

Chapter 1 About Science



What is Science?

- The body of knowledge which describes order within nature and the causes of that order
- The ongoing activity of the human race dedicated to gathering knowledge about the world and organizing it into testable laws and theories




When was Science “Invented”?

- Science had its beginnings before recorded history
- It started when people first discovered patterns in the world around them
- What are some examples of these patterns?



Scientific Method


- Usually credited to Galileo Galilei and Francis Bacon
- Provides a method of effectively collecting, organizing, analyzing, and applying science.



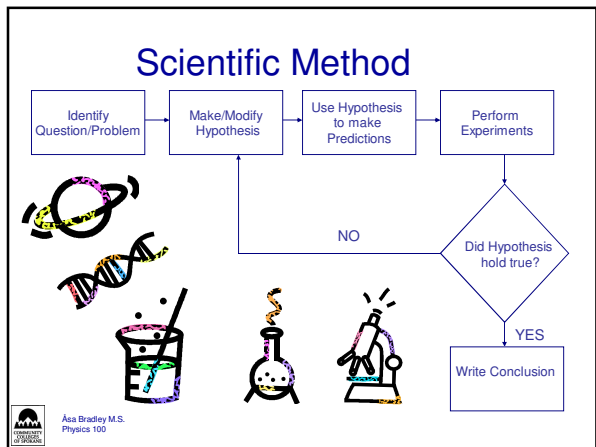
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Scientific Method

1. Recognize a question or a problem.
2. Make an educated guess – a hypothesis- of the answer or outcome of experiment.
3. Use the hypothesis to predict what would happen if your guess is right, or what would happen/not happen if your guess is wrong.
4. Perform experiments to see if what you thought would happen/not happen does.
5. Repeat steps 3 and 4 and modify your hypothesis until there are no discrepancies between theory (3) and experiment (4).




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Scientific Method

Why use it?


- It is unprejudiced: you do not have to believe a scientist, you can redo the experiment and determine whether his/her results are true or false.
- Results are repeatable: anyone can repeat an experiment that follows the scientific method.



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Scientific Method Terms



- A **Fact** is a revisable "truth" about the world.
- A **Hypothesis** is an educated guess about the solution to a problem or an answer to a question.
- When a **Hypothesis** has been tested over and over again and not contradicted, it becomes a **Law** (or **Principle**)



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Scientific Method Terms

- **Fact** is a close agreement by competent observers who make a series of observations about the same phenomenon.
- A scientific **Hypothesis** is an educated guess that is only presumed to be factual until supported by experiment.



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Scientific Method Terms

- A scientific hypothesis has to be able to be tested for both “rightness” and “wrongness” if it can’t, then it is not a hypothesis, it is speculation.



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Scientific Method Terms CHECK YOUR NEIGHBOR

Which of these is a scientific **hypothesis**?

- A. The Moon is made of green cheese.
- B. Atomic nuclei are the smallest particles in nature.
- C. A magnet will pick up a copper penny.
- D. Cosmic rays cannot penetrate the thickness of your *Conceptual Physics* textbook.



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Explanation:


All are scientific hypotheses!
All have tests for proving wrongness, so they pass the test of being a scientific hypothesis.



Scientific Method Terms
CHECK YOUR NEIGHBOR

Which of these is *not* a scientific **hypothesis**?

- A. Protons carry an electric charge.
- B. Undetectable particles are some of nature's secrets.
- C. Charged particles bend when moving in a magnetic field.
- D. All of the above are scientific hypotheses.




The Scientific Attitude
CHECK YOUR NEIGHBOR

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Explanation:
Choices A and C can be disproved by experiments.
Choice B has no test for wrongness, so it is *not* a scientific hypothesis.



Scientific Method Terms

- Where does the word **theory** fit in?
 - Scientists use theory to mean a synthesis of large body of information that encompasses well-tested and verified hypotheses about certain aspects of the natural world.
 - In other words, if you put multiple true and tested hypothesis together, that support each other, they combine to make a *scientific theory*



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Scientific Method Terms

Law or principle

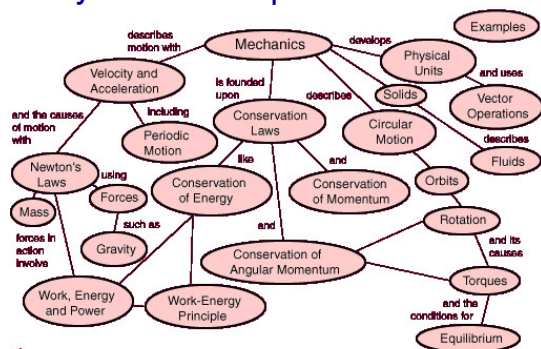
- A hypothesis that has been tested repeatedly and has not been contradicted

Theory

- A synthesis of a large body of information that encompasses well-tested and verified hypotheses about certain aspects of the natural world



Physics Concepts and Theories



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Example: How do flies get on rotten meat?

- Before refrigerators, the mandatory, daily trip to the butcher shop, especially in summer, meant battling the flies around the carcasses. Typically, carcasses were “hung by their heels,” and customers selected which chunk the butcher would carve off for them.
- **Conclusion before Scientific Process:** Obviously, the rotting meat that had been hanging in the sun all day was the source of the flies - Spontaneous Generation

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Example: How do flies get on rotten meat?

- **Question:** Where do the flies at the butcher shop really come from? Does rotting meat turn into or produce the flies?
- **Hypothesis:** Rotten meat does not turn into flies. Only flies can make more flies.
- **Prediction:** If meat cannot turn into flies, rotting meat in a sealed (fly-proof) container should not produce flies or maggots.



Example: How do flies get on rotten meat?

- Design of the experiment



Example: How do flies get on rotten meat?

- Presence or absence of flies and maggots seen in each jar was recorded.
 - **Open jar:** flies were seen entering the jars. Later, maggots, then more flies were seen on the meat.
 - **Gauze-covered jar:** no flies were seen in the jars, but were observed around and on the gauze, and later a few maggots were seen on the meat.
 - **Sealed jar:** no maggots or flies were ever seen on the meat.



Example: How do flies get on rotten meat?

- **Conclusion(s):** Only flies can make more flies.
 - **Open jar:** flies entered and laid eggs on the meat. Maggots hatched from these eggs and grew into more adult flies.
 - **Gauze-covered jar:** adult flies laid eggs on the gauze. These eggs or the maggots from them dropped through the gauze onto the meat.
 - **Sealed jar:** no flies, maggots, nor eggs could enter, thus none were seen in those jars.
 - Maggots arose only where flies were able to lay eggs. This experiment disproved the idea of spontaneous generation for larger organisms.



Scientific Method Terms
CHECK YOUR NEIGHBOR

Which of these often changes over time with further study?

- A. Facts.
- B. Theories.
- C. Both of the above.
- D. Neither of the above.



Scientific Method Terms
CHECK YOUR NEIGHBOR

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- C. **Both of the above.**
- D. Neither of the above.


Explanation:
 Both can change. As we learn new information, we refine our ideas; likewise in science.



Scientific Method Terms
CHECK YOUR NEIGHBOR

A person who says, "that's only a theory" likely doesn't know that a scientific theory is a

- A. guess.
- B. number of facts.
- C. hypothesis of sorts.
- D. vast synthesis of well-tested hypotheses and facts.




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CHECK YOUR NEIGHBOR

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- A. guess.
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Explanation:
The word "theory" in everyday speech is different than its use in science.
In science, only a vast, experimentally verifiable body of knowledge is a theory.



Science & Technology

- Science gathers, organizes, and analyses knowledge.
- Technology applies that knowledge and also crafts tools that scientists can use for further explorations.



For Next Time:

- **Read** the *Fake, Mistake, Replicate* article and the questions on the back page.
- **Research the following on your own:** What is the penalty for scientific fraud in the science community. In other words, what happens when a scientist is caught cheating or lying and how is he or she penalized?



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