Chapter Two: The Scientific Process

- 2.1 Inquiry and the Scientific Method
- 2.2 Experiments and Variables
- 2.3 The Nature of Science and Technology

Section 2.1 Learning Goals

- Apply deductive reasoning skills to solve problems.
- Contrast hypotheses, theories, and laws.
- Explore the scientific process and apply steps of the scientific method.

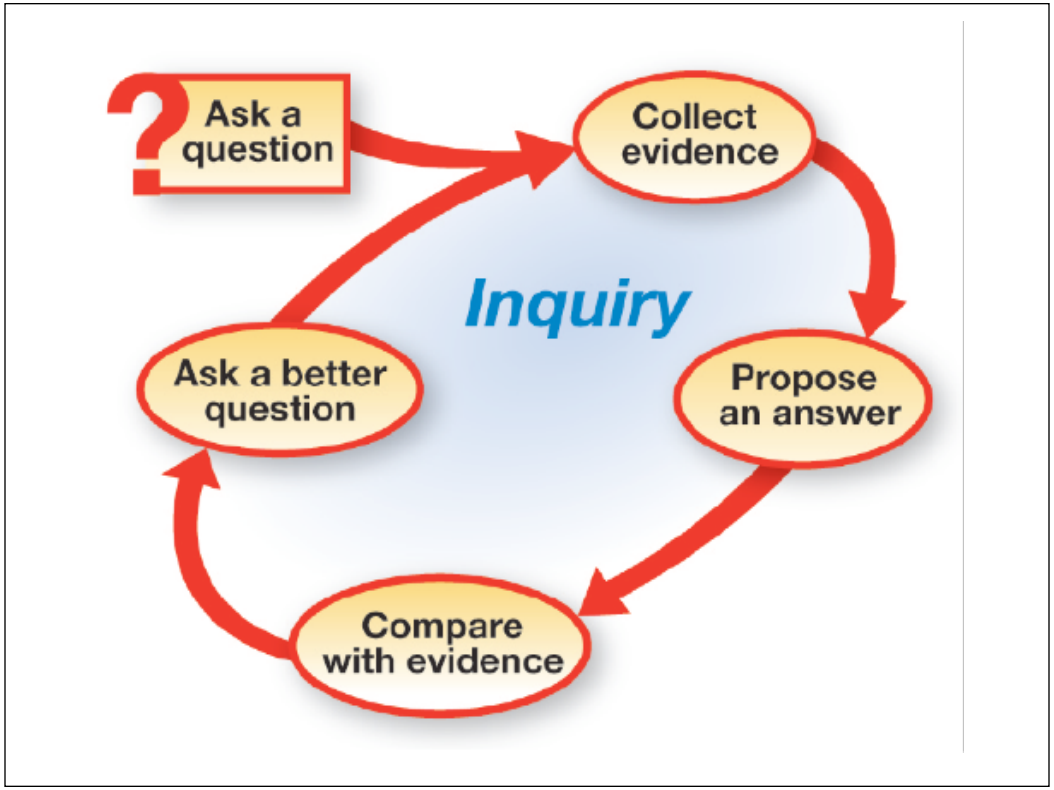
2.1 Inquiry and the Scientific Method

- Scientists believe the universe follows a set of rules called natural laws.
- The primary goal of science is to discover these natural laws and what they mean.

2.1 Inquiry and the Scientific Method

- Learning about science by asking questions is called inquiry.
- An inquiry is like a crime investigation with a mystery to solve.

How is science like solving a mystery?

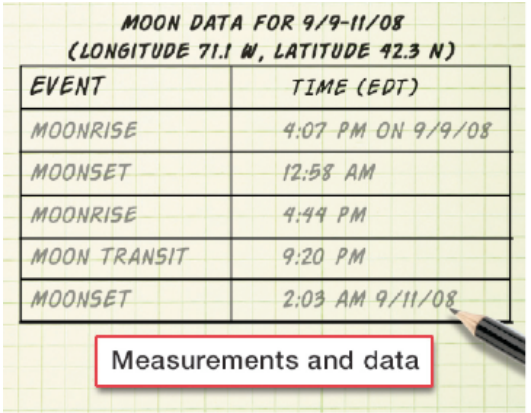

Ask a question
Collect evidence
Inquiry
Ask a better question
Propose an answer
Compare with evidence

2.1 Inquiry and the Scientific Method

- Because evidence is so important in science, there are careful rules defining what counts as scientific evidence.
- The evidence must accurately describe what happens in the real world.

2.1 Scientific evidence

- Scientific evidence must be objective.
- "Objective" means the evidence should describe only what actually happened as exactly as possible.
- It is reported without bias or opinion.



2.1 Scientific evidence

Galileo's drawings of the moon.

More evidence of lunar cycles.

- Scientific evidence must repeatable.
- "Repeatable" means that others who look the same way at the same thing will observe the same results.

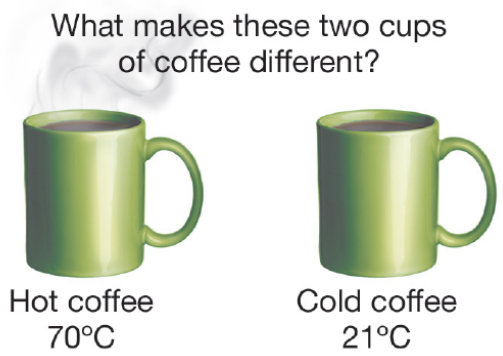
2.1 Scientific evidence

- Scientific evidence may include numbers, tables, graphs, words, pictures, sound recordings, or other information.
- It is important that scientific evidence be communicated clearly, with no room for misunderstanding.

2.1 Scientific theories

- **A scientific theory is a human attempt to describe a natural law.**

Understanding heat puzzled people for a long time.



2.1 Scientific theories

- Before 1843, scientists believed that heat was a kind of fluid that flowed from hotter objects to colder objects.
- They called this fluid caloric.
- The caloric theory explained what people knew at the time.

Hot coffee

2.1 Scientific theories

- However, a big problem came up when people learned to measure weight accurately.
- The caloric theory was soon given up because it could not explain this new evidence.

Hot coffee

Cold coffee

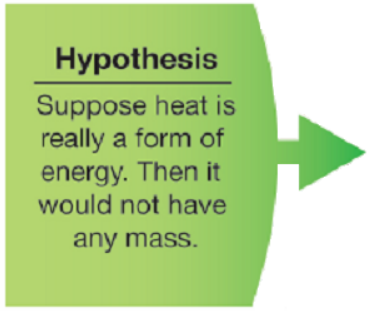
2.1 Scientific theories

One of two things can happen when new evidence is found:

1. **The current theory correctly explains the new evidence. Or,**
2. **the current theory does not explain the new evidence so a new (or improved) theory is waiting to be discovered.**

2.1 Scientific theories

- The word theory in science means a single explanation is supported by lots of evidence collected over a long period of time.
- Theories in science start out as hypotheses.



2.1 Scientific hypotheses

- A scientific hypothesis must be testable.
- We collect evidence that supports or refutes the hypothesis.

2.1 Scientific experiments

- Experiments done by James Joule in 1843 were confirmed over many years and became the theory of heat we accept today.

cpo science making it real.

Hypothesis to Theory

Hypothesis

Suppose heat is really a form of energy. Then it would not have any mass.

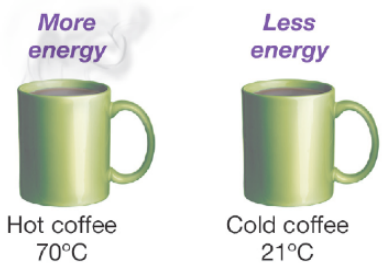
Many experiments are done to see if heat might be energy.

Theory

Heat is a form of energy.

2.1 Scientific theories

- A hot cup of coffee has more heat energy than a cold cup of coffee.
- As coffee cools, it's heat energy is transferred to the room.
- As a result, air in the room is warmed, but no change in weight or mass can be detected in the two cups.



2.1 The Scientific Method

1. Scientists observe nature, then develop or revise hypotheses about how things work.

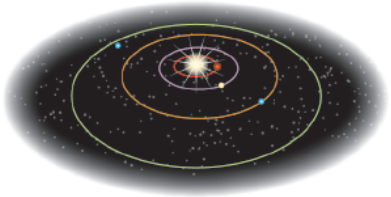
2. The hypotheses are tested against evidence collected from observations and experiments.

3. Any hypothesis that correctly accounts for all of the evidence from the observations and experiments is a potentially correct theory.

4. A theory is continually tested by collecting new and different evidence. Even one piece of evidence that does not agree with a theory forces scientists to return to step one.

Early civilizations thought the Earth was covered by a dome on which the Sun, stars, and planets moved.

In the middle ages people thought the Sun, stars, and planets circled the Earth, which sat in the center.



Today we know the Earth and planets orbit around the Sun, and the stars are very far away.

Investigation 2A

Observation, Question, and Hypothesis

- **Key Question:**

  Is the flow rate constant no matter how much water is in the bucket?