

OBSERVATIONS AND THE SCIENTIFIC METHOD

In this experiment, you will apply the scientific method to the investigation of an unknown substance. You will make observations and then formulate a hypothesis to explain the phenomena you observed.

The **Scientific Method** involves three steps. First, an observation is made and a model is developed to explain the observation. This model is called a **hypothesis**. Experiments are then designed and carried out to test your hypothesis under controlled conditions.

If the results of the initial experiments support your hypothesis, additional testing must be done to further support the hypothesis. Only when the results of many experiments support the hypothesis, can the hypothesis be called a **theory**. A theory is a hypothesis that has met the test of repeated experiments.

Materials:

Two Styrofoam coffee cups stacked together, an unknown substance for observation, two clothes pins, two polyethylene transfer pipets.

Procedures:

1. Observe the substance in the stacked cups carefully. Record as many observations as you can during a 10-15 minute period. Use all of your senses (except taste) to determine the properties of your unknown substance. Negative observations (nothing happened) are just as important as positive observations. List your observations as well as your conclusions about that observation on a separate sheet of paper.

Some useful properties of your substance might be:

What is the phase of this substance? Is it a solid, liquid, or gas?

Is it changing phase? That is, is it boiling, condensing, melting, freezing, evaporating, or subliming?

Does your substance have an odor?

How does the density of the substance or its vapor compare with the density of air?

Does the substance have any effect on the coffee cups and describe any effect you might observe?

What else do you observe about your substance?

Perform some experiments with your substance:

Pour a few drops on your desktop and observe. What do you observe about both your substance and your desk? Again, what does your observation tell you?

Measure the temperature of your substance both initially and after 15-20 minutes. How are the temperature readings consistent with your observations?

Create and perform some additional original experiments with your substance.

2. After reviewing your observations, formulate a hypothesis about some of your observations and perform some additional experiments of support or refute your hypothesis. Explain the reasoning behind your hypothesis.
3. Clamp the top of two polyethylene transfer pipets with clothes pins and immerse their bulbs into your substance. Occasionally remove the pipets from your substance and observe. What is happening inside your pipet? Does the diameter of the pipet stem make a difference and how does that variation explain your observations?
4. Place the partly filled pipet on the floor when instructed to do so by your instructor. What do you observe happening and what is the explanation for the phenomena observed?
5. Clean up by discarding any used pipets or pipet parts in the trash. Return the cups, clothes pins, and any unused unknown substance to your instructor.

Additional Questions:

- Q1. Write a description of your unknown substance, based on your list of observations, and upon any additional phenomena you may have observed formulating a hypothesis about your substance.
- Q2. Explain the difference between qualitative and quantitative observations. Give examples of both qualitative and quantitative observations in this experiment.
- Q3. Write a short paragraph describing what material you think is filling the pipets immersed in your unknown substance and the rationale behind your explanation.
- Q4. Find the accepted value for the boiling point of your unknown substance (pure nitrogen) in a handbook or encyclopedia and calculate the percent error for both temperature measurements.

$$\text{Percent Error} = \frac{\left(\begin{array}{c} \text{Difference between the} \\ \text{experimental value and} \\ \text{the accepted value} \end{array} \right)}{\text{the accepted value}} \times 100$$

- Q5. Write a short paragraph describing what happens when the filled pipet is placed on the floor. Why do you think the pipets behaved in the manner that they did?