

CHEM P106

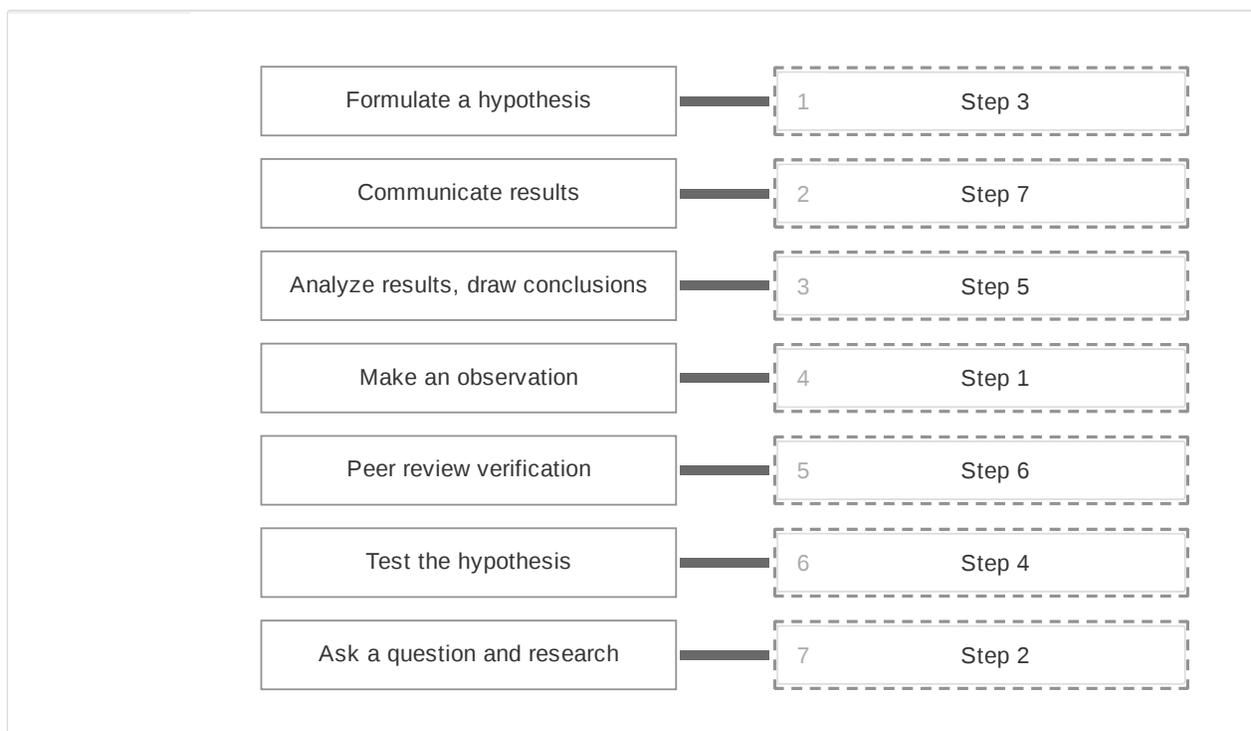
Using the Scientific Method to Identify Unknowns

Final Report

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Lesson Using the Scientific Method to Identify Unknowns
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Session Spring 2021
Course CHEM P106
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Test Your Knowledge

1. Order the steps of the scientific method.



2. Classify each statement as either an observation or hypothesis.

Hypothesis	Observation
1 A buttered slice of toast will always land on the floor butter side down when it is dropped. All matter is made of tiny, indestructible particles called atoms.	2 Copper metal turns green when exposed to air. A piece of metallic zinc bubbles when it comes in contact with HCl.

3. Identify the statements as true or false.

True	False
1 A hypothesis must be testable to be useful in science. In scientific fields, the terms hypothesis and theory are used interchangeably. Scientific laws are often expressed as mathematical equations. Unlike theories, laws do not explain why phenomenon occur.	2 The only worthwhile experiments are those in which the experimental results support the hypothesis. Scientific laws can never be disproven.

4. Determine if each statement is qualitative or quantitative.

Qualitative	Quantitative
1 A penny is copper colored. Methyl salicylate smells like wintergreen. Sodium metal reacts explosively when dropped in water.	2 A penny weighs 2.49 g. The density of water is 1.00 g/mL.

Exploration

1. The scientific method is a rigid process.

- True
- False

2. Hypotheses are often stated in "if - then" language.

- True
- False

3. Air temperature in degrees is an example of qualitative data.

- True
- False

4. How do scientists share their data?

- Posting findings on a website
- Writing papers for peer-reviewed journals
- Presenting at meetings
- During volunteer and outreach opportunities
- All of the above

5. Laws, but not theories, are supported by empirical data

- True
- False

Exercise 1

1. List the steps of the scientific method.

Make an observation, ask a question and research, formulate a hypothesis, test the hypothesis, analyze data and draw conclusions, peer review verification, and communicate results.

2. When you make important decisions in your life, do you use any of the steps in scientific method? Compare a person's typical decision-making process to the scientific method. Which of the steps in scientific method do we typically use and which do we omit?

Yes. Before making a decision, we have to make observation and think before making a step. We always skip the step of 'questions'. After making a hypothesis, we go ahead to test the hypothesis (try it). After accomplishing it, the conclusion is made if the person is satisfied or not.

3. Make a scientific observation about the world around you and construct a question to address the observation. State a testable hypothesis that focuses your question.

I have realized that most people like taking supplements after eating. The question related to this real world problem is: do people need all those supplements? A testable hypothesis is that some of the people get nutrients through eating foods and comparing to those taking supplements. The results will be measured by considering age, gender and body mass index.

Data Table 1: Scientific Method Data

Soy Bean Study	1) Ask a question	Does the amount of water used by soy bean directly impact the amount crop yield daily?
	2) Research what is already known	The use of water by soy bean varies based on the season and stage of growth. During longer season, soy bean uses more water than shorter period with high crop yield. During hot and dry condition, soy bean required about 0.45 inch of water daily.
	3) Create a hypothesis	Soy bean needs 0.45 inches of water to have an optimum production.
	4) Test the hypothesis	There will be experieimntal crop grouping and growing of oy beans by farmers. The same soil will be used and simliar conditions in green house to grow soy beans to ensure rain does not affect the experiment. Experiment crops will receive 0.45 inches of water daily as the control experiemnt crops recives o.25 inches of water daily. The end result will be yield from two crops under same conditions but different amount of water helping in supporting or refuting the hypothesis of the experiment.
Weight Loss Study	1) Ask a question	Are weight loss drugs most effective in solely overweight men?
	2) Research what is already known	

	Body mass index of 25-35 is considered obese. Daily activities and exercises are used to reduce obesity. But some of the healthcare providers and professionals have identified drugs for treating obesity.
3) Create a hypothesis	Drug 'G' will provide better results for controlling the BMI as compared to daily activities in men.
4) Test the hypothesis	To test the hypothesis, a period of 5-6 months will be required. 10 Men with a BMI of more than 30 will take drug G for five months and the results will be recorded. Another group of 10 men with BMI of above 30 will be subjected to daily activity and the results recorded. After the period, the average BMI of the two groups will be determined to show the effectiveness of the drug.

Exercise 2

1. A hypothesis for Exercise 2 might state, "If the five substances are distinct, then they will have unique characteristics that distinguish them from one another." Was this hypothesis supported or disproved? Support with your answer with a 1-2 sentence explanation.

The hypothesis was supported because all the substances had different appearance. Despite having the same color, white, some had finer textures than others.

2. Define quantitative data and qualitative data. Which variables in the experiment were quantitative and which were qualitative?

qualitative data are observed-based and non-numerical. In the experiment, qualitative data included behavior, scent and appearance in vinegar and water. Quantitative data are numerical based. In the experiment, mass was the quantitative data because it deals with numbers.

3. List each substance and its distinguishing characteristics. (You do not have to list every characteristic of each substance, just the characteristics that set each substance apart from the others.)

Powdered sugar-pebble-like, white substance
Zinc Oxide-white substance, pebble like
Baking soda-grainy, white substance
baby powder-silky, white substance
corn starch, white substance, silky

4. In Exercise 3, you will identify three unknown substances. Using the characteristics from the previous question, create a set of hypotheses that may be applied to each unknown. (Hint: Phrase the hypothesis as an "if-then" statement. For example, "If the unknown substance is an insoluble white powder that has no scent, then the substance is X.")

If the unknown substance is is a soluble white powder and create a creamy white mixture, then the substance is zinc oxide
If the unknown substance is an insoluble white powder having no scent, then the substance is baking soda
If the unknown substance forms bubbles and begins fizzing up, then the substance is baking soda

Data Table 2: Appearance

Baby Powder	Baking Soda
White, thin, loose	White, granulated
Baby Powder	Corn Starch
White, thin, loose	Moderate clumping, off white color
Baby Powder	Powdered Sugar
White, thin, loose	White clumping
Baby Powder	Zinc Oxide
White, thin, loose	Granulated and white with some dark particles

Data Table 3: Scent

Baby Powder	Baking Soda
Strong Freshening	Lightly freshening
Baby Powder	Corn Starch
Strong Freshening	No scent
Baby Powder	Powdered Sugar
Strong Freshening	No scent
Baby Powder	Zinc Oxide
Strong Freshening	No scent

Data Table 4: Mass (g)

Baby Powder	Baking Soda
0.85g	1.31g
Baby Powder	Corn Starch
0.85g	0.46g
Baby Powder	Powdered Sugar
0.85g	0.44g
Baby Powder	Zinc Oxide
0.85g	0.63g

Data Table 5: Behavior in Water

Baby Powder	Baking Soda
Most of the powder settle at the bottom of water in the beaker	Settles towards the bottom of the tube
Baby Powder	Corn Starch
Most of the powder settle at the bottom of water in the beaker	Starch is distributed throughout the tube with thickened appearance
Baby Powder	Powdered Sugar
Most of the powder settle at the bottom of water in the beaker	Mix uniformly with water forming a cloudy appearance
Baby Powder	Zinc Oxide
Most of the powder settle at the bottom of water in the beaker	Settles at the bottom of the tube and seems to become larger particles than before

Data Table 6: Behavior in Vinegar

Baby Powder	Baking Soda
Mixes with vinegar, clumping at the bottom	Fizzes and produces bubbles
Baby Powder	Corn Starch
Mixes with vinegar, clumping at the bottom	some clumps at the bottom, cloudy mix
Baby Powder	Powdered Sugar
Mixes with vinegar, clumping at the bottom	Mix completely
Baby Powder	Zinc Oxide
Mixes with vinegar, clumping at the bottom	Immiscibles as all the zinc oxide settles at the bottom and vinegar at the top

Exercise 3

1. What were the three unknown substances? What characteristics do the three substances have in common? What characteristics set the three substances apart?

Unknown substance 1-powdered sugar

Unknown substance 2-baking soda

Unknown substance 3-corn starch

All the substances are white. The appearance of baking soda is different from powdered sugar and corn starch. The behavior of corns starch amnd sugar in different liquids (water and vinegar) is different.

2. Was it necessary to apply every test to each of the unknowns? Why or why not?

It was necessary to apply every test to ecah unkwoiwn. Two of the subsnatces looked very similar requiring both tsets to differentaite them

3. List an additional test that might have been useful in Exercises 2 and 3.

Adding iodine to each of the substances and recording the behavior.

4. Summarize how you used the steps in the scientific method to identify the unknowns.

A statement was first presented and supported. Based on several factors, a hypothesis was presented on each substance and tested to prove the correctness. Observations were recorded and conclusion made on the identity of each unknown.

Panel 1: Experimental Methods

The scientific methods involved both quantitative and qualitative analysis to determine the unknowns.
Identification of the unknowns

Data Table 7: Experimental Data and Conclusions

Unknown #	Appearance
1	white and clumpy
2	Granualated white crystal
3	Off white color

Unknown #	Scent
1	no scent
2	Slightly fresh and clean
3	No scent

Unknown #	Mass (g)
1	0.43
2	1.29
3	0.45

Unknown #	Behavior in water
1	Mix uniformly with ater
2	immiscible
3	Distributed throughout the tube with thickened appearenc

Unknown #	Behavior in vinegar
1	mixes completely with vinegar
2	Produces bubbles as it reacts with vinegar
3	Mixes with vinegar to form cloudy appearance

Unknown #	Conclusion
1	<input type="text" value="Powdered sugar"/>
2	<input type="text" value="Baking soda"/>
3	<input type="text" value="Corn starch"/>

Competency Review

1. The first few steps of the scientific method include making an observation, asking a question, and conducting research.

- True
 False
-

2. A hypothesis is a(n) _____.

- educated prediction of expected results
 non-numerical solution to a question
 close examination of collected data
-

3. Once a hypothesis is not supported, it may not be tested again.

- True
 False
-

4. Qualitative data are _____.

- numerical
 non-numerical
-

5. If a hypothesis is not supported, it is likely not useful for scientific progress.

- True
- False

6. Laws are supported by empirical evidence and explain why phenomenon occur.

- True
- False

7. Once a theory becomes a law, it can not be disproven.

- True
- False

8. Consider the statement, "High temperatures are caused by the tilt of the Earth and the angle of the sun hitting the Earth." Is this a hypothesis or an observation?

- Hypothesis
- Observation

9. An example of quantitative data is _____.

- scent
- mass
- behavior in water
- appearance

10. A researcher would like to address the following question: "Should employees be able to work out during company time?" Give an example of a well thought out hypothesis that aligns with this question.

- Working out makes employees healthier, which means they may work for the company longer.
 - If exercise is correlated to weight loss, then employees will lose weight.
 - If employees are allowed to work out for 30 minutes each day, then productivity increases.
 - Employees won't work out if they must do so out of office hours.
-

11. A chemist would like to identify an unknown liquid chemical. What type of data are useful?

- Qualitative data are the most useful.
 - Quantitative data are the most useful.
 - Both qualitative and quantitative data are useful.
-

12. If a white powder is placed in a test tube full of water, and the powder sinks to the bottom of the test tube, what conclusion may be drawn?

- The white powder is baby powder.
 - The white powder is zinc oxide.
 - The white powder is corn starch.
 - The white powder does not dissolve in water, and more information is needed.
-

Extension Questions

1. There is a common thought that hot water freezes faster than cold water. Develop a strategy to investigate this theory.

Construct a well thought out question and a testable hypothesis. Write a justification for your hypothesis; for instance, if you hypothesize that cold water freezes faster than hot water, include an explanation as to why you believe this to be true. Come up with an experimental design to test your hypothesis. Include an explanation of how the data you collect will be able to support or disprove the hypothesis.

The thought that hot water freezes faster than cold water is not correct since cold water freezes faster than hot water.

Explanation: Kinetic energy is directly proportional to absolute temperature thus hot water has higher kinetic energy than cold water. It will therefore require more time to freeze.

Experimental design: Take equal amount of water in two beakers one at 20°C and the other at 40°C. Allow the water in both beakers to freeze for a time (t). Record the time required for water to freeze.

Conclusion: Time required for water at 20°C to freeze is less than time required by water at 40°C.