

CHEMISTRY 120: INTRODUCTION TO CHEMISTRY

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CHAPTER ONE

The Chemical World

What is Chemistry?

- Chemistry is the study of *matter* and its properties/interactions.
- What *exactly* is matter?
 - Matter is anything which has mass and takes up space (volume)
 - Examples of matter:
 - Sand (a solid)
 - Water (a liquid)
 - Air (a mixture of gases)

Why Study Chemistry?

- Chemistry is a fundamental science, with applications in all walks of life.
 - Medical care
 - Development of new materials
 - General engineering applications
 - Consumer applications
- Though often complex, there is beauty in the organization and behavior of matter, making it an interesting field to study.

How do we learn chemistry?

- Chemistry is an *empirical science*, meaning that it is based on the results of experiments.
- In the lecture we will study theories and laws based on many years of observations and experiments.
- In the laboratory we will verify many of these principles.

The Scientific Method

- The scientific method is a loosely defined procedure for carrying out scientific investigations.
 - Broken into several steps
 - Most scientific work is *cyclical*
 - New findings rarely bring an end to the research, but provide new avenues to investigate
 - The process is *flexible*
 - While there certainly are incorrect ways of applying the scientific method, it may be adjusted *within reason* to accommodate a given application

Important Related Terms

- **Fact:** A single observation
 - *Example: When 1.00 grams of table salt is dissolved in a liter of water, its boiling point decreases by 0.1 °C.*
- **Law:** A summary of several facts/observations. A law does not generally attempt to explain these facts.
 - *Example: The freezing point of a liquid is lowered by the presence of a solute (something which is dissolved in it, like table salt.)*

Important Related Terms

- The **hypothesis** attempts to offer explanation for these observations.
 - *Example: A solute lowers the freezing point of its solvent by interfering in the molecules' ability to attract each other.*
- Once a hypothesis has survived rigorous testing and clarification, it evolves into a **theory**.
 - Theories also may need to be adjusted or thrown out altogether if they are shown to be inaccurate.

Examples

- Is each statement below a fact, a law, or a hypothesis?
 - Objects fall to the earth when dropped.
 - My cat weighs 4.5 lbs.
 - The high temperature in Los Angeles on 5/4/02 was 83 °F.
 - Temperatures are warmer in the summer months because the Earth is closer to the sun at this time.
 - Is the last statement true?

The Scientific Method

1. Define the problem.

Must be the first step: have to know what we're studying!

2. Make a series of observations, and collect some preliminary information.

Perhaps this would be a good time to do some simple experiments?

The Scientific Method

3. Propose a reasonable hypothesis.

A *hypothesis* is a tentative explanation of one or more observations.

4. Design and carry out a set of experiments. Note:

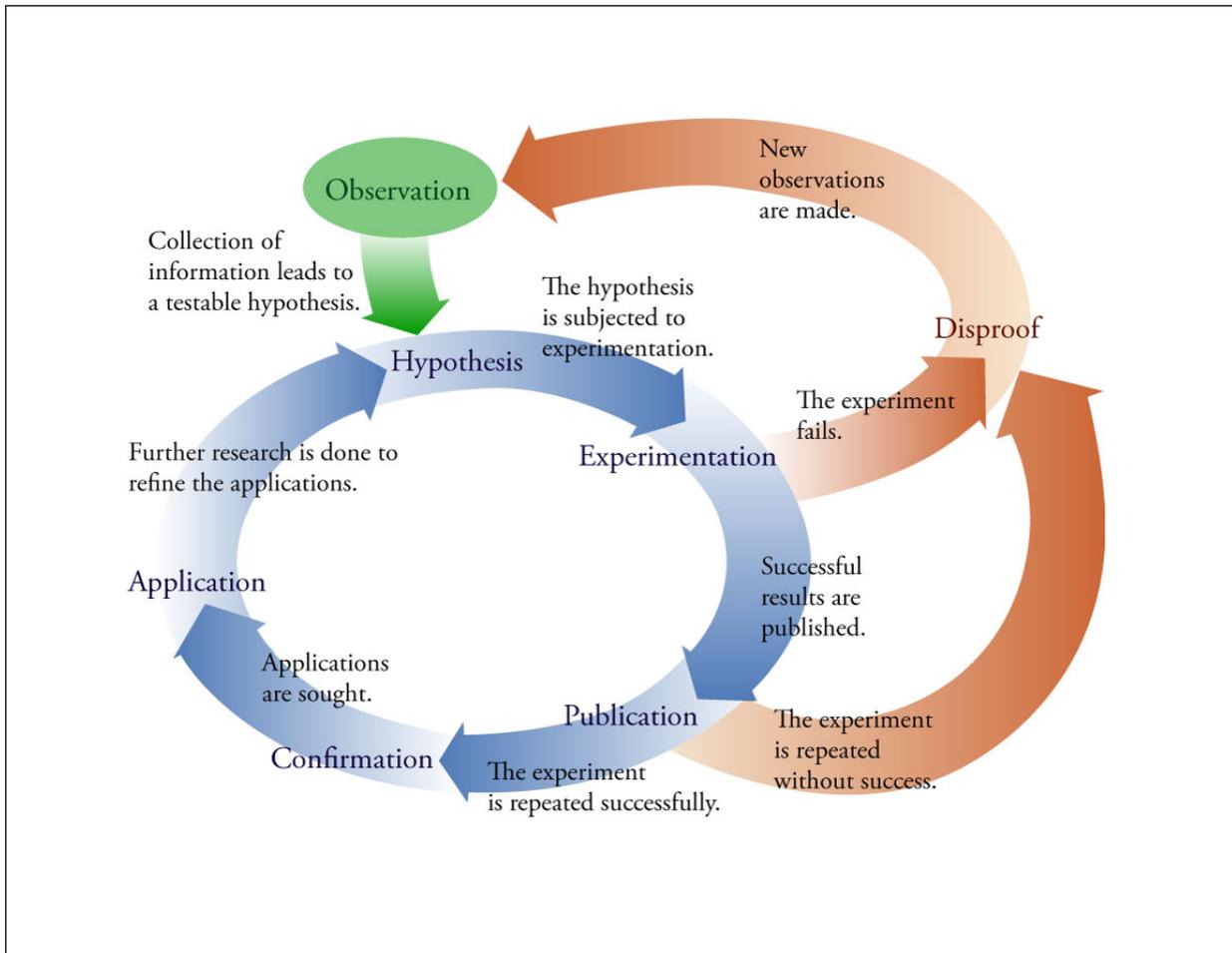
Data must be *consistently reproducible by others* and as *free of bias* as possible for these experiments to have validity.

The Scientific Method

5. Analyze the data.

The results of the data can be used to confirm, disprove, or restrict the validity of the hypothesis.

6. If necessary, continue experimentation and repeat the process to gain greater insight into the problem.



The Scientific Method at Work: Scurvy

- Prior to the nineteenth century, many sailors become afflicted with the disease known as *scurvy*
- Scurvy causes pain, loss of hair and/or teeth, excessive bleeding, mental problems, and—ultimately— death
 - ▣ It was alleged at the time that scurvy was more of a threat to sailors than enemy combat
- The Scottish doctor James Lind hypothesized that scurvy was caused by a deficiency of acids in the body
- To test the hypothesis, Lind took twelve ailing sailors, and separated them into six groups of two sailors each

Lind's Experiments on Scurvy

Group	Daily Treatment
1	a quart of cider
2	dilute sulfuric acid
3	six spoonful of vinegar
4	half-pint of seawater
5	two oranges and one lemon
6	spicy concoction and barley water

The condition of the sailors in group 5 improved dramatically. Slight improvement was also observed in group 1.

Lind's Experiments on Scurvy

- Lind interpreted these results as proof that his hypothesis was essentially correct
- Lind encouraged the administration of limes in place of oranges and lemons because they were considered to be more acidic
 - ▣ This is the origin of the word *limey*, an insult commonly applied to the British
- While Lind's work is an important benchmark in the history of science, it is flawed in several ways: