so do this step before preparing your solutions. Plug the LabQuest Colorimeter into one of the LabQuest sensor ports and turn on the instrument.

2. Load a 25 mL buret with DI water.

3. Use a measuring pipet to deliver the following volumes of **FLUORIDE STOCK SOLUTION (3.0 ppm).** Deliver the exact volumes of stock solution and water shown in the Table below into large test tubes (TT) marked with the letters A through G.

Test Tube	STOCK (3.0 ppm) F^- SOLN (mL)	DI WATER (mL)	F^- concentration (ppm)
A	0	3.0	0
B	0.5	2.5	
C	1.0	2.0	
D	1.5	1.5	
E	2.0	1.0	
F	2.5	0.5	
G	3.0	0.0	3.0

4. The fluoride concentration in each TT after the addition of water should have been determined and entered in the above table as a Pre-Lab exercise.

5. Using a volumetric pipet, deliver 3.0 mL of an unknown fluoride solution into a TT labeled U for the unknown.

6. Go to the COLOR REAGENT DISPENSER. Gently lift and then depress the plunger to deliver the preset volume (5.0 mL) of reagent into each TT.

7. Mix the contents of each tube well without spilling.

8. Check for cloudiness and proceed only if the solutions are clear.

9. You will not experimentally determine the wavelength of maximum absorbance in this lab.

    Be sure one of the four green wavelength lights is on. The wavelength of maximum absorbance in this experiment is 565 nm. Using the front panel arrow keys on the colorimeter choose 565 nm.

10. Calibrate the colorimeter. Place the cuvette containing the blank in the colorimeter set at the wavelength of maximum absorbance. Press the **CAL** button on the front of the colorimeter. Release it when the red LED begins to flash. When the red light stops flashing, the colorimeter is calibrated and ready to use.

11. Using the stylus (never touch the LabQuest screen with your fingers): touch Sensors, Data Collection, choose Events with Entry in the Mode box. Highlight the word Event in the Name: box and replace it with Concentration. Put ppm in the Units box. OK.

12. Place the cuvette containing the prepared solution in the colorimeter. Touch the begin data collection button (triangle) on the bottom left of the screen. When the absorbance reading stabilizes, touch the **KEEP** button located just to the right of the data collection button. Don't touch the stop data collection button (square). Type in the concentration of the solution that is in the cuvette (don't include units). OK.

13. Pour your samples back into the original TT after you have measured each absorbance and discard them in the waste container only after you have acceptable data.

14. Working in order of most dilute to most concentrated of the remaining solutions, rinse and then fill a cuvette with the solution that will be analyzed. Place the cuvette in the colorimeter. When the absorbance reading stabilizes, touch the KEEP button, and enter the concentration of the analyzed solution. Repeat until the absorbance of all solutions has been determined.

15. When the absorbance of all prepared solutions has been determined, touch the stop data collection button (square) located on the bottom left of the screen and **save** your data.

16. Your calibration curve should be linear.

    Use the LabQuest to determine the equation of the line. To receive full credit for this lab your calibration curve must be a good, straight-line graph, with a correlation coefficient of 95% or better (Corr: on the screen reads 0.9500 or greater).

17. Rinse and fill a cuvette with the solution containing your unknown. Place it in the colorimeter. Touch the Sensor icon on the upper left of the LabQuest. Record the absorbance once the reading has stabilized.

18. Print out a copy of the calibration curve for each lab partner. Each lab report must have a LabQuest generated printout of the calibration curve attached to it. The printout must show the graph, the information needed to generate the equation (slope and intercept) for the line, and the correlation reading. This should all show up automatically on the printout. Be sure that the names of all lab partners are entered in the footnote and that the date box is checked.

19. Delete all saved files before returning your LabQuest to Lab Services.

DATA AND ANALYSIS SHEET: FLUORIDE IN WATER

Name: ____ Date _____________

Lab Partner _________________________________

Wavelength of maximum absorbance: ___________________________

Attach the LabQuest-generated calibration curve (graph), with curve characteristics to this report sheet.

Equation of line for the calibration curve: ____

Correlation: _______________________

Unknown Identification: _____________________________

Absorbance of your assigned unknown fluoride solution: ____________________________

Determine the concentration of fluoride in your unknown solution using the calibration curve (not the equation). Mark and identify the point on the printout of the calibration curve.

Concentration: _______________________

Determine the concentration of your unknown using the equation for the line for **your** calibration curve (show work).

Concentration: _______________________

Name: ____

Lab Instructor:_____________________________________

QUESTIONS ABOUT THIS LAB: FLUORIDE

In these problems the solvent is water and the solution is sufficiently dilute so that the density of the solution is the same as the density of water, 1.00 g/mL. You may assume that the definition, ppm = (mg solute)/(L solution), can be used.

1. A 5.34 g sample of groundwater was found to contain 4.16 micrograms (micro: 10^{-6}) of zinc ions. What is the concentration of zinc ions in mg/L and in ppm?

2. Sodium fluoride (NaF) is one of the compounds used to fluoridate water. A community decides to supply its citizens with fluoridated water using a concentration of 1.2 ppm of NaF. How many grams of NaF must be added to the water in a 2.85 million gallon storage tank in order to reach this concentration? (946 mL = 1 qt, 4 qt = 1 gal)

3. Death can result from ingestion of between 5 g and 10 g of fluoride. How many gallons of fluoridated water, with a fluoride concentration of 1.2 ppm, does a person have to drink at one time to get 7.0 g of fluoride? (946 mL = 1 qt, 4 qt = 1 gal)