

Lesson 1.1

Scientific Reasoning

reasoning: the process of forming conclusions, judgments, or inferences based on facts or other evidence

deduction: reasoning from the general to the specific, in which a conclusion must be true because it's based on true statements

induction: reasoning that uses specific events or facts to draw more general conclusions

evidence: something that helps either prove or disprove a conclusion

theory: statement that explains a group of facts or phenomena; most accepted theories have been repeatedly tested and can be used to make predictions about nature

law: a scientific statement that describes a fact about or an event in the universe that has never been observed to occur differently

The example of deductive reasoning that's probably more famous than any other is: Socrates is a man. All men are mortal. Therefore, Socrates is mortal.

What's the difference between deductive and inductive reasoning?

Science is about discovering the reasons why things happen in the universe, so it shouldn't be a surprise to learn that scientific knowledge is gained through reasoning. There's more than a single way to reason, though, and one plays a much bigger role in science than any other.

Deduction is a form of reasoning that uses broad, generalized facts to draw conclusions about specific questions or events. For example, let's say you go to bed one night, wake up at dawn, and the ground is covered in a layer of fresh snow. You also see a line of tiny footprints imprinted on the snow. Using deductive reasoning, you know an animal walked there during the night. ~~You reach this conclusion because,~~ **a:** animals leave footprints when they walk through snow; and **b:** the snow fell during the night; therefore, **c:** an animal walked across the snow during the night. If **a** and **b** are true, then **c** must be true.

Deduction doesn't really lead to new knowledge, though. When a more general truth is already known, deduction simply proves that more specific instances are true as well. You know that gravity causes objects to fall when they're dropped, and an apple is an object, so concluding that an apple will fall when it's dropped isn't particularly informative.

Science is mainly based on **induction**, which, in a way, is the opposite of deduction. Inductive reasoning uses specific examples to draw more general conclusions. Going back to the tracks in the snow, induction might lead you to conclude that a possum walked across the yard at night. In five years, you've never observed any animals but possums during the night. The tracks also appear to have been made by a small, four-legged animal. Therefore, it was most likely a possum that crossed the yard. Inductive reasoning leads to most likely conclusions, but there's always a chance, no matter how small, that something else is the answer.

Scientific knowledge is gained through inductive reasoning. Scientists observe specific events—whether they occur in nature or in controlled experiments. Then, based on the accumulated evidence from many specific observations, they draw conclusions about the world. A hypothesis that's been tested many, many times and never proven wrong will eventually become a **theory**. The theory that's never proven wrong might become a **law**. Even so, scientists understand that science is based on induction, and that even the strongest theories and laws have to be adjusted if new evidence appears.



Read the following examples of reasoning. Then, write **deductive** or **inductive** on the line to indicate which type of reasoning was used.

1. _____ A biologist studying chimpanzees in the wild knows that young chimps have light brown faces and older chimps have dark gray faces. Chimp 1435 has a light brown face, so the biologist reasons that it's a young chimp.
2. _____ A truck traveling from Detroit to Chicago takes the most direct route. The most direct route from Detroit to Chicago runs through Michigan City, Indiana. Before arriving in Chicago, the truck will pass through Michigan City, Indiana.
3. _____ Most nights you look outside and see light from a street lamp illuminating the sidewalk. Then, one night you look outside and the street is dark. You reason that the bulb must have burned out in the lamp.
4. _____ In the 1920s, Edwin Hubble and other astronomers made the observation that galaxies are expanding away from each other at a steady rate. Other scientists calculated the galaxies' speeds and directions of movement, and then worked backward. They reasoned that all the galaxies and the matter in them must have once been combined into a single point of matter that exploded and began the observed, expanding motion.
5. _____ Each year, Alfonse has observed the leaves on trees near his home changing colors and falling to the ground during autumn. Then, in spring, the leaves reemerge. Alfonse reasons that the same thing will happen this year as well.

Write your answers on the lines below.

6. Write your own example of deductive reasoning.

7. Write your own example of inductive reasoning.
