Quantitative Analysis Lab - Phosphates

Purpose: In this laboratory activity, you will analyze a fertilizer solution to determine the mass and percent of phosphate.

Introduction: Fertilizers are typically a solid material with nutrients in it. When placed on the plants and then watered, the nutrients dissolve into the water to get to the root system. The fertilizer solution as made by your teacher was a 0.50 g sample of solid fertilizer dissolved in 250 ml. This solution is much too concentrated to use the colorimetry method we will employ to determine the amount of phosphate in the sample. Therefore, your teacher has diluted the solution to 1/50 of the dissolved solution, or has taken 5.0 mL of the dissolved fertilizer solution and diluted again to 250 mL.

Procedure:

1) Your teacher has made an unknown phosphate fertilizer solution labeled "x ppm". Pipet 10 ml of the solution into a test tube. Label this test tube "x ppm".
2) Label four clean test tubes as follows: 10 ppm, 7.5 ppm, 5 ppm and 2.5 ppm.
3) Place a 400 ml beaker half full of tap water on a hot plate or over a burner. Do not boil the water. temperature of the water bath should be above 50°C by the time you get to step 11.
4) Your teacher has already prepared a supply of 10 ppm phosphate ion solution. Pipet 10 ml of this standard solution in the test tube labeled "10 ppm".
5) Given supplies of 10 ppm solution and distilled water, decide what volumes of 10 ppm solution and distilled water should be measured and mixed to prepare 10 ml samples of 7.5 ppm, 5.0 ppm and 2.5 ppm phosphate solutions. Write your plan in your lab notebook. Have the teacher check your plan to make sure you are correct.
6) After receiving your teacher's approval, prepare the three solutions using the pipets. Pour each standard solution into its appropriately labeled test tube.
7) Add 1.0 ml (using a pipet) of ammonium molybdate–sulfuric acid solution to each of the four phosphate standards and the unknown solution.
8) Your teacher will add a few crystals of ascorbic acid (no more than the volume of a pencil eraser tip) to each tube. Stir to dissolve. Rinse and dry the stirring rod after mixing each tube.
9) Carefully place your five test tubes into the hot water bath, Heat the water bath and test tubes until a faint blue color appears in the 2.5 ppm solution.
10) Using test tube tongs, remove the test tubes from the water bath and place them in numerical order in a test tube rack.
11) Obtain 5 square cuvettes for the colorimeter. Hold the cuvettes by the ridged sides. Pour some of the 2.5 ppm solution into the first cuvette, filling it about ¾ full. Repeat pouring each solution into a different cuvette, including the unknown. Keep track of which is which.
12) Take each of the cuvettes to the colorimeter. One by one, place the cuvettes in the colorimeter and record the absorbance for each solution in the data table below.
13) Discard your cuvette solutions and test tube solutions and leftover fertilizer solution as directed by your teacher. Return the cuvettes to the teacher and clean out your test tubes.
14) Wash you hands before leaving the lab.

Data

ppm	absorbance
2.5	
5	

7.5	
10	
x	

Calculations

1) Plot a graph of the first four data points, absorbance (y) versus ppm (x). Draw a best fit line, using (0,0) as a data point. Determine the slope of the line. Label axes appropriately.

2) Using the equation, determine the ppm of the unknown solution.

3) This solution was made by your teacher by taking 0.50 g of fertilizer solution in 250 mL of water. Calculate the mass (grams) of phosphate present in your original 250 ml fertilizer solution, To determine this, use the following calculation:

$$Mass\ of\ phosphate\ (in\ grams) = \frac{??\ g\ phosphate}{1{,}000{,}000\ g\ solution} x\ 250\ g\ solution\ x\ 50$$

In place of ??, substitute the value for "x ppm" obtained in question 2.

4) Based on your answer in calculation 3, find and record the percent phosphate (by mass) in your original 0.50 g fertilizer sample.

Questions

1) Name two common household products for which you can estimate relative concentrations just by observing their color intensities.

2) Chemists often use an instrument called a colorimeter to determine solution concentrations. A colorimeter measures the quantity of light that passes through an unknown sample and compares it to the quantity of light that passes through a known standard solution. What advantages does a colorimeter offer over the human eye?

3) Explain this statement: "The accuracy of the results of a colorimetric analysis depends, in part, on the care taken in preparing the standards used in the analysis."

4) In the previous lab, the tests were qualitative – they were used to only indicate whether a particular ion was present. How could an ion test involving formation of a colored solution be modified so it would be quantitative – indicating the concentration of ion present?

5a) Why must farmers know the composition of the fertilizers they use?
b) What risks are involved in applying more of a soil nutrient than is actually needed?

6) Initially, your teacher retained 1/50 of the total fertilizer solution to dilute. Consider this alternative: Instead of starting with a solution, you were told to measure out 1/50 of the starting mass of solid fertilizer (0.50 g x 1/50 = 0.010 g) and then dissolved it in 250 ml of water. What are the possible disadvantages to the shorter procedure?

Conclusion: