

# Unit 3- Lesson 1

Chemistry 0

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## Scientific Method

- Observation
- Research
- Hypothesis
- Experiment
- Data collection and analysis
- Conclusion
- Communication of ideas and results

# Observation

- Scientists explore and collect information with their senses and ask questions that they would like to answer.
- Questions guide scientists in their research and can usually be answered by collecting evidence.





## Observation

Example: You pour hot water into an ice cube tray and place the tray in the freezer. When you check the freezer a bit later, you notice that the hot water seemed to form ice cubes faster than you expected.

- What is the observation here?
- What is the question?

# Background Research

- Scientists perform background research including reading papers and books on past research.
- They might find the other scientists have conducted experiments that try to answer a similar question.
- 
- It can help scientists better understand their observations and questions before their own experiment.



[www.centralaz.edu](http://www.centralaz.edu)



## Background Research

- Example: Your friend writes a paper on why they think dinosaurs went extinct without doing any research. On the other hand, a team of 10 scientists studied the earth and the bones of dinosaurs for years and wrote a paper on their findings, which was reviewed critically by another team of scientists. The paper written by the team of scientists is considered to be more credible.

# Hypothesis

- With a question in mind, scientists state clearly what they plan to test during their experiment. This statement is called hypothesis.
- It is a predicted answer to scientific question or an educated guess that may explain an observation.
- A hypothesis guides the experiment.



<https://www.enago.com/academy/how-to-develop-a-good-research-hypothesis/>



# Hypothesis

Example:

This would be a hypothesis below:

If containers of hot and cold liquid water are put in a freezer, the container with hot water will freeze (form ice cubes) faster than the cold water.

A hypothesis must be testable. For example, the hypothesis above can be tested by conducting an experiment that measures the time it takes for ice cubes to form from water starting at different temperatures.



# Experiment

- After making a hypothesis, scientists design and conduct an experiment.
- Scientists must be sure to design the experiment so that only one factor is tested at a time so they will know that their results are directly related to the one factor that was changed.
- It may take several tries to design a right experiment.



<https://www.pdx.edu/chemistry/undergraduate-programs-chemistry-and-biochemistry>



## Experiment

Example: To test your hypothesis about the effect of temperature on the rate at which ice cubes form, there are a few factors you must consider:

1. How soon after you measure the temperature should the water go into the freezer?
2. Should the amount of the water you use each time be consistent?
3. Should you get water from the same source such as a kitchen sink or a botter water each time?

# Data collection and analysis

- Data are pieces of information collected before, during and after an experiment.
- It is important to keep detailed notes and to record all data during an experiment so that it can be analyzed to determine the results.
- Sometime scientists may also choose to record data on a table and then put the information into a graph.
- They also need to make sure they collect accurate data so that they can trust the results, and also repeat an experiment to see if they can obtain the same results.



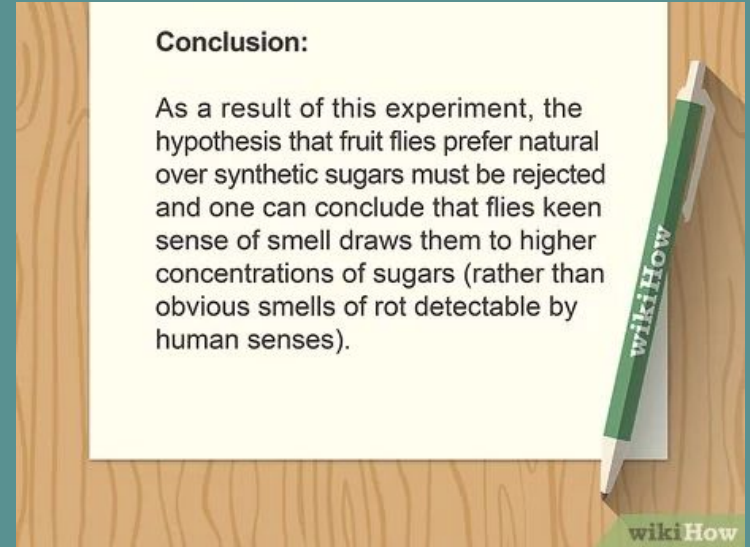
<https://www.scinote.net/electronic-lab-notebook-perception-study/>

## Data collection and analysis

Example: To conduct your experiment, you set up 2 cups of water at different temperatures. You measure the temperature of the first cup of water and record a measurement of 25 °C in your notebook. You then determine that the temperature of the second cup is 55 °C and record this measurement in your notebook. As you conduct your experiment, you write down the amount of time it takes for each cup of water to freeze and any other observations you make. Then you can show the results in a graph that illustrates the freezing time in relation to the starting temperature. You can also repeat the experiment.

# Conclusion

- A conclusion is a statement that tells whether or not the hypothesis was correct.
- If the data support the hypothesis, then the hypothesis is considered correct or valid.
- If the data do not support the hypothesis, then the hypothesis is considered incorrect or invalid.
- Scientist learn something from both valid and invalid hypothesis. Both of them lead to scientific learning.



<https://www.wikihow.com/Write-a-Science-Lab-Report>



## Conclusion

Example: Base on your data, you can say whether or not hot water freezes faster than cold water. If your data show that hot water freezes faster than cold water, your hypothesis is valid. If your data show that cold water freezes faster than hot water, your hypothesis is invalid. Even if your hypothesis is invalid, you can still form a conclusion based on your data.

# Communication

- Scientists will often report their findings in journals or speeches to tell others what they have learned.
- They may create diagrams or other images to show their results.
- Communication is very important!
- It gives other people a chance to learn more and at the same time, it also allows scientists to improve their own experiments when other people comment on the results.



<https://images.app.goo.gl/WFu7izsiT9Wriwis6>



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# This week's assignment

- Title: Ageless Apples
- Overview:
  - Place apple slices into solutions that are acids, bases or neutral.
  - A day later, examine the apples and can see dramatic differences in how much each of the slides browned.
  - Explore how acidity changes reaction rates.



# This week's assignment

- Inquiry questions:
  - How do we know if a chemical or physical change has occurred?
  - What is an acid and a base, and how do they affect the rate at which an apple browns?
  - What chemical reaction causes apples to brown and how can we slow this process using our knowledge of acids and bases?



# This week's assignment

- Please complete the assignment using a report:
  - Start to think about the inquiry questions stated in the previous slide. Perform background research on these topics.
  - Make your hypothesis before you start the experiment: What effect do you think each of the liquids will have on the apple? Draw what you think each sample might look like tomorrow.
  - The procedure of the experiment will be handed out in your assignment portal, please paste them to your report. Record your observations of the experiment.
  - Analyze and discuss your results (data collection and analysis) using the questions in your assignment sheet.
  - Provide your conclusion of the experiment in your report.
  - Presentations (communication) can be shown in our next class.