

Appendix B

Solutions to *Check for Understanding Problems*

Chapter 1

Check for Understanding 1.1

1. Which of the following represents the fundamental steps of the scientific method?
- A. observation → law → hypothesis → theory.
 - B. observation → hypothesis → experiment → theory.
 - C. hypothesis → theory → experiment → law.
 - D. observation → theory → experiment → hypothesis.

Answer: B

Solution

You can reject A because it lacks the experimentation that is central to the scientific method. Also, a law is not formulated until numerous observations have been made.

You can reject C because the steps taken between a tentative explanation (hypothesis) and a well established explanation (theory) require numerous experiments.

You can reject D because a hypothesis is always developed before a theory.

2. Characterize each of the following as an example of a scientific law, scientific theory, observation, or none of these.
- a) The liquid in a glass of water is composed of molecules.
 - b) Flammable materials always contain oxygen.
 - c) When a can of soda pop is opened, a fizzing sound is heard.
 - d) The force of gravity between two objects increases as they get closer.

Answers: a) theory c) observation
 b) none of these d) law

Solutions

- a) This represents an explanation for the composition and observable properties of water. Scientists cannot observe molecules directly so this is not a simple observation or a summary of repeated observations (a law).
- b) This cannot be a theory because it does not provide an explanation for flammability. A single example of a flammable material that does not contain oxygen will invalidate this as an observation that is always made and a law. Hydrogen is the simplest example of a flammable substance that does not contain oxygen. Others include fuels like natural gas and propane. This leaves *none of these* as the correct choice.
- c) This is a simple observation. It is not a scientific law because it is not always observed; a can of soda may be flat or not highly carbonated so no fizzing is heard. It does not provide any explanation so it cannot be a theory.
- d) No explanation is provided so it cannot be a theory. It is an observation that is repeatedly made (there are no known exceptions) so it represents a scientific law.

Check for Understanding 1.2

- 1. In Figure 1.6, which quantity is the independent variable and which is the dependent variable?

Answers: volume is the independent variable

pressure is the dependent variable

Solution

In the absence of additional information you should assume that the independent variable is plotted on the x -axis and the dependent variable is plotted on the y -axis. So volume is the independent variable and pressure is the dependent variable.

Check for Understanding 1.3

- 1. The equation for the straight-line graph in Figure 1.5 is $y = 0.0038x - 0.047$. Determine the Kelvin temperature (K) at which the pressure of this gas sample equals 0.94 atm.

Answer: 260 K

Solution

The equation for the straight line in Figure 1.5 can be expressed as:

$$\text{pressure (atm)} = 0.0038(\text{temp (K)}) - 0.047$$

Substituting 0.94 atm for the pressure and solving for temperature yields:

$$\text{temp (K)} = \frac{0.94 + 0.047}{0.0038} = 260$$

2. Imagine doing an experiment in which you burn a candle and measure its diminishing mass at various times.
- a) If you plot candle mass (in grams) on the y -axis and time (in minutes) on the x -axis and fit the data with a straight line, what are the units for the slope of this line?

Answer: g/min

Solution

The slope of a straight-line graph is given by $\frac{y_2 - y_1}{x_2 - x_1}$ so the units of the slope are the units of the y -axis variable (g) divided by the units of the x -axis variable (min). In this case the ratio of units is g/min.

- b) Do you expect the slope of this straight line to be positive or negative? Explain your answer.

Answer: negative

Solution

Think about how this graph might look. As the candle burns its mass decreases so a plot of candle mass versus time might look like that below. Since it slopes downward from left to right, the slope is negative. You can also see this by noting that $(y_2 - y_1)$ is positive but $(x_2 - x_1)$ is negative so the ratio of these quantities is negative.

A.10 **APPENDIX B** **SOLUTIONS TO CHECK FOR UNDERSTANDING PROBLEMS**

