

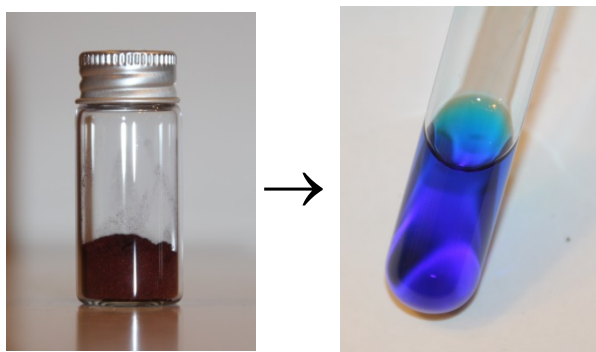
Lab 10. Identification of an Unknown Based on Physical Properties: What Type of Solution Is the Unknown Liquid?

Introduction

Physical changes to chemical substances occur when the physical appearance and structure of a substance change but the chemical structure does not. *Chemical changes* happen when the chemical structure of matter is altered into a different structure that is a completely different substance. Chemists can understand which kind of changes have occurred by examining their relevant physical and chemical properties. *Physical properties* of matter are characteristics of substances that relate to the structure of matter and can be measured without changing them. These properties can be observed or measured in a variety of ways. Physical properties can include boiling point, color, conductivity, density, freezing point,

FIGURE L10.1

A sample of methyl blue (left) and an aqueous solution of methyl blue (right)



melting point, viscosity, and many more. *Chemical properties* refer to characteristics of matter that can only be observed by changing the structure of a substance through a chemical change. Examples of chemical properties include reactivity, flammability, and oxidation states.

Many of the liquids that you interact with daily are aqueous solutions (see Figure L10.1). Dissolving a solute in water can result in either a physical change or a chemical change, depending on the chemical properties of the solute. If a solute can separate into different chemical substances when mixed in water, then a chemical change has occurred. But if the solute stays in the same chemical structure when mixed with water, then only a physical change has occurred because

the solute has not changed its chemical structure; it has only changed its physical distribution in the water. The differences between these changes affect the *colligative properties* of the solutions. Colligative properties of solutions are characteristics that are dependent on the number of particles present and not on the specific type of particles present in a solution.

Your Task

Determine the identity of an unknown solution by comparing its physical and chemical properties with the same properties of known solutions.

The guiding question of this investigation is, **What type of solution is the unknown liquid?**

Materials

You may use any of the following materials during your investigation:

Consumables	Equipment
<ul style="list-style-type: none">• 1 M solution of acetic acid, CH_3COOH• 2 M solution of CH_3COOH• 1 M solution of sodium chloride, NaCl• 2 M solution of NaCl• 1 M solution of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$• 2 M solution of $\text{C}_{12}\text{H}_{22}\text{O}_{11}$• Unknown solution A• Unknown solution B	<ul style="list-style-type: none">• Erlenmeyer flasks• Temperature probe• Hot plate• Electronic or triple beam balance• Graduated cylinder (50 ml)• Conductivity meter• pH paper

Safety Precautions

Follow all normal lab safety rules. Your teacher will explain relevant and important information about working with the chemicals associated with this investigation. In addition, take the following safety precautions:

- Wear indirectly vented chemical-splash goggles and chemical-resistant gloves and apron while in the laboratory.
- Use caution when working with hot plates because they can burn skin. Hot plates also need to be kept away from water and other liquids.
- Handle all glassware with care.
- Wash your hands with soap and water before leaving the laboratory.

Investigation Proposal Required? Yes No

Getting Started

The first step in this investigation is to identify all the various physical and chemical properties that are possible to measure using the available materials. Once you have determined which physical and chemical properties you can measure, you can then design your investigation. To do this, you will need to think about what type of data you need to collect, how you will collect the data, and how you will analyze the data. To determine *what type of data you need to collect*, think about what type of measurements you will need to record during your investigation.

To determine *how you will collect the data*, think about the following questions:

- What will serve as a control (or comparison) condition?
- What types of treatment conditions will you need to set up and how will you do it?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?

To determine *how you will analyze the data*, think about the following questions:

- How will you determine if there is a difference between the treatment and control conditions?
- What type of table could you create to help make sense of your data?

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- how scale, proportion, and quantity are important in understanding the natural world;
- how energy and matter are related to each other;
- the difference between observations and inferences; and
- the difference between data and evidence.

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a *claim*, which is your answer to the guiding question. Your argument must also include *evidence* in support of your claim. The evidence is your analysis of the data and your interpretation of what the analysis means. Finally, you must include a *justification* of the evidence in your argument. You will therefore need to use a scientific concept or principle to explain why the evidence that you decided to use is relevant and important. You will create your initial argument on a whiteboard. Your whiteboard must include all the information shown in Figure L10.2.

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group stays at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the initial arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. To critique an argument,

you might need more information than what is included on the whiteboard. You might therefore need to ask the presenter one or more follow-up questions, such as:

- What did your group do to make sure the data you collected are reliable? What did you do to decrease measurement error?
- What did your group do to analyze the data, and why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your group's analysis? How do you know that your interpretation of the analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before deciding on that one? Why did you abandon those alternative ideas?
- How confident are you that your group's claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!

FIGURE L10.2

Argument presentation on a whiteboard

The Guiding Question:	
Our Claim:	
Our Evidence:	Our Justification of the Evidence: