Scientific Method

- The purpose of science is to find the truth or the closest we can get to it.
- Mathematics is the purest form of science. 1 + 1 = 2, we know this to be truth.
- There can be some ambiguity with chemistry. In fact, scientist will never know the absolute 100% truth about chemistry.
- To clarify what is actually happening, chemist use what is called “The scientific method.”

Scientific Method

The scientific method approach to find answers.

1. Observe and ask questions
2. Research
3. Formulate a falsifiable hypothesis using facts and research.
4. Test hypothesis to see if imperial results support the hypothesis.
5. Conclude analysis
6. Share results

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Observation:

- Observation can be done with all five senses and/or instrumentation.
- Observation are used by the five senses to gather facts and empirical evidence.
- What is a fact?
- **Facts:** are simple basic observation that can be shown to be true.
- Example: The sun is out.
- Example: the sun is out because it undergoes a series of nuclear reactions to cause light to shine on the earth. NOT A FACT

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Observation:

- What is imperial evidence?
- **Empirical evidence:** when facts are collected by the five senses.
- The series of facts are used as accountable events that can be refer to when research is being done.

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Observation:

Example 1: someone opened some lip gloss and noticing a strong smell of grapes, and over a period of time you notice the smell seems less potent.

Example 2: An NMR spectra was recorded of the same lip gloss. Over a period of time there seemed to be a decrease in a specific signal. The smell of the lip-gloss faded as the NMR signal decreased.

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Observation:

- **Set 1:** Fact 1, The lip gloss smelt like grapes when it was opened. Fact 2, the smell seemed less potent a week later.
- **Set 2**: Fact 1: The NMR spectra of the lip gloss had a distinct signal. Fact 2, a week later, the NMR spectra seemed to decrease in a specific signal.
- With the collected facts, it would appear that the smell seemed to fades. So, the questions would be does the smell fade, why does the smell fade, or why does the NMR signal decrease? What would cause this to happen?

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Research:

Why does the smell fade?

Determine what is important and what is not.

1. what chemicals make the lip gloss smell like grapes.
2. the lip gloss ingrediency have a list of chemicals on the container.
3. Information can be found about the chemicals found on the lip gloss ingrediency list.

Observation and research can be done throughout the entire process.

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- **Hypothesis**: A hypothesis should be falsifiable, meaning it has the capability to be proven wrong, and a hypothesis should predict something. A hypothesis can be formulated from the research gathered.
- If-then/cause-effect statements can help bring this together to a distinct point.
- **Premise:** A premise is a proposed offer of reason to accept another claim. Ques are since, if, or because.
- **Conclusion:** A conclusion is a main point that is being asked to accept.
- Ques are therefore, thus, as such, as a result.
- “if the compound evaporates then the smell will fade.”

Modus Ponens

- **Modus Ponens Format**:
- **If** the compound evaporates, **then** the smell fades.

  the compound evaporates.

  Therefore, the smell fades.
- Premise (**a**) = the compound evaporation.
- Conclusion (**b**) = the smell fades.

- If___**a**___, Then___**b**___.

  ___**a**___.

Therefore,___**b**___.

Modus tollens

- **Modus Tellens:** are arrangements of the form:

  If a, then b
  ~b.
  Therefore, ~a.

- **If**___a___, **Then**___b___.
  ___~b___.

Therefore,___~a___.

- Premise (a) = the compound evaporation.
- Conclusion (b) = the smell fades.
- Premise not true (~a) = the compound does not evaporation.
- Conclusion not true (~b) = the smell does not fade.
- **If** the compound evaporates, **then** the smell fades.

  the smell does not fades

Therefore, the compound did not evaporates.

Scientific Method

- **Experement:**
- In the experiment, a point is made to isolate what is being studied and measured, so a relationship can be clearly defined between the cause and the effect.
- How is this done?
- All things outside of what is being measured are purposely set up where they will not interact to change or affect the experimental outcome

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- **Experement:**
- **Variables and parameters:** are words used for things that can interact with an experiment. Some variables or parameters are temperature, pressure, and amount of substance.

- **An example** is when oxygen will affect a reaction, so a reaction is done in the absents of oxygen with a sealed flask.

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- **Parameters change:**

Parameters are set up so they will not affect an outcome with changes made during the experiment.

- How do changes effect an experiment?
- The point of an experiment is to see how value “A” changes to value “B”. When parameters change, they can affect value “A” so it is no longer value “A”, as a result, there is no longer a relationship between value “A” and value “B”, there is value “A” that has been influenced by something else that changes to give value “B.” Parameters need to be locked into place to give a clear relationship between “A” and “B.” When parameters are locked into place, the term held constant is used.

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- **Parameters change:**
- **An example** of a reaction with parameters that are held constant would be the following:
- An experimental sequence was carried out where the reaction times were 1 min, 5 min, and 10min. The pressure, temperature, and volume were held constant, meaning they did not change.

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- A + X → C 30F
- B + X → C 60F
- C + X → C 600F

Reaction Rate???

- A + X C 60F
- B + X C 60F
- C + X C 60F

Reaction Rate Determined

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- Eliminate as many added questions as possible with experiments.
- Very slight changes should be made between experiments.

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- **Experement: Lip gloss**
- How could we set up an experiment with our hypothesis for lip gloss?

- We suspected that the good smelling chemicals evaporated. How can a quantitative measurement be recorded when the compound evaporates?

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- isolate compound X and put 1 mL in a 10mL graduated cylinder.
- If we want and additional way to measure the difference, we can put the graduated cylinder on a scale.
- How long should we do the experiment? The lipgloss was noticableley less potent after 1 week, so compound X was left out to evaporate for 1 week.

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- **Conclution data analysis:** (analyze data to determine if it supports hypothesis) The results either do not rejected or reject the hypothesis. Compound X completely evaporated and the smell faded. The experiment supported the hypothesis, so the hypothesis was not rejected.
- **Share:** We could then report these findings to the world for brutal scrutiniy by others. Brace yourself for impact.

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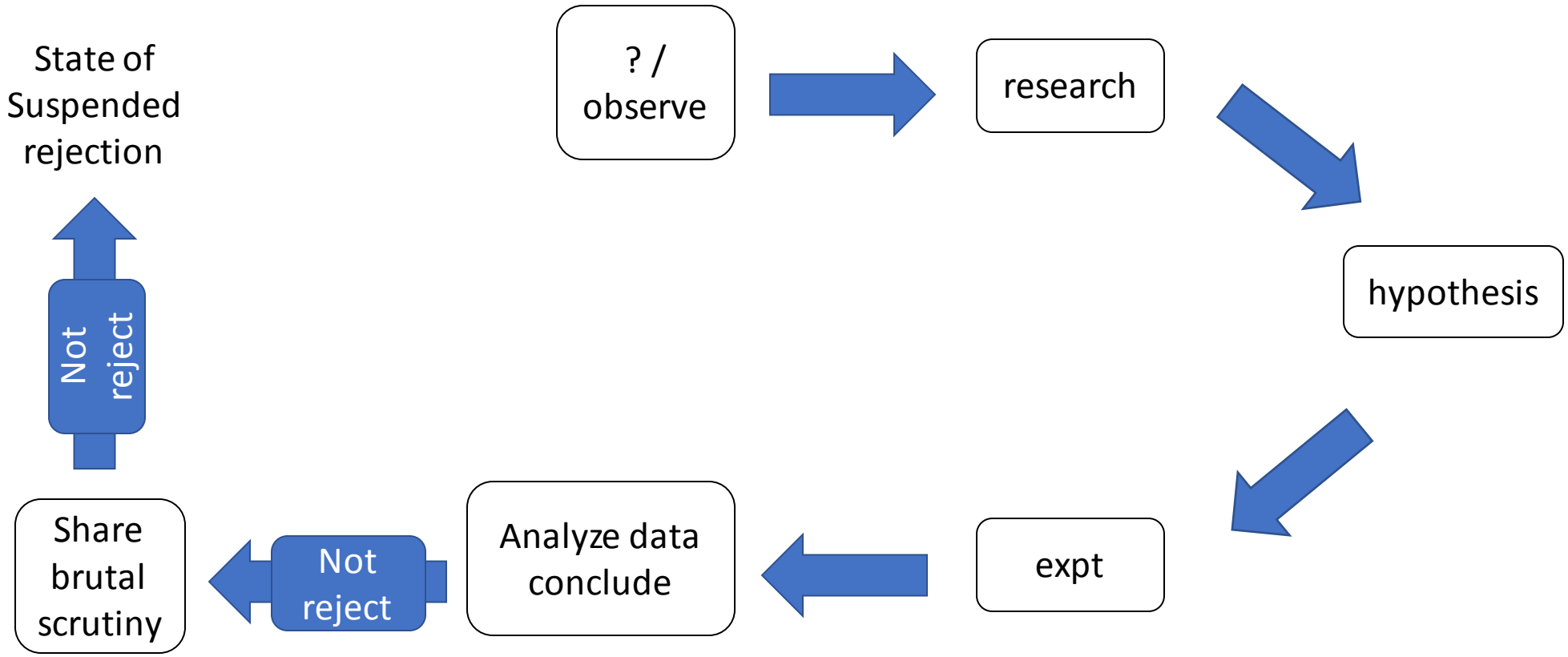

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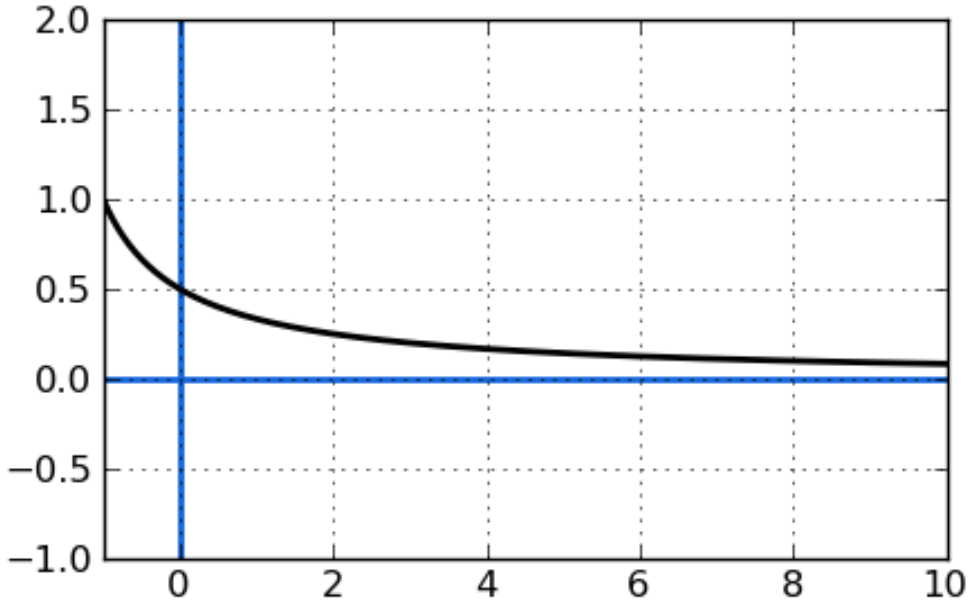

- This process chips away any possible doubt or error.
- At somewhere during point this process, the science community finds that a significant body of research is compelling enough to develop laws and theories

Scientific Method

- Laws and theories do not develop into each other. Much like a rook cannot develop into a knight. They are similar, but not the same.

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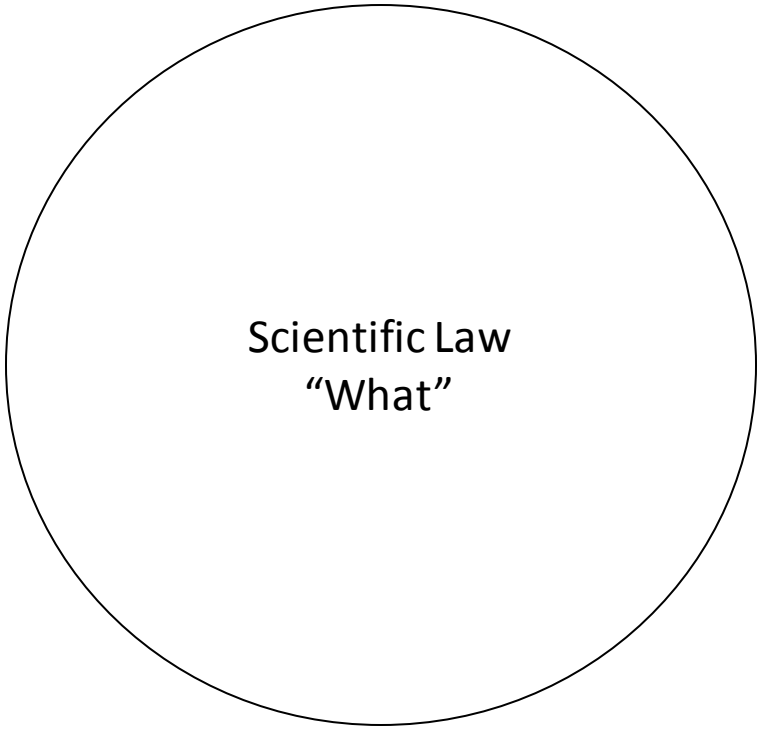
- Law: what happened
- A scientific law DOES describe what happens. A scientific law DOES NOT explain why something happens.
- Example 1: If two bodies move away from each other, the force of gravity decreases. Describes what happened.
- Example 2: when white light passes through a prism, the light will separate into a spectrum of different colors. Describes what happens, not why.

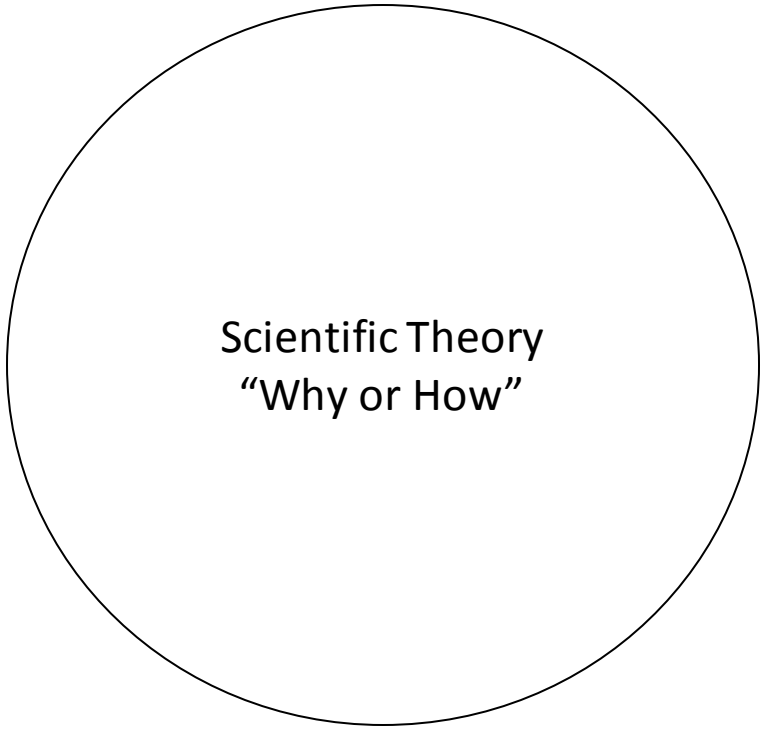
Scientific Method

- Scientific Theory: describes how or why a phenomena happens.

- Example: The theory of relativity explain why light bends around massive objects.

Scientific Method





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