What is Science?

Decide whether the following statements are true or false.

What is Science?

True or False

1. Science is concerned with understanding how nature and the physical world work.
2. Science can prove anything, solve any problem, or answer any question.
3. Any study done carefully and based on observation is scientific.
4. Science can be done poorly.
5. Anything done scientifically can be relied upon to be accurate and reliable.

What is Science?

True or False

6. Different scientists may get different solutions to the same problem.
7. Knowledge of what science is, what it can and cannot do, and how it works, is important for all people.
8. A hypothesis becomes a theory which becomes a law.
9. A hypothesis is an educated guess.
10. A general and universal scientific method exists.

1. Science is concerned with understanding how nature and the physical world work.

True

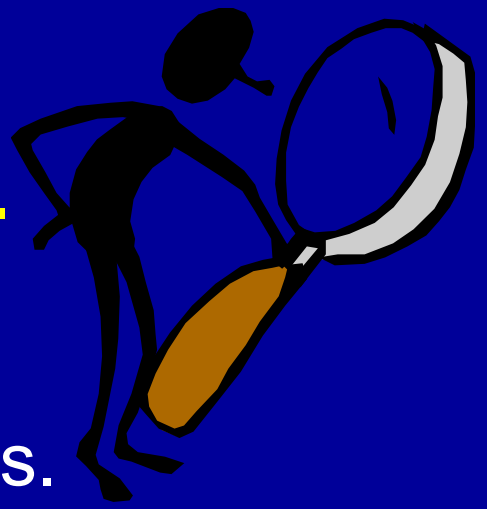
Science is a process by which we try to understand how the natural and physical world works and how it came to be that way.

2. Science can prove anything, solve any problem or answer any question.

False

- Science actually attempts to disprove ideas (hypotheses).
- Science is limited strictly to solving problems about the *physical* and *natural world*.
- Explanations based on supernatural forces, values or ethics can never be disproved and thus **do not** fall under the realm of science.

3. Any study done carefully and based on observation is scientific.



False

- Science must follow certain rules.
- The rules of science make the scientific process as objective as is possible.

Objective = Not influenced by feelings, interests and prejudices; UNBIASED

vs.

Subjective = Influenced by feelings, interests and prejudices; BIASED

4. Science can be done poorly.

True

5. Anything done scientifically can be relied upon to be accurate and reliable.

False

- Science can be done poorly, just like any other human endeavor.
- Quality control mechanisms in science increase the reliability of its product.

6. Different scientists may get different solutions to the same problem.

Yes

No

True

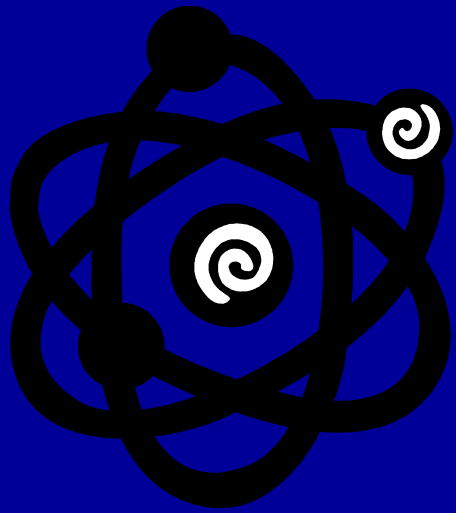
- Results can be influenced by the race, gender, nationality, religion, politics or economic interests of the scientist.
- Sampling or measurement bias can result in different solutions to the same problem.

7. Knowledge of what science is, what it can and cannot do, and how it works, is important for all people.

True

People need to be able to evaluate scientific information in order to make informed decisions about:

- Health care
- Environmental issues
- Technological advances
- Public health issues



8. A hypothesis becomes a theory which becomes a law.

False

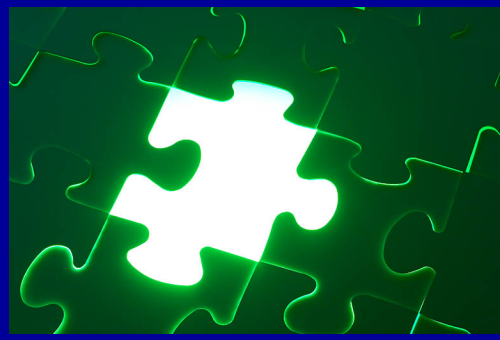
- Major misconception
- There is not a natural progression from hypothesis to theory to law
- This myth deals with the general belief that with increased evidence there is a developmental sequence through which scientific ideas pass on their way to final acceptance

9. A hypothesis is an educated guess.

False

- A hypothesis is a testable statement based upon research
- Most of the time in science class, students are asked to propose a *hypothesis* during a laboratory experience, but they are actually giving a *prediction*.
- As for those hypotheses that are really forecasts, perhaps they should simply be called what they are, predictions.

10. A general and universal scientific method exists.



False

- Scientists approach and solve problems with imagination, creativity, prior knowledge and perseverance.
- These are the same methods used by all problem-solvers.
- The lesson to be learned is that science is no different from other human endeavors when puzzles are investigated.

What is Science NOT?

- Science ≠ Proof
- Science ≠ Certainty
- Science ≠ Belief

What is Science?

- Scientific understanding can always be challenged, and even changed, with new ways of observing, and with different interpretations.
- The same is true of scientific **facts**.
- New tools, techniques, and advances in technology have resulted in new observations, sometimes forcing revision of what had been taken as fact in the past.

What is good science?

Objectivity is the key to good science.

To be objective, experiments need to be designed and conducted in a way that does not introduce bias into the study.

Bias = A prejudiced presentation of material

Two main types of bias:

1. Sampling bias

2. Measurement Bias

Sampling Bias

Sample = A group of units selected to be "measured" from a larger group (the population).

Sampling bias is introduced when the sample used is not representative of the population or inappropriate for the question asked.

Factors that contribute to sampling bias

SAMPLE SIZE: Is the sample big enough to get a good average value?

SELECTION OF SAMPLE: Does the composition of the sample reflect the composition of the population?

Factors such as location, age, gender, ethnicity, nationality and living environment can affect the data gathered.

How to minimize sample selection bias:

1. Use a **RANDOM SAMPLE** = every individual has an equal likelihood of being chosen.
2. Limit the question asked to the specific group sampled.

Measurement Bias

Is the method of data collection chosen in such a way that data collected will best match reality?

Evaluate the technique:

1. Measurements taken accurately
2. No additions to the environment that will influence results
3. Experiment designed to isolate the effect of multiple factors

Identifying good science: Look for signs of bias!

- Language
- Appropriate data reported to back conclusions
- Data source

Language

"Scientifically-proven"

* Science does not seek to prove but to disprove
* Be suspicious of this claim!

Emotional appeals

* Conclusions should be data-based
* Emotional appeals usually are not data-based

Strong language

* Scientific conclusions should only report what the data supports.
* Words should be chosen very carefully to avoid exaggeration or claims not supported by data.

THE DATA SHOULD CONVINCE YOU,
NOT THE WORDS USED!

Data Sources

1. University Research
2. Corporate Research
3. Government Research
4. Research by Special Interest Groups

All organizations produce unbiased data. However, it is important to understand the organization's motivation to be able to identify potential bias. In some situations, the need to promote special interests or make profits may lead to bias.

You are now scientists

- Learn to question
- Do not prejudge
- Have an open mind to topics
- Realize there is more that you do not know, than what you do know