

Observation and Experiment

Introduction to the Scientific Method

Introduction

"The world is full of obvious things, which nobody by any chance ever observes."

This quote is from Sherlock Holmes, talking about the importance of careful observation in detection. Careful observation is also the foundation of chemistry as an experimental science, leading us to question what we have observed. How, what, why? The answers to these questions are sought in experiments, which may be described as observations made under controlled conditions. Observation and experiment – twin pillars of the scientific method.

Concepts

- Scientific method
- Observation
- Chemistry
- Experiment

Background

The scientific way of knowing, often called the scientific method, is sometimes presented as a rigid sequence of events. The scientific method, however, is not a rigid path, it is a process – a process of discovery! Discovery begins when we make observations and then try to understand what we have observed by asking key questions and proposing possible answers. The process of discovery continues as we design and conduct experiments to test whether our answers to these questions are valid.

Chemistry is defined as the study of matter – what a substance is made of, its structure and properties, and the changes that it undergoes. Observations of the properties of matter are often complex, arising from the interaction of many different factors or variables. Experiments should be designed so that the effects of different variables on the behavior of a substance can be studied independently. This is done by making observations under controlled experiments make it possible to separate or isolate the factors that are responsible for a given observation in a complex series of events.

When three substances – solid calcium chloride, solid sodium bicarbonate, and a solution of phenol red in water – are mixed in a closed container, a complex series of changes is observed. Observations include temperature changes, color changes, and changes in state. How can we learn more about the individual interactions responsible for each observation? Imagine that each substance in the mixture represents a variable. By changing only one variable at a time, it should be possible to determine the contribution of each substance to the changes observed for the overall reaction.

The three substances that are used in this experiment are all common chemicals. Sodium bicarbonate, or baking soda, is used as a food additive in baking. It is also used as a natural deodorant to absorb and remove odor-causing chemicals in refrigerators and carpets. Calcium chloride ("road salt") is a salt-like compound that is used as a de-icer for sidewalks and roads. Phenol red is a naturally occurring dye that is used as an indicator – it changes color under different conditions.

Note: Because phenol red is a solution of the dye dissolved in water, it is actually composed of two substances. Thus, water must be considered as a fourth substance (variable) in the overall reaction, and its effect should also be examined.

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A Gutmann



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