Section 1 Review

1. Possible answer: I would make observations and ask a question based on the observations. I would research what is already known about the problem and form a hypothesis. I would design and carry out an experiment to test my hypothesis and analyze the results. I would check to see whether the results supported my hypothesis. I might ask another question based on the results or observations I made during the experiment.
2. A hypothesis is a possible explanation for a problem using what you know and what you observe. A hypothesis can be tested by making observations, by building a model, or by performing an experiment.
3. Bias can affect the results or conclusion of an investigation, making them invalid.
4. Scientists use models to help explain or learn more about things that are too large, too small, or too far to visualize or observe easily. Examples may include the solar system, a cell, DNA model, or the aerodynamics of an aircraft.
5. A scientific theory is an explanation of an event based on knowledge from observations and investigations. A scientific law is a statement about what happens in nature and that seems to be true all the time. Since a theory explains why something happens and a law does not, a theory cannot change into a law.
6. Testing opinions is not scientific. It is impossible to prove that an opinion is true for everyone. In addition, the survey was based on a small part of the population, and it only included students at one school. The results cannot be extended to the entire population.
7. No; the value of 9.8 m/s^2 has been established by many other experiments, and to discard the finding you would have to explain why it is wrong. There are probably some factors affecting your calculation, such as friction or how precisely you can measure the different variables.

Section 2 Review

8. The formulas are concise and can be used to predict new data.
9. Answers might include that SI units help people communicate their results, that SI units are the units of measurement in most countries around the world, or that SI units are easy to manipulate because they are based on multiples of ten.
10. 750,000 kHz
11. 31,622,400 s
12. **a.** 2.5 g after rounding
    b. 4.33 m after rounding
    c. 3.2×10^2 cm^2
    d. 1.22 g/mL
    e. 93.6 cm after rounding
    f. 1600 m after rounding
13. $v = \frac{F}{Bq}$
14. Sample answer: For most cars, the answer is unreasonable because 290 km/h is equivalent to 81 m/s or 180 mph. The speed might be reasonable for a race car.

Section 3 Review

15. It would be more precise but less accurate.

16. As the edge of the ruler gets worn away over time, the first millimeter or two of the scale would also be worn away if the scale started at the edge.

17. No; it doesn't change the fineness of the divisions on its scale.

18. His height would be between 181.5 and 182.5 cm. Precision of a measurement is one-half the smallest division on the instrument. The height 182 cm would range ±0.5 cm.

19. a. 7.05×10^3 cm^3

b. nearest tenth of a cm; nearest 10 cm^3

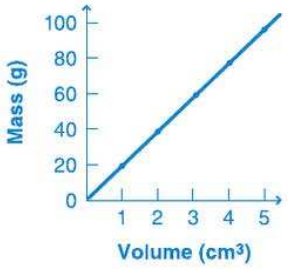
c. 243.6 cm

d. nearest tenth of a cm; nearest tenth of a cm

20. You should not have much confidence in the precision of the report. A result can never be more precise than the least precise measurement. The calculated average lap time exceeds the precision possible with the clock.

Practice Problems

21. a.



b. a straight line

c. The relationship is linear.

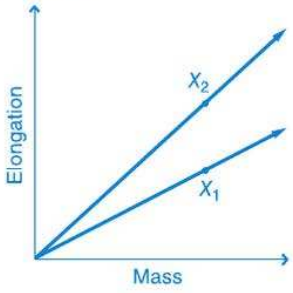
d. 19 g/cm^3

e. $m = (19\ \text{g/cm}^3)V$

f. The mass for each cubic centimeter of pure gold is 19 g.

Physics Challenge

1.



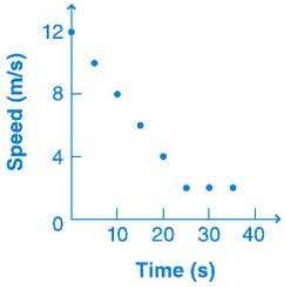
2. Yes; the origin corresponds to 0 elongation when the mass is 0.

3. The slope for the second spring is steeper.

4. $x_2 = 1.6x_1$, 5.3 cm $= 1.6x_1$, 3.3 cm $= x_1$

Section 4 Review

22.



23. There is a nonzero total mass when the volume of the material is zero. This could happen if the mass value includes the material's container.

24. 16 g

25. About 2.6 h

26. The spring whose line has a smaller slope is stiffer and, therefore, requires more mass to stretch it 1 cm.

CHAPTER 1 ANSWERS

SECTION 1

Mastering Concepts

27. Possible answer: Identify a problem, gather information about it by observing and experimenting, create a model or theory to explain the results, analyze the information to test the model, and use the model to predict new results.

28. a. The solar system is very large.

b. Airplane aerodynamics are complex and dynamic.

c. The mathematical model can quantify the force each object is exerting.

SECTION 2

Mastering Concepts

29. Mathematics allows you to be quantitative, to say "how fast," not just "fast."

30. The International System of Units, or SI, is a base 10 system of measurement that is the standard in science. The base units are the meter, kilogram, second, kelvin, mole, ampere, and candela.

31. The derived units are combinations of the base units.

32. a. Zeros are necessary to indicate the magnitude of the value, but there is no way of knowing whether the instrument used to measure the values actually measured the zeros. The zeros may serve only to locate the 1.

b. Write the number in scientific notation, including only the significant figures.

33. a. centimeter

b. millimeter

c. kilometer

34. $\frac{60\ \text{min}}{1\ \text{h}}$

35. a. 3.49×10^{5} g

b. 2.87×10^{5} J/cm^3

Mastering Problems

36. a. 0.423 m

b. 6.2×10^{-12} m

c. 2.1×10^{4} m

d. 2.3×10^{-5} m

e. 2.14×10^{-4} m

f. 5.7×10^{-8} m

37. a. 6.12×10^{9} s

b. 2.94×10^{-6} m

c. 1.250×10^{-4} kg

d. 7.50×10^{7} g

38. 1.234 and 7.603 are tied with 4, 0.250 has 3, 0.13 has 2, and 0.08 has 1

39. a. 1

b. 4

c. 5

d. 1

e. 3

40. a. 34.7 m

b. 25.022 m

c. 46.00 cm^2

d. 3.1 kg

41. a. 2.9×10^{9} m^2

b. 2.0×10^{5} m/s

c. 1.3×10^{-6} km^2

d. 1.9×10^{2} kg/m^3

42. a. 408 N

b. 64.5 kg

43. No; it is in kg•s.

SECTION 3

Mastering Concepts

44. the precision of a measuring device, which is limited by the finest division on its scale

45. The final digit is estimated.

Mastering Problems

46. 48.2 kg

47. 2.4×10^{2} m^3

48. 362.1 m

49. $\pm$0.05 g

50. 3.6 $\pm$ 0.1 A

51. A standard residential doorframe height is about 80 inches, which is about 200 cm. The precision depends on the measurement instrument used.

52. a. 1.2°C/h

b. about 8°C

c. No; temperature is unlikely to continue falling sharply and steadily that long.

SECTION 4

Mastering Concepts

53. The slope of a linear graph is the ratio of the vertical change to the horizontal change, or rise over run.

54. a. Positive. As speed increases, reaction distance increases.

b. Larger. The driver who was distracted would have a longer reaction time and thus a greater reaction distance at a given speed.

55. Temperature is the independent variable; volume is the dependent variable.

56. quadratic; $y = ax^2 + bx + c$

57. a. inverse relationship

b. linear relationship

c. quadratic relationship

Mastering Problems

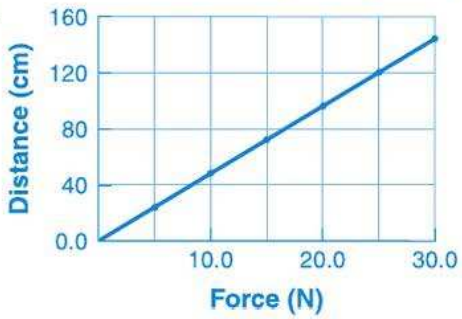
58. a. (A) 80 g, (B) 260 g, (C) 400 g

b. (A) 36 cm^3, (B) 12 cm^3, (C) 7 cm^3

c. The slope represents the increased mass of each additional cubic centimeter of the substance.

d. The *y*-intercept is (0, 0). It means that when $V = 0\ cm^3$, there is none of the substance present ($m = 0$ g).

59. a.



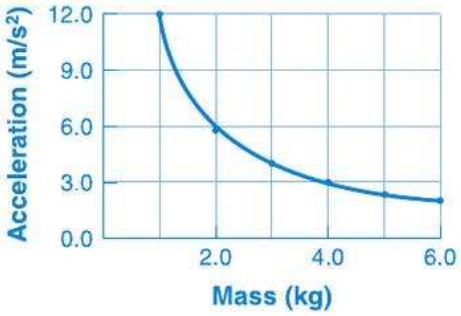
b. a straight line

c. $d = 4.9F$

d. The constant is 4.9 and has units cm/N.

e. 108 cm or 110 cm using 2 significant figures

60. a.



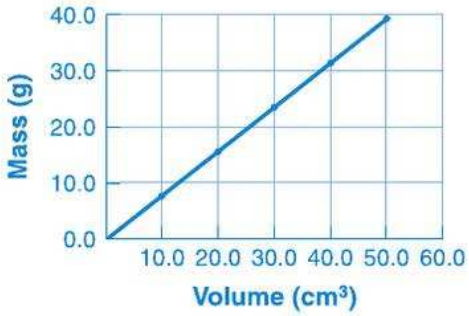
b. a hyperbola

c. $a = \frac{12}{m}$

d. $kg \cdot m/s^2$

e. 1.5 m/s^2

61. a.



b. a straight line

c. $m = 0.79V$

d. g/cm^3; density

e. 25.7 g

Applying Concepts

62. There is no definite order of specific steps. However, whatever approach is used, it always includes close observation, controlled experimentation, summarizing, checking, and rechecking.

63. A scientific law is a rule of nature, where a scientific theory is an explanation of the scientific law based on observation. A theory explains why something happens; a law describes what happens.

64. When $t = 0$ and $t = 2$, the ball's height will be about 20 m. When $t = 5$, the ball will have landed on the ground, so the height will be 0 m.

65. a. possible answers include g/cm^3, kg/m^3

b. derived unit

66. a. cm

b. mm

c. m

d. km

67. The chart might include: radius of an atom, 5×10^{-11} m; virus, 10^{-7} m; thickness of paper, 0.1 mm; width of paperback book, 10.7 cm; height of a door, 1.8 m; width of town, 7.8 km; radius of Earth, 6×10^{6} m; distance to the Moon, 4×10^{8} m.

68. The chart might include: half-life of polonium-194, 0.7 s; time between heartbeats, 0.8 s; time to walk between physics class and math class, 2.4 min; length of school year, 180 days; time between elections for the U.S. House of Representatives, 2 years; time between U.S. presidential elections, 4 years; age of the United States, (about) 235 years

69. a. $(3.001 \pm 0.001)\times10^{8}$ m/s

b. $(2.999 \pm 0.006)\times10^{8}$ m/s

70. In addition and subtraction, you ask what place the least precise measure is known to: in this case, to the nearest centimeter. So the answer is rounded to the nearest centimeter. In multiplication and division, you look at the number of significant figures in the least precise answer: in this case, 2. So the answer is rounded to 2 significant figures.

71. The slope would be negative, because the change in vertical distance is negative for a positive change in horizontal distance

72. The slope is zero. The change in vertical distance is zero. y does not depend on x.

73. The units in each term of the equation must be in meters because distance (d) is measured in meters. $av^2 = a(\text{m/s})^2$, so a is in s^2/m; $bv = b(\text{m/s})$, so b is in s^{-1}.

74. 8.3 cm $\pm$ 0.05 cm or 83 mm $\pm$ 0.5 mm

75. A scientific theory has been tested and supported many times before it becomes accepted. A hypothesis is an idea about how things might work; it has much less support than a theory.

76. Possible answers include Newton's laws of motion, law of conservation of energy, law of conservation of charge, law of reflection

77. Air resistance affects many light objects. Without controlled experiments, everyday observations might have suggested to the ancient Greeks that heavier objects did fall faster.

78. $\pm$0.5 mL

79. Answers will vary, but a correct form of the answer is, "Every minute, three more people enter a room. If the room was initially empty at time = 0, how many people will be there after 8 minutes?"

Mixed Review

80. 0.0034 m, 45.6 m, 1234 m

81. 80 m is equivalent to about 260 feet, which would be very large. 5 meters would be a more reasonable value.

82. 162 shorts

83. volume $= 1.87\times10^{-4}$ m^3, density $= 8.87$ g/cm^3

84. 5.4×10^{7} y

85. 8.00 g/cm^3

Thinking Critically

86. The "right" question is one that points to fruitful research and to other questions that can be answered.

87. 286 kg

88. 0.0494 g/cm^3

89. mass of ball, footing, practice, and conditioning

90. Answers will vary. A possible form of the correct answer would be, "…. You then add 46.3 mL of rubbing alcohol to it. How much total liquid do you have?"

Writing in Physics

91. Answers will vary. For example, students might describe how scientists' views of the basic forces of nature have changed over time or how scientists' views of radiation have changed.

92. For example, students might suggest that improved precision can lead to better observations.

Standardized Test Practice

Multiple Choice

1. C

2. C

3. B

4. A

5. A

6. B

Free Response

7. a. $a = \frac{F}{m}$

b. $\frac{1\text{ kg}}{1000\text{ g}}$

c. $a = \left(\frac{2.7\text{ kg}\cdot\text{m/s}^2}{350\text{ g}}\right)\left(\frac{1000\text{ g}}{1\text{ kg}}\right) = 7.7\text{ m/s}^2$

8. $d = -\left(\frac{6}{7}\right)t + 11$