3. Dependent variables: time; independent variable: distance
   *Note:* This is reversed from what is typically measured in a finding-speed experiment.
4. The gray vehicle's graph has a steeper slope. The slope is equal to the speed of the vehicle, 28 m/s.
5. A horizontal line would mean that the vehicle is not moving. A line with a steeper slope would mean that the vehicle is traveling faster than the other vehicle.

#### Going Further

Answers will vary. Student responses should suggest protocols for ensuring accuracy, such as using evenly spaced markers. As for improving their measurements, rigging a motion detector to a digital chronometer that measures to the one-hundredth of a second has a far higher degree of accuracy than checking the second hand on a clock face.

#### Real-World Physics

Parallax creates the differences. The passenger seats and possibly the rear seat will not provide an accurate view of the speedometer. Looking straight at the speedometer will provide the most accurate reading.

#### Share Your Data

Answers will vary. Review student procedures from *Going Further* before posting them.

## Study Guide

### A Physics Toolkit

#### Vocabulary Review

1. physics
2. scientific method
3. significant digits
4. inverse relationship
5. line of best fit
6. hypothesis
7. independent variable
8. scientific law
9. measurement
10. linear relationship
11. scientific theory
12. accuracy
13. dependent variable
14. dimensional analysis
15. quadratic relationship
16. precision

### Section 1-1 Mathematics and Physics

1. experiments
2. experimental data
3. results
4. theories
5. equations
6. units
7. dimensional analysis
8. graphs
9. c
10. e
11. a
12. f
13. h
14. d
15. b
16. i
17. g
18. least
19. three
20. with the number of significant digits required by the problem
21. 2
22. 1
23. 3
24. This can best be described as an observation because you have noticed a natural phenomenon.
25. The fact that exact units are mentioned makes this a quantitative measurement.
26. This statement describes the summing up of observations into a scientific law.
27. This is a hypothesis or prediction based on previous experience.
28. This is an example of reproducing results because you are doing the experiment a second time.

**29.** This is a scientific theory based on many observations and supported by experimental results.

## Section 1-2 Measurement

**1.** a
**2.** c
**3.** d
**4.** b
**5.** c
**6.** a
**7.** d

## Section 1-3 Graphing Data

**1.** quadratic
**2.** The dependent variable is time and the independent variable is distance.
**3.** positive
**4.** $\frac{\text{m}}{\text{s}}$
**5.** The graph is steeper at 2.0 s than at 1.0 s.
**6.** 15 m
**7.** $d = 5t^2$
$= 5(2.4)^2$
$= 28$
The distance is 28 m
**8.** inverse
**9.** negative
**10.** ohms/A
**11.** 5 A
**12.** $I = \frac{k}{A}$
**13.** d
**14.** c
**15.** f
**16.** a
**17.** e
**18.** b

## Section 1-1 Quiz

**1.** Physicists communicate with other scientists from all over the world. Making research understandable to all is important for the progress of science. All scientists understand SI units.
**2.** The steps are to define the problem, make a hypothesis, conduct experiments, collect data, and create explanations.
**3.** Significant digits are the valid digits in a measurement. For example, if you measure a pencil and find that it is 12.5 cm long, all three digits are significant. However, the last digit is uncertain because it is at the limit of your measuring instrument. The pencil could really be 12.54 cm long, but the measurer cannot determine that due to the limits of the equipment. Zero can be a significant digit in a measurement such as 26.50 m because it is the estimated (possibly uncertain) digit. However, the zeros are not significant in the measurement 0.0079 m because the number could be rewritten as $7.9 \times 10^{-3}$. The zeros are only in the measurement to fix the location of the decimal point.
**4.** $v = at$
$t = \frac{v}{a}$
$= \frac{5 \text{ m/s}}{0.5 \text{ m/s}^2}$
$= 10$ s

## Section 1-2 Quiz

**1.** Precision is the degree of exactness of a measurement. Precision is limited by the number of divisions on the measuring tool. A measurement can only be precise to one-half of the smallest division of the instrument. Accuracy refers to a comparison between a measuring instrument and a standard. Scientists calibrate their instruments to verify that they maintain their accuracy.