8 A The Scientific Method

Although the scientific method is not the only means of discovering truths about the natural world, it is widely accepted as a valid process for answering questions and solving problems. The scientific method provides clear and systematic steps for using experiments to prove or disprove a hypothesis and reach some conclusion. Some authorities claim that there are four steps; some others claim there are five. There is some disagreement as to whether articulating a conclusion can properly be described as a step. For the purposes of this discussion, however, the method involves a series of five steps.

The first step of the scientific method is the recognition of some phenomenon and the articulation of a question about it such as, What is this? Why does this happen? A phenomenon is anything that can be sensed or experienced; it may also be something that is suggested by common sense, even though it cannot be perceived directly.

Step two is observation: a person collects data that concerns the subject in question and organizes the data. The information that the person collects, combined with facts already known, leads to the formulation of a hypothesis, the third step. A hypothesis is an informed guess and reasonable explanation for the question posed in step one, and it must undergo testing in a fourth step. This testing is usually in the form of experiments that must be objective and take into account as many variables as possible. Precise measurements and control over the circumstances under which experiments are carried out is a standard feature of testing. The experiments are generally repeated to ensure that results are consistent and reproducible.

Once the results have been tabulated and interpreted, the researcher should draw a conclusion as the final step. The conclusion may verify the hypothesis; it may also modify it or disprove it. If a conclusion is to be widely accepted, subsequent related experiments must produce similar or consistent results.

The scientific method might seem to be a straight road to discovery. Often, however, it is a twisting path filled with dead ends, U-turns, and detours. Different hypotheses may predict the same results but for different and even contradictory reasons. Likewise, researchers may have different interpretations of the same data. Within the realm of research, there is always ample opportunity for imagination. The scientific method creates a common language for researchers everywhere, helping the scientific community to bring new knowledge into the world.

Reading Time _____

Recalling Facts

1. The scientific method involves
   - ❑ a. the collection of random observations.
   - ❑ b. the systematic use of experiments.
   - ❑ c. 10 specific steps of discovery and demonstration.

2. Scientists repeat their tests
   - ❑ a. to imitate the work of other scientists.
   - ❑ b. to make sure the results are consistent.
   - ❑ c. because each test has to have different results.

3. A hypothesis is
   - ❑ a. a conclusion reached after the completion of an experiment.
   - ❑ b. a type of experiment.
   - ❑ c. a reasonable explanation of a phenomenon.

4. Which of the following groups of steps is in the correct order?
   - ❑ a. hypothesis, testing, conclusion
   - ❑ b. observation, testing, hypothesis
   - ❑ c. testing, observation, conclusion

5. Which of the following is *not* a true statement?
   - ❑ a. Scientists will always develop identical hypotheses given the same observations.
   - ❑ b. Scientists may come to different conclusions given the same test results.
   - ❑ c. Scientists may use different hypotheses to explain the same phenomenon.

Understanding Ideas

6. One could conclude that
   - ❑ a. the scientific method is the only approved research method.
   - ❑ b. most scientists agree on the value of the scientific method.
   - ❑ c. scientists prefer to develop their own research methods.

7. One could conclude that
   - ❑ a. most scientists are distrustful of research conducted by imaginative people.
   - ❑ b. scientists rely mainly on their creativity and imagination when testing hypotheses.
   - ❑ c. imagination may help a scientist form a hypothesis.

8. Which of the following is true?
   - ❑ a. The same facts may suggest different things to different scientists.
   - ❑ b. Scientists learn the most from a hypothesis they prove to be true.
   - ❑ c. Scientists try to make the results of their experiments agree with their hypotheses.

9. A hypothesis about a phenomenon
   - ❑ a. mostly requires imagination.
   - ❑ b. is shaped by known facts and by observations.
   - ❑ c. is likely to be true.

10. Which of these is *not* likely to be true of good scientists?
    - ❑ a. They work carefully and keep accurate records.
    - ❑ b. They are observant and quick to notice similarities.
    - ❑ c. They use traditional knowledge and reject hypotheses that have never been used.

8 B Scientific Observations and Photography

Following its invention in the 1830s, photography has played a key role in science as well as in art. Scientists have often used photography to observe and analyze forms and to record changes that occur over time. The special value of photography lies in film's ability to record what the human eye cannot. A single photograph provides a wealth of detail, but the eye focuses on one part of a scene—usually what is biggest or brightest. Light-sensitive film can show action that otherwise would be only a blur.

In 1877, Eadweard Muybridge proved that all four of a galloping horse's legs are, at certain points, off the ground at the same time. As a horse galloped past a series of cameras aimed at a calibrated backdrop, it tripped the camera shutters. Each photograph showed a different phase of movement against lines that measured the distance the horse had traveled. In the 1880s Muybridge made many studies of human and animal locomotion. He recorded the movements of different sports and the unique gaits of camels, deer, lions and sloths. He even photographed a cockatoo in flight.

In 1931, Dr. Harold Edgerton, a professor at the Massachusetts Institute of Technology, ushered in ultra-high speed photography when he invented a rapidly flashing light called a strobe. Over the next 40 years, he used it to capture images of motion, including wires snapping, a balloon popping, and milk droplets splashing.

1. Recognizing Words in Context

Find the word *calibrated* in the passage. One definition below is closest to the meaning of that word. One definition has the opposite or nearly opposite meaning. The remaining definition has a completely different meaning. Label the definitions C for *closest,* O for *opposite or nearly opposite,* and D for *different.*

_____ a. unmeasured and random

_____ b. brightly colored

_____ c. systematically measured

2. Distinguishing Fact from Opinion

Two of the statements below present *facts,* which can be proved correct. The other statement is an *opinion,* which expresses someone's thoughts or beliefs. Label the statements F for *fact* and O for *opinion.*

_____ a. Cameras have provided the most important scientific information.

_____ b. Scientists have used photography ever since it was invented.

_____ c. The strobe light made it possible to photograph movement that is too fast to be seen.

3. Keeping Events in Order

Label the statements below 1, 2, and 3 to show the order in which the events happened.

_____ a. Edgerton photographed things that happened too fast for the eye to see.

_____ b. Muybridge documented the movement of a galloping horse.

_____ c. Muybridge published books on animal locomotion.

4. Making Correct Inferences

Two of the statements below are correct *inferences,* or reasonable guesses. They are based on information in the passage. The other statement is an incorrect, or faulty, inference. Label the statements C for *correct* inference and F for *faulty* inference.

_____ a. Photographs can record more information about a scene than the human eye can.

_____ b. The human eye cannot record still images from a figure in motion.

_____ c. Photographers who work with scientists should have an advanced degree in science.

5. Understanding Main Ideas

One of the statements below expresses the main idea of the passage. One statement is too general, or too broad. The other explains only part of the passage; it is too narrow. Label the statements M for *main idea,* B for *too broad,* and N for *too narrow.*

_____ a. Photography has contributed to the study of objects in motion.

_____ b. Photography has made valuable contributions to many fields.

_____ c. Scientists use strobe lights to photograph objects moving at ultra-high speeds.

Correct Answers, Part A _____

Correct Answers, Part B _____

Total Correct Answers _____