What is the Concentration of that Urine?

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Lesson
#10

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Suggestions for Teachers

Purpose:
To explore molarity and concentration, and identify substances effecting concentration of solutions.

Objectives:
The student will be able to calculate molarity, prepare a solution of a given molarity and identify the solute dissolved in the solvent.

Process skills:
Using a centigram balance, preparing solutions, using a calculator-based laboratory unit (CBL) and colorimeter for the CBL. The correct use of the appropriate laboratory equipment.

Materials:
- Various concentrations of Potassium Chloride (KCl) solution
- KCl crystals (lab grade)
- Distilled water
- Beaker
- Stirring rod
- Electronic or manual centigram balances
- CBL units; TI 83 graphing calculators
- Colorimeters with CBL adapters
- Graph Link Cable (optional)
- Bunsen burners (possibly)

Preparation and Procedure:
1. Divide the class into lab groups of two to three students. Hand out index cards to the lab groups.

2. Prepare index cards with various molarity values written on them. Here is a list of possible molarities and the recipes to prepare them:

   0.5M KCl solution: dissolve 37.3g KCl in 1L distilled water.
   0.1M KCl solution: dissolve 7.5g/1L H_2O.
   0.01M KCl solution: 0.75g KCl/1L H_2O
   0.02M KCl solution: 1.49g KCl/1L H_2O
   0.25M KCl solution: 18.65g KCl/1L H_2O

Experiment with various molarities to achieve different shades of yellow color prior to trying this lab.

3. Direct students to prepare a solution with the molarity of the value written on the card.

4. Each lab group will write a laboratory procedure describing the preparation of a solution with the specified molarity from the card.

5. Lab groups will then exchange solutions, and attempt to identify the substance in the solution.

6. Before attempting this activity, teach about molarity, concentrations, solvents and solutes. Teach about Beer's Law, uses of a colorimeter and when this may be used in health sciences.

   Molarity = Moles of Solute/Liters of Solvent
   Beer's Law: $A = \text{Log } [I_o/I]¢cl$

   A= Absorbance (optical density)
   l = Path link of the monochromatic light in centimeters
   Io = Intensity of the incidence of the monochromatic light
   I = Intensity of the emergent monochromatic light
   ¢ = Molar absorptivity (extinction coefficient) a/cl
   c = Concentration

7. Student lab groups will present a poster with their findings, a clearly stated purpose, materials, procedure, data and calculations and results and conclusions should be included on the poster.

Safety:
Students should wear safety goggles, as well as handle glassware and chemicals with caution.

References:
Human Physiology, Sixth Edition. Arthur J.Vander, James H..Sherman, Dorothy S. Luciano; McGraw-Hill, Inc., 1994

Concepts of Human Physiology. Richard L. Johnson, Micheal D. Johnson, Gary Malvin; Addison Wesley Longman, Inc., 1994

Chemistry, Third Edition. Anthony C. Wilbraham, Dennis D. Staley, Candace J. Simpson, Michael S. Matta; Addison-Wesley Publishing Co., 1994.

Assessment:
Grade procedure students will write out using a rubric. Students will receive credit for their written procedure as well as their evaluation of the concentration and contents of their solution. Each lab group should present their findings to the class. Calculations showing how they arrived at their molarity will be counted as an important part of the activity and presentation.

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Information for Students

Background Information:

The concentration of a solution tells us the amount of solute that is dissolved in a given amount of solvent. "Concentrated" means that there is a relatively high amount of solute in a solvent. "Dilute" means there is a relatively low quantity of a solute in a solvent. Solutes can be liquids, solids or gases. The concentration or dilution of a solution is measured in moles per liter, or by using the term *Molarity* (M). Concentration can also be represented by percent of weight of the solute per weight of the solvent, called *percent by volume.*

If you drink a large volume of H_2O, your urine would be very light colored because it is very diluted. If you play a game of tennis on a hot day and don't drink enough water, your urine output would be less, and the color would be a darker yellow because it is concentrated. The darker color is due to an increase in the amount of solutes in the solvent, urine.

Untreated diabetics have a high level of glucose in their blood. The concentration of glucose may be so high that the amount of glucose presented to the kidneys exceeds their ability to reabsorb all that is presented, so large amounts of glucose enters the urine. (1994, R. Malvin, M. Johnson, and G. Malvin) The reason for this is because the amount of solutes (glucose and ketones) are being excreted in the urine due to the disease process. Ketones are products of fatty acid metabolism that accumulate in the blood during what the body interprets as starvation, or Diabetes Mellitus. The solvent in this case is the urine.

How would you be able to tell if there were high amounts of glucose and ketones in this urine? If it were urine from a diabetic, a diabetic "dip stick" would tell us there was sugar and ketones in the urine, but we want to know exactly how much. There are automatic glucose testers that available for purchase at the pharmacy. How do these small, costly units work?

Materials:

- Index card with the specified concentration of solution
- Beaker
- Stirring rod
- Electronic or manual centigram balances
- CBL units; TI 83 graphing calculators
- Colorimeters with CBL adapters
- Graph Link Cable (optional)

Problem # 1:

1. Prepare a solution with the molarity of the value written on the card.

2. Write a laboratory procedure describing the preparation of a solution with the specified molarity from the card.

Problem #2:

1. Exchange your solution with another lab group's solution and proceed to identify the substance dissolved in the solution. You may use the available equipment or devise a procedure using the equipment normally at your disposal in the chemistry laboratory.

2. Write a clear set of procedures explaining how you identified the solution.

3. Present a poster with your findings from problem #2. Included on your poster: a clearly stated purpose, materials, procedure, data and calculations, and results and conclusions.