Chapter 3 Answers

3.1 Section Review

1. The answer is (b).
2. A hypothesis is an unproven or preliminary explanation that can be tested. A theory is an explanation of why or how something occurred that is supported by lots of evidence collected over a long period of time.A natural law is a theory that has been tested many times without any contradictions.
3. The answer is (b).
4. The information in (a) is evidence that could be used to evaluate Julie's hypothesis. Julie has made an observation about the moon. The information in (b) is not evidence, it is a different hypothesis made by Julie's sister.
5. Repeatable means that anyone else who performs the same experiment in the same way observes the same results.
6. b

Challenge

Sample topics that illustrate a change in beliefs: (1) The geocentric model versus the heliocentric model of our solar system. (2) Spontaneous generation. (3) The germ theory of disease. (4) The age of Earth. (5) Lamarckian evolution versus natural selection and Mendelian inheritance.

3.2 Section Review

1. Experimentation is important because it is the way scientists perform tests to confirm or disprove hypotheses. Collecting scientific evidence through experimentation is the key to learning more about natural laws.
2. If you change more than one variable at a time in an experiment, you won't be able to easily tell what change affected the results.
3. An experimental variable is the thing you are testing or changing in the experiment. Control variables are the things you keep the same from trial to trial. An example is if you design an experiment to test the effect of different amounts of sunlight on plant growth; the experimental variable is the amount of sunlight and some control variables would be type of plant, amount of water, and temperature.
4. Sample answer: Two variables in the system would be the size of the grass stain and the types of detergent used. Two variables that would not be in the system would be the kind of pen that is used by the experimenter to record the data and what the experimenter ate for breakfast.
5. Answers will vary. Here are some example answers:
   a. Which type of cup keeps hot cocoa hot for the longest time?
   b. The foam cup will keep the cocoa hot for the longest time.
   c. The experimental variable. is the type of cup.
   d. The control variables are: the size and shape of the cup; starting temperature of cocoa, and the amount of cocoa in each cup. All three control variables need to be the same for each cup.
   e. Record starting temperature of cocoa in each cup and temperature every minute for 5 minutes.
   f. Students who conduct this experiment should record their data and summarize their findings in a report. This challenge could be done by individual students, by pairs of students, or by project groups.
6. Student answers will vary. Teacher tip: For this particular question, the teacher could assign an scientific article and have the students pick out each part of this question based on reading the article. The publication *Science News* has short and easy to interpret articles that would work with this assignment.
7. Possible important techniques include: (1) Use small enough volumes of liquid that you can notice a difference more quickly. (2) Put liquids in same types of containers; make sure the containers have a large amount of area exposed to air (like Petri dishes). (3) Start with same amount of liquid in each dish and find the starting mass of each. Find the mass at one hour intervals for several hours until you see enough of a difference to draw conclusions. (4) Make sure the experiment is done in a place that has good ventilation since nail polish remover (often acetone) and alcohol can be irritating to smell.

Challenge

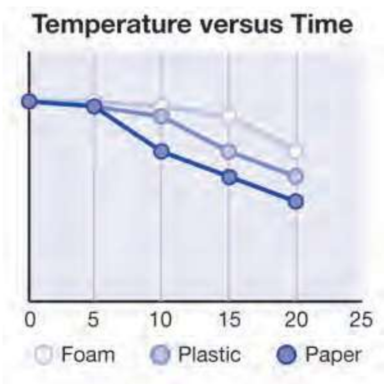
Serendipity and Science

(1) Student answers will vary. A possible answer might be making a mistake while making a recipe but the change to the recipe works out and tastes better.

(2) Objects that were invented by serendipity include the microwave oven and vulcanized rubber. Other objects, like the automobile or the airplane, were invented on purpose and took years to develop and improve.

Solve it!

Sample graph:



3.3 Section Review

1. Scientific journals are important because scientists use them to communicate their findings to each other. The journals give official reports of current scientific research. The findings from one group can influence the direction another group takes on their research. Journals bring the scientific community together. Because papers must be reviewed and accepted by peers, journals contain reliable, repeatable, durable scientific evidence.
2. If the scientist publishes results on her own website, readers will not know for sure that other scientists have reviewed the results. If the results are published in a scientific journal, readers will know that the work was reviewed by experts and judged to be acceptable for publication.
3. Examples of science: b, c, e, g. The others are examples of technology.
4. The auto would most likely have many design flaws. You cannot work out all of the problems in a design by building and testing only one prototype. Manufacturers typically build many versions of a prototype, improving the design each time, until the best design becomes the manufactured product. Even after the product is manufactured and sold, some design issues may come up. This is what happens when items are recalled.

Connection

1. Ethics can be defined as standards of conduct that enable a person to determine what behavior is right or wrong in a given situation.
2. Answers are:
   a. Making up results (known as fabrication).
   b. Changing data or results (known as falsification).
   c. Not giving the proper credit for someone else's ideas or written work (known as plagiarism).
3. Although it might be tempting to falsify the results so that funding would continue, this would be an unethical path to follow. Falsifying results can lead to a loss of trust that could damage or destroy the careers of the team members. It could put funding for future projects in jeopardy. It could damage the team's chances of gaining public participation in future clinical trials. Patients need to know they can trust the doctors involved in clinical trials.

Chapter 3 Assessment

Vocabulary

Section 3.1

1. deduce
2. theory
3. repeatable
4. inquiry
5. hypothesis
6. objective
7. natural laws
8. scientific method

Section 3.2

9. trials
10. experimental variable
11. control variable
12. procedure
13. experimental technique
14. experiment

Section 3.3

15. prototype
16. engineering cycle
17. technology
18. engineer

Concepts

Section 3.1

1. A hypothesis is a possible explanation of a scientific phenomenon. A theory is an accepted explanation for which a lot of evidence has been gathered over a long period of time.
2. a. N (a scientific illustration or diagram would be scientific evidence)
   b. S
   c. S
3. a. N (you cannot test something that is undetectable)
   b. N (this is not testable)
   c. S

Section 3.2

4. An experimental variable is the thing you are testing or changing from trial to trial in an experiment. Control variables are the things you keep the same from trial to trial.
5. An experimental technique is something you do in an experiment to make sure the results are reliable, objective, and repeatable. The procedure is the step-by-step list of exactly how you conduct an experiment, written so someone else can repeat the experiment. Suppose you want to see what happens to an air-filled balloon when the surrounding temperature gets hotter or colder. An example of experimental techniques would be describing how to carefully and consistently measure the diameter of the balloon. The procedure would be a step-by-step list of how you did the experiment so someone else could repeat it.

Section 3.3

6. Science is the study of the natural laws of the universe. Technology is the application of science to create new devices or ways of doing things to solve problems.
7. A scientist conducts experiments to test hypotheses about how things in the natural world work. An engineer takes scientific knowledge and uses it to create new ways of doing things, or new devices or products that solve problems or fulfill needs.

Problems

Section 3.1

1. Sample student answer: First, come up with a hypothesis. For example: I think the player doesn't work because the batteries are dead. Then, test your hypothesis. For example: take out the batteries and test them with a battery tester or in a different device. Alternately, you could just put new batteries in the player right away to see if it solves the problem. Next, analyze what you learned from your experiment. If the batteries work in another device, or if the batteries are fully charged according to the battery tester, you must come up with a different hypothesis. NOTE: If you change the battery AND reset the device, you might not know if the problem was due to a bad battery, or due to a computer problem. That's what happens when you change more than one variable in an experiment.

Section 3.2

2. Answers:
   a. The closer the marble is to the dough when dropped, the deeper the hole in the dough will be.
   b. The experimental variable is the height from which the marble is dropped.
   c. The marble must be the same; the dough must have equal thickness across the tray, and be thick enough so the marble doesn't break through the modeling dough and hit the tray underneath.
   d. The depth of the hole the marble makes in the modeling dough in millimeters.
   e. Procedure:
      1. Place an even layer of modeling dough in a baking tray (1 inch depth minimum).
      2. Drop a small marble from 5 different heights over different places in the modeling dough. The heights should be about 1.5 m, 1 m, 50 cm, 25 cm, and 12 cm.
      3. For each trial, measure the depth of the hole made by the marble.
   f. The data will disprove Monique's hypothesis. The higher the marble is when you drop it, the deeper the hole it will make in the dough. This is because the marble has more energy when you drop it from greater heights.

Section 3.3

3. Sample student answer: First, draw a diagram of your idea, and label the types of materials you would use. Next, build a prototype. You might have to modify your design if you can't gather the right materials. Then test your prototype on an open carton of eggs. Can you stand on the eggs without breaking any? Is your shoe stable enough so you could walk across several cartons? Make design adjustments as necessary. When you have a working prototype, make a pair of shoes according to the design. Setup a short path of open egg cartons. Have a friend help you up on the first two cartons. Then, walk across the path of egg cartons with your new shoes. Did you break any eggs? You might have to go back to the design stage another time.