Module 1: Foundations
The Scientific Method

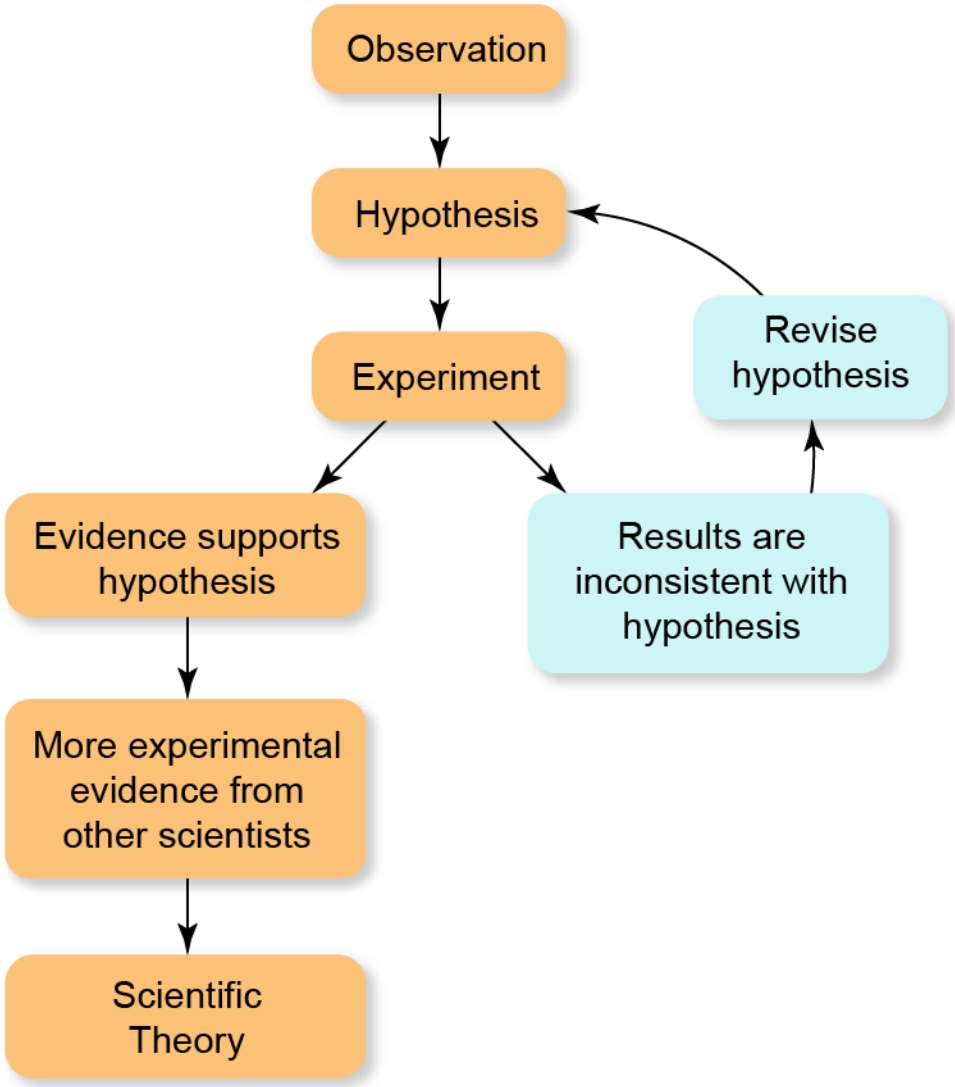
Fundamentals of Chemistry Open Course

Learning Objectives | Module 1

1. Extract useful quantitative information from problems; generate a list of known and unknown quantities from the text of a problem.
2. Solve equations for a single unknown variable using standard algebraic operations.
3. Draw and interpret graphs relating physical variables with relevance to chemistry.
4. Recognize the essential components of a measurement.
5. Apply dimensional analysis with knowns and unknowns to solve equations involving measured quantities.
6. Calculate measures of accuracy and precision to assess the quality of a set of measurements.
7. Express quantities calculated from measurements at the appropriate level of precision by applying the rules for significant digits.
8. Recognize and distinguish between physical and chemical properties.
9. Classify different types of matter as pure substances or mixtures; compare and contrast homogeneous and heterogeneous mixtures.
10. Describe and apply the scientific method.

The Scientific Method; Hypotheses, Theories, and Laws | 1 of 3

- Scientific knowledge is **empirical**—based on observation and experiment.

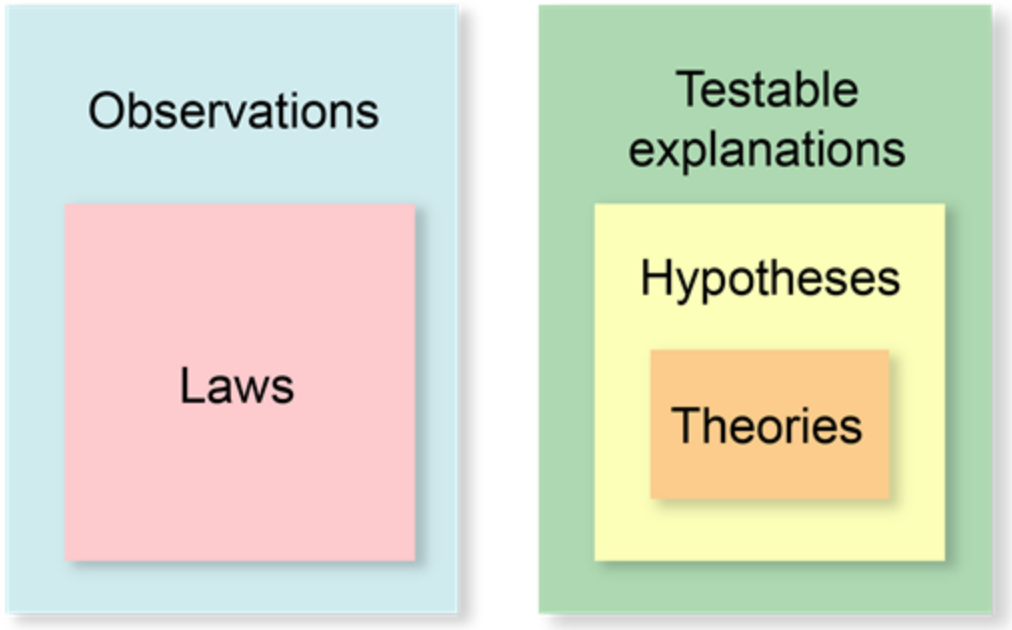


- **Hypothesis**
  - A tentative interpretation or explanation of observations
  - Should be *falsifiable*, making predictions that can be supported or refuted by further observation

- **Experiments**
  - Highly controlled procedures designed to generate observations that can support or refute a hypothesis

- **Scientific theory**
  - A model for the way nature is that attempts to explain not merely what nature does, but why.
  - Often, theories predict behavior far beyond the observations or laws from which they were developed.
  - Example: Dalton's atomic theory proposed that matter is composed of small, indestructible particles (atoms) that rearrange during chemical changes such that the total amount of mass remains constant.

- **Scientific law**
  - A brief statement that summarizes past observations and predict future ones
  - Example: The *law of conservation of mass:* "In a chemical reaction, matter is neither created nor destroyed."
  - Subject to experiments which can add support to them or prove them wrong (like hypotheses)

The Scientific Method; Hypotheses, Theories, and Laws | 3 of 3

- Laws are scientific observations that have always been seen to be true, but they are not explanations for why the observation is always that way.
- Theories are scientific explanations that so far have not been proven wrong.
- A theory and a law are two entirely different things.
- A hypothesis can become a theory, but a theory can never become a law.