1.E: Exercises

1.1: Soda Pop Fizz

1.2: Chemicals Compose Ordinary Things

1.3: All Things Are Made of Atoms and Molecules

1.4: The Scientific Method: How Chemists Think

Use the following paragraph to answer the first two questions. In 1928, Sir Alexander Fleming was studying Staphylococcus bacteria growing in culture dishes. He noticed that a mold called Penicillium was also growing in some of the dishes. In Figure 1.13, Petri dish A represents a dish containing only Staphylococcus bacteria. The red dots in dish B represent Penicillium colonies. Fleming noticed that a clear area existed around the mold because all the bacteria grown in this area had died. In the culture dishes without the mold, no clear areas were present. Fleming suggested that the mold was producing a chemical that killed the bacteria. He decided to isolate this substance and test it to see if it would kill bacteria. Fleming grew some Penicillium mold in a nutrient broth. After the mold grew in the broth, he removed all the mold from the broth and added the broth to a culture of bacteria. All the bacteria died.

1. Which of the following statements is a reasonable expression of Fleming's hypothesis?
    a. Nutrient broth kills bacteria.
    b. There are clear areas around the Penicillium mold where Staphylococcus doesn't grow.
    c. Mold kills bacteria.
    d. Penicillium mold produces a substance that kills Staphylococcus.
    e. Without mold in the culture dish, there were no clear areas in the bacteria.
2. Fleming grew Penicillium in broth, then removed the Penicillium and poured the broth into culture dishes containing bacteria to see if the broth would kill the bacteria. What step in the scientific method does this represent?
    a. Collecting and organizing data
    b. Making a hypothesis
    c. Testing a hypothesis by experiment
    d. Rejecting the old hypothesis and making a new one
    e. None of these

A scientific investigation is NOT valid unless every step in the scientific method is present and carried out in the exact order listed in this chapter.

a. True
b. False

Which of the following words is closest to the same meaning as *hypothesis*?

a. fact
b. law
c. formula
d. suggestion
e. conclusion

Why do scientists sometimes discard theories?

a. the steps in the scientific method were not followed in order
b. public opinion disagrees with the theory
c. the theory is opposed by the church
d. contradictory observations are found
e. congress voted against it

Gary noticed that two plants which his mother planted on the same day, that were the same size when planted, were different in size after three weeks. Since the larger plant was in the full sun all day and the smaller plant was in the shade of a tree most of the day, Gary believed the sunshine was responsible for the difference in the plant sizes. In order to test this, Gary bought ten small plants of the same size and type. He made sure they had the same size and type of pot. He also made sure they had the same amount and

type of soil. Then Gary built a frame to hold a canvas roof over five of the plants while the other five were nearby but out in the sun. Gary was careful to make sure that each plant received exactly the same amount of water and plant food every day.

1. Which of the following is a reasonable statement of Gary's hypothesis?
    a. Different plants have different characteristics.
    b. Plants that get more sunshine grow larger than plants that get less sunshine.
    c. Plants that grow in the shade grow larger.
    d. Plants that don't receive water will die.
    e. Plants that receive the same amount of water and plant food will grow the same amount.
2. What scientific reason might Gary have for insisting that the container size for the all plants be the same?
    a. Gary wanted to determine if the size of the container would affect the plant growth.
    b. Gary wanted to make sure the size of the container did not affect differential plant growth in his experiment.
    c. Gary want to control how much plant food his plants received.
    d. Gary wanted his garden to look organized.
    e. There is no possible scientific reason for having the same size containers.
3. What scientific reason might Gary have for insisting that all plants receive the same amount of water everyday?
    a. Gary wanted to test the effect of shade on plant growth and therefore, he wanted to have no variables other than the amount of sunshine on the plants.
    b. Gary wanted to test the effect of the amount of water on plant growth.
    c. Gary's hypothesis was that water quality was affecting plant growth.
    d. Gary was conserving water.
    e. There is no possible scientific reason for having the same amount of water for each plant every day.
4. What was the variable being tested in Gary's experiment?
    a. the amount of water
    b. the amount of plant food
    c. the amount of soil
    d. the amount of sunshine
    e. the type of soil
5. Which of the following factors may be varying in Gary's experimental setup that he did not control?
    a. individual plant variation
    b. soil temperature due to different colors of containers
    c. water loss due to evaporation from the soil
    d. the effect of insects which may attack one set of plants but not the other
    e. All of the above are possible factors that Gary did not control.

When a mosquito sucks blood from its host, it penetrates the skin with its sharp beak and injects an anti-coagulant so the blood will not clot. It then sucks some blood and removes its beak. If the mosquito carries disease-causing microorganisms, it injects these into its host along with the anti-coagulant. It was assumed for a long time that the virus typhus was injected by the louse when sucking blood in a manner similar to the mosquito. But apparently this is not so. The infection is not in the saliva of the louse, but in the feces. The disease is thought to be spread when the louse feces come in contact with scratches or bite wounds in the host's skin. A test of this was carried out in 1922 when two workers fed infected lice on a monkey, taking great care that no louse feces came into contact with the monkey. After two weeks, the monkey had NOT become ill with typhus. The workers then injected the monkey with typhus and it became ill within a few days. Why did the workers inject the monkey with typhus near the end of the experiment?

a. to prove that the lice carried the typhus virus
b. to prove the monkey was similar to man
c. to prove that the monkey was not immune to typhus
d. to prove that mosquitoes were not carriers of typhus
e. the workers were mean

Eijkman fed a group of chickens exclusively on rice whose seed coat had been removed (polished rice or white rice). The chickens all developed polyneuritis (a disease of chickens) and died. He fed another group of chickens unpolished rice (rice that still had its

seed coat). Not a single one of them contracted polyneuritis. He then gathered the polishings from rice (the seed coats that had been removed) and fed the polishings to other chickens that were sick with polyneuritis. In a short time, the birds all recovered. Eijkman had accurately traced the cause of polyneuritis to a faulty diet. For the first time in history, a food deficiency disease had been produced and cured experimentally. Which of the following is a reasonable statement of Eijkman's hypothesis?

a. Polyneuritis is a fatal disease for chickens.
b. White rice carries a virus for the disease polyneuritis.
c. Unpolished rice does not carry the polyneuritis virus.
d. The rice seed coat contains a nutrient that provides protection for chickens against polyneuritis.
e. None of these is a reasonable statement of Eijkman's hypothesis.

The three questions below relate to the following paragraphs.

Scientist A noticed that in a certain forest area, the only animals inhabiting the region were giraffes. He also noticed that the only food available for the animals was on fairly tall trees and as the summer progressed, the animals ate the leaves high and higher on the trees. The scientist suggested that these animals were originally like all other animals but generations of animals stretching their necks to reach higher up the trees for food, caused the species to grow very long necks.

Scientist B conducted experiments and observed that stretching muscles does NOT cause bones to grow longer nor change the DNA of animals so that longer muscles would be passed on to the next generation. Scientist B, therefore, discarded Scientist A's suggested answer as to why all the animals living in the area had long necks. Scientist B suggested instead that originally many different types of animals including giraffes had lived in the region but only the giraffes could survive when the only food was high in the trees, and so all the other species had left the area.

1. Which of the following statements is an interpretation, rather than an observation?
   A. The only animals living in the area were giraffes.
   B. The only available food was on tall trees.
   C. Animals which constantly stretch their necks will grow longer necks.
   D. A, B, and C are all interpretations.
   E. A, B, and C are all observations.
2. Scientist A's hypothesis was that
   A. the only animals living in the area were giraffes.
   B. the only available food was on tall trees.
   C. animals which constantly stretch their necks will grow longer necks.
   D. the animals which possess the best characteristics for living in an area, will be the predominant species.
   E. None of the above are reasonable statements of Scientist A's hypothesis.
3. Scientist A's hypothesis being discarded is
   A. evidence that the scientific method doesn't always work.
   B. a result achieved without use of the scientific method.
   C. an example of what happened before the scientific method was invented.
   D. an example of the normal functioning of the scientific method.
   E. an unusual case.

When a theory has been known for a long time, it becomes a law.

a. True
b. False

During Pasteur's time, anthrax was a widespread and disastrous disease for livestock. Many people whose livelihood was raising livestock lost large portions of their herds to this disease. Around 1876, a horse doctor in eastern France named Louvrier, claimed to have invented a cure for anthrax. The influential men of the community supported Louvrier's claim to have cured hundreds of cows of anthrax. Pasteur went to Louvrier's hometown to evaluate the cure. The cure was explained to Pasteur as a multi-step process during which: 1) the cow was rubbed vigorously to make her as hot as possible; 2) long gashes were cut into the cows skin and turpentine was poured into the cuts; 3) an inch-thick coating of cow manure mixed with hot vinegar was plastered onto the cow and the cow was completely wrapped in a cloth. Since some cows recover from anthrax with no treatment, performing the cure on a single cow would not be conclusive, so Pasteur proposed an experiment to test Louvrier's cure. Four healthy cows were to be

injected with anthrax microbes, and after the cows became ill, Louvrier would pick two of the cows (A and B) and perform his cure on them while the other two cows (C and D) would be left untreated. The experiment was performed and after a few days, one of the untreated cows died and one of them got better. Of the cows treated by Louvrier's cure, one cow died and one got better. In this experiment, what was the purpose of infecting cows C and D?

a. So that Louvrier would have more than two cows to choose from.
b. To make sure the injection actually contained anthrax.
c. To serve as experimental controls (a comparison of treated to untreated cows).
d. To kill as many cows as possible.

A hypothesis is

a. a description of a consistent pattern in observations.
b. an observation that remains constant.
c. a theory that has been proven.
d. a tentative explanation for a phenomenon.

A number of people became ill after eating oysters in a restaurant. Which of the following statements is a hypothesis about this occurrence?

a. Everyone who ate oysters got sick.
b. People got sick whether the oysters they ate were raw or cooked.
c. Symptoms included nausea and dizziness.
d. The cook felt really bad about it.
e. Bacteria in the oysters may have caused the illness.

Which statement best describes the reason for using experimental controls?

a. Experimental controls eliminate the need for large sample sizes.
b. Experimental controls eliminate the need for statistical tests.
c. Experimental controls reduce the number of measurements needed.
d. Experimental controls allow comparison between groups that are different in only one independent variable.

A student decides to set up an experiment to determine the relationship between the growth rate of plants and the presence of detergent in the soil. He sets up 10 seed pots. In five of the seed pots, he mixes a precise amount of detergent with the soil and the other five seed pots have no detergent in the soil. The five seed pots with detergent are placed in the sun and the five seed pots with no detergent are placed in the shade. All 10 seed pots receive the same amount of water and the same number and type of seeds. He grows the plants for two months and charts the growth every two days. What is wrong with his experiment?

a. The student has too few pots.
b. The student has two independent variables.
c. The student has two dependent variables.
d. The student has no experimental control on the soil.

A scientist plants two rows of corn for experimentation. She puts fertilizer on row 1 but does not put fertilizer on row 2. Both rows receive the same amount of sun and water. She checks the growth of the corn over the course of five months. What is acting as the control in this experiment?

a. Corn without fertilizer.
b. Corn with fertilizer.
c. Amount of water.
d. Height of corn plants.

If you have a control group for your experiment, which of the following is true?

a. There can be more than one difference between the control group and the test group, but not more three differences, or else the experiment is invalid.
b. The control group and the test group may have many differences between them.
c. The control group must be identical to the test group except for one variable.
d. None of these are true.

If the hypothesis is rejected by the experiment, then:

a. the experiment may have been a success.
b. the experiment was a failure.
c. the experiment was poorly designed.
d. the experiment didn't follow the scientific method.

A well-substantiated explanation of an aspect of the natural world is a:

a. theory.
b. law.
c. hypothesis.
d. None of these.

1.5: A Beginning Chemist: How to Succeed
