Answers to Concept Checks

1-1 5

Answers to Practice Problems

1-1 (*a*) 300 ns; (*b*) 40 Mm

1-2 (*a*) 0.05, (*b*) 3.9, (*c*) 0.003

1-3 2.39×10^2

1-4 3.2×10^5 y

1-5 $\approx 6 \times 10^{15}$

1-6 $A_x = -17.3$ km, $A_y = 10.0$ km

1-7 (*a*) $A = 5.00$ m, (*b*) $B = 3.61$ m, (*c*) $\vec{A} + \vec{B} = (6.00\text{ m})\hat{i}$
(*d*) $\vec{A} - \vec{B} = (2.00\text{ m})\hat{i} + (6.00\text{ m})\hat{j}$

Problems

In a few problems, you are given more data than you actually need; in a few other problems, you are required to supply data from your general knowledge, outside sources, or informed estimate.

Interpret as significant all digits in numerical values that have trailing zeroes and no decimal points.

- • Single-concept, single-step, relatively easy
- •• Intermediate-level, may require synthesis of concepts
- ••• Challenging, for advanced students
- SSM Solution is in the *Student Solutions Manual*

Consecutive problems that are shaded are paired problems.

CONCEPTUAL PROBLEMS

1 • Which of the following *is not* one of the base quantities in the SI system? (*a*) mass, (*b*) length, (*c*) energy, (*d*) time, (*e*) All of the above are base quantities. SSM

2 • In doing a calculation, you end up with m/s in the numerator and m/s^2 in the denominator. What are your final units? (*a*) m^2/s^3, (*b*) 1/s, (*c*) s^3/m^2, (*d*) s, (*e*) m/s

3 • The prefix giga means (*a*) 10^3, (*b*) 10^6, (*c*) 10^9, (*d*) 10^{12}, (*e*) 10^{15}.

4 • The prefix mega means (*a*) 10^{-9}, (*b*) 10^{-6}, (*c*) 10^{-3}, (*d*) 10^6, (*e*) 10^9.

5 • Show that there are 30.48 cm per foot. How many centimeters are there in one mile? SSM

6 • The number 0.000 513 0 has _____ significant figures. (*a*) one, (*b*) three, (*c*) four, (*d*) seven, (*e*) eight

7 • The number 23.0040 has _____ significant figures. (*a*) two, (*b*) three, (*c*) four, (*d*) five, (*e*) six

8 • Force has dimensions of mass times acceleration. Acceleration has dimensions of speed divided by time. Pressure is defined as force divided by area. What are the dimensions of pressure? Express pressure in terms of the SI base units kilogram, meter, and second.

9 • True or false: Two quantities must have the same dimensions in order to be multiplied.

10 • A vector has a negative x component and a positive y component. Its angle measured counterclockwise from the positive x axis is (*a*) between zero and 90 degrees, (*b*) between 90 and 180 degrees, (*c*) more than 180 degrees.

11 • A vector $\vec{A}$ points in the $+x$ direction. Show graphically at least three choices for a vector $\vec{B}$ such that $\vec{B} + \vec{A}$ points in the $+y$ direction. SSM

12 • A vector $\vec{A}$ points in the $+y$ direction. Show graphicall at least three choices for a vector $\vec{B}$ such that $\vec{B} - \vec{A}$ points in th $+x$ direction.

13 • Is it possible for three equal-magnitude vectors to add t zero? If so, sketch a graphical answer. If not, explain why not. SSM

ESTIMATION AND APPROXIMATION

14 • The angle subtended by the moon's diameter at a poir on Earth is about 0.524° (Figure 1-18). Use this information and th fact that the moon is about 384 Mm away to find the diameter of th moon. *Hint: The angle can be determined from the diameter of the moo and the distance to the moon.*

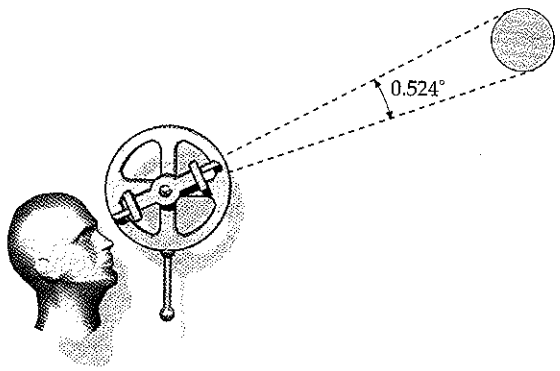
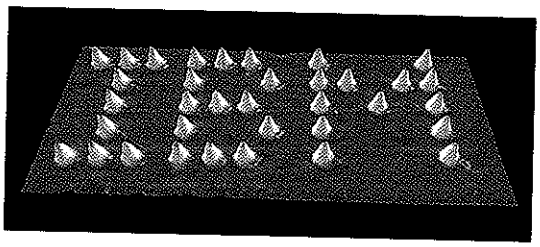


FIGURE 1-18 Problem 14

15 • **BIOLOGICAL APPLICATION** Some good estimates abou the human body can be made if it is assumed that we are made mostly of water. The mass of a water molecule is 29.9×10^{-27} kg. I the mass of a person is 60 kg, estimate the number of water mole cules in that person. SSM

16 •• **ENGINEERING APPLICATION** In 1989, IBM scientists moved atoms with a scanning tunneling microscope (STM). One of the first STM images seen by the general public was of the letters IBM spelled with xenon atoms on a nickel surface. The letters IBM were 15 xenon atoms across. If the space between the centers of adjacent xenon atoms is 5 nm (5×10^{-9} m), estimate how many times "IBM" could be written across this 8.5-inch page.



(By permission of IBM Reasearch, Almaden Research Center.)

17 •• There is an environmental debate over the use of cloth versus disposable diapers. (*a*) If we assume that between birth and 2.5 y of age, a child uses 3 diapers per day, estimate the total number of disposable diapers used in the United States per year. (*b*) Estimate the total landfill volume due to these diapers, assuming that 1000 kg of waste fills about 1 m^3 of landfill volume. (*c*) How many square miles of landfill area at an average height of 10 m is needed for the disposal of diapers each year?

18 •• (*a*) Estimate the number of gallons of gasoline used per day by automobiles in the United States and the total amount of money spent on it. (*b*) If 19.4 gal of gasoline can be made from one barrel of crude oil, estimate the total number of barrels of oil imported into the United States per year to make gasoline. How many barrels per day is this?

19 •• **ENGINEERING APPLICATION** A megabyte (MB) is a unit of computer memory storage. A CD has a storage capacity of 700 MB and can store approximately 70 min of high-quality music. (*a*) If a typical song is 5 min long, how many megabytes are required for each song? (*b*) If a page of printed text takes approximately 5 kilobytes, estimate the number of novels that could be saved on a CD. SSM

UNITS

20 • Express the following quantities using the prefixes listed in Table 1-1 and the unit abbreviations listed in the table Abbreviations for Units. For example, 10000 meters = 10 km. (*a*) 1000000 watts, (*b*) 0.002 gram, (*c*) 3×10^{-6} meter, (*d*) 30000 seconds

21 • Write each of the following without using prefixes: (*a*) 40 μW, (*b*) 4 ns, (*c*) 3 MW, (*d*) 25 km.

22 • Write the following (which are not SI units) using prefixes (but not their abbreviations). For example, 10^3 meters = 1 kilometer: (*a*) 10^{-12} boo, (*b*) 10^9 low, (*c*) 10^{-6} phone, (*d*) 10^{-18} boy, (*e*) 10^6 phone, (*f*) 10^{-9} goat, (*g*) 10^{12} bull.

23 •• In the following equations, the distance x is in meters, the time t is in seconds, and the velocity v is in meters per second. What are the SI units of the constants C_1 and C_2? (*a*) $x = C_1 + C_2 t$, (*b*) $x = \frac{1}{2}C_1 t^2$, (*c*) $v^2 = 2C_1 x$, (*d*) $x = C_1 \cos C_2 t$, (*e*) $v^2 = 2C_1 v - (C_2 x)^2$ SSM

24 •• If x is in feet, t is in milliseconds, and v is in feet per second, what are the units of the constants C_1 and C_2 in each part of Problem 23?

CONVERSION OF UNITS

25 • **MULTISTEP** From the original definition of the meter in terms of the distance along a meridian from the equator to the North Pole, find in meters (*a*) the circumference of Earth and (*b*) the radius of Earth. (*c*) Convert your answers for (*a*) and (*b*) from meters into miles.

26 • The speed of sound in air is 343 m/s. What is the speed of a supersonic plane that travels at twice the speed of sound? Give your answer in kilometers per hour and miles per hour.

27 • A basketball player is 6 ft $10\frac{1}{2}$ in tall. What is his height in centimeters?

28 • Complete the following: (*a*) 100 km/h = _____ mi/h, (*b*) 60 cm = _____ in., (*c*) 100 yd = _____ m.

29 • The main span of the Golden Gate Bridge is 4200 ft. Express this distance in kilometers.

30 • Find the conversion factor to convert from miles per hour into kilometers per hour.

31 • Complete the following: (*a*) 1.296×10^5 km/h^2 = _____ km/(h · s), (*b*) 1.296×10^5 km/h^2 = _____ m/s^2, (*c*) 60 mi/h = _____ ft/s, (*d*) 60 mi/h = _____ m/s.

32 • There are 640 acres in a square mile. How many square meters are there in one acre?

33 •• **CONTEXT-RICH** You are a delivery person for the Fresh Aqua Spring Water Company. Your truck carries 4 pallets. Each pallet carries 60 cases of water. Each case of water has 24 one-liter bottles. The dolly you use to carry the water into the stores has a weight limit of 250 lb. (*a*) If a milliliter of water has a mass of 1 g, and a kilogram has a weight of 2.2 lb, what is the weight, in pounds, of all the water in your truck? (*b*) How many full cases of water can you carry on the cart? SSM

34 •• A right circular cylinder has a diameter of 6.8 in. and a height of 2 ft. What is the volume of the cylinder in (*a*) cubic feet, (*b*) cubic meters, (*c*) liters?

35 •• In the following, x is in meters, t is in seconds, v is in meters per second, and the acceleration a is in meters per second squared. Find the SI units of each combination: (*a*) v^2/x, (*b*) $\sqrt{x/a}$, (*c*) $\frac{1}{2}at^2$. SSM

DIMENSIONS OF PHYSICAL QUANTITIES

36 • What are the dimensions of the constants in each part of Problem 23?

37 • The law of radioactive decay is $N(t) = N_0 e^{-\lambda t}$, where N_0 is the number of radioactive nuclei at $t = 0$, $N(t)$ is the number remaining at time t, and λ is a quantity known as the decay constant. What is the dimension of λ?

38 •• The SI unit of force, the kilogram-meter per second squared (kg · m/s^2) is called the newton (N). Find the dimensions and the SI units of the constant G in Newton's law of gravitation $F = Gm_1m_2/r^2$.

39 •• The magnitude of the force (F) that a spring exerts when it is stretched a distance x from its unstressed length is governed by Hooke's law, $F = kx$. (*a*) What are the dimensions of the *force constant*, k? (*b*) What are the dimensions and SI units of the quantity kx^2?

40 •• Show that the product of mass, acceleration, and speed has the dimensions of power.

41 •• The momentum of an object is the product of its velocity and mass. Show that momentum has the dimensions of force multiplied by time. SSM

42 •• What combination of force and one other physical quantity has the dimensions of power?

43 •• When an object falls through air, there is a drag force that depends on the product of the cross sectional area of the object and the square of its velocity, that is, $F_{air} = CAv^2$, where C is a constant. Determine the dimensions of C. SSM

44 •• Kepler's third law relates the period of a planet to its orbital radius r, the constant G in Newton's law of gravitation ($F = Gm_1m_2/r^2$), and the mass of the Sun M_s. What combination of these factors gives the correct dimensions for the period of a planet?

SCIENTIFIC NOTATION AND SIGNIFICANT FIGURES

45 • Express as a decimal number without using powers of 10 notation: (*a*) 3×10^4, (*b*) 6.2×10^{-3}, (*c*) 4×10^{-6}, (*d*) 2.17×10^5. SSM

46 • Write the following in scientific notation: (*a*) 1 345 100 m = _____ km, (*b*) 12 340. kW = _____ MW, (*c*) 54.32 ps = _____ s, (*d*) 3.0 m = _____ mm.

47 • Calculate the following, round off to the correct number of significant figures, and express your result in scientific notation: (*a*) $(1.14)(9.99 \times 10^4)$, (*b*) $(2.78 \times 10^{-8}) - (5.31 \times 10^{-9})$, (*c*) $12\pi/(4.56 \times 10^{-3})$, (*d*) $27.6 + (5.99 \times 10^2)$. SSM

48 • Calculate the following, round off to the correct number of significant figures, and express your result in scientific notation: (*a*) (200.9)(569.3), (*b*) $(0.000\,000\,513)(62.3 \times 10^7)$, (*c*) $28\,401 + (5.78 \times 10^4)$, (*d*) $63.25/(4.17 \times 10^{-3})$.

49 • BIOLOGICAL APPLICATION A cell membrane has a thickness of 7.0 nm. How many cell membranes would it take to make a stack 1.0 in. high? SSM

50 •• ENGINEERING APPLICATION A circular hole of radius 8.470×10^{-1} cm must be cut into the front panel of a display unit. The *tolerance* is 1.0×10^{-3} cm, which means the actual hole cannot differ by more than this quantity from the desired radius. If the actual hole is larger than the desired radius by the allowed tolerance, what is the difference between the actual area and the desired area of the hole?

51 •• ENGINEERING APPLICATION A square peg must be made to fit through a square hole. If you have a square peg that has an edge length of 42.9 mm, and the square hole has an edge length of 43.2 mm, (*a*) what is the area of the space available when the peg is in the hole? (*b*) If the peg is made rectangular by removing 0.10 mm of material from one side, what is the area available now? SSM

VECTORS AND THEIR PROPERTIES

52 • MULTISTEP A vector that is 7.0 units long and a vector that is 5.5 units long are added. Their sum is a vector 10.0 units long. (*a*) Show graphically at least one way that the vectors can be added. (*b*) Using your sketch in Part (*a*), determine the angle between the original two vectors.

53 • Determine the x and y components of the following three vectors in the xy plane. (*a*) A 10-m displacement vector that makes an angle of 30° clockwise from the $+y$ direction. (*b*) A 25-m/s velocity vector that makes an angle of 40° counterclockwise from the $-x$ direction. (*c*) A 40-lb force vector that makes an angle of 120° counterclockwise from the $-y$ direction. SSM

54 • Rewrite the following vectors in terms of their magnitude and angle (counterclockwise from the $+x$ direction). (*a*) A displacement vector with an x component of +8.5 m and a y component of −5.5 m (*b*) A velocity vector with an x component of −75 m/s and a y component of +35 m/s (*c*) A force vector with a magnitude of 50 lb that is in the third quadrant with an x component whose magnitude is 40 lb.

55 • CONCEPTUAL You walk 100 m in a straight line on a horizontal plane. If this walk took you 50 m east, what are your possible north or south movements? What are the possible angles that your walk made with respect to due east?

56 • ESTIMATION The final destination of your journey is 300 m due east of your starting point. The first leg of this journey is the walk described in Problem 55, and the second leg in also a walk along a single straight-line path. Estimate graphically the length and heading for the second leg of your journey.

57 •• Given the following vectors: $\vec{A} = 3.4\hat{i} + 4.7\hat{j}$, $\vec{B} = (-7.7)\hat{i} + 3.2\hat{j}$, and $\vec{C} = 5.4\hat{i} + (-9.1)\hat{j}$. (*a*) Find the vector $\vec{D}$, in unit vector notation, such that $\vec{D} + 2\vec{A} - 3\vec{C} + 4\vec{B} = 0$. (*b*) Express your answer in Part (*a*) in terms of magnitude and angle with the $+x$ direction.

58 •• Given the following force vectors: $\vec{A}$ is 25 lb at an angle of 30° clockwise from the $+x$ axis, and $\vec{B}$ is 42 lb at an angle of 50° clockwise from the $+y$ axis. (*a*) Make a sketch and visually estimate the magnitude and angle of the vector $\vec{C}$ such that $2\vec{A} + \vec{C} - \vec{B}$ results in a vector with a magnitude of 35 lb pointing in the $+x$ direction. (*b*) Repeat the calculation in Part (*a*) using the method of components and compare your result to the estimate in (*a*).

59 •• Calculate the unit vector (in terms of $\hat{i}$, and $\hat{j}$) in the direction opposite to the direction of each of vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ in Problem 57. SSM

60 •• Unit vectors $\hat{i}$ and $\hat{j}$ are directed east and north, respectively. Calculate the unit vector (in terms of $\hat{i}$ and $\hat{j}$) in the following directions. (*a*) northeast, (*b*) 70° clockwise from the $-y$ axis, (*c*) southwest.

GENERAL PROBLEMS

61 • The Apollo trips to the moon in the 1960s and 1970s typically took 3 days to travel the Earth–moon distance once they left Earth orbit. Estimate the spacecraft's average speed in kilometers per hour, miles per hour, and meters per second. SSM

62 • On many of the roads in Canada the speed limit is 100 km/h. What is this speed limit in miles per hour?

63 • If you could count $1.00 per second, how many years would it take to count 1.00 billion dollars?

64 • (*a*) The speed of light in vacuum is 186 000 mi/s = 3.00×10^8 m/s. Use this fact to find the number of kilometers in a mile. (*b*) The weight of 1.00 ft^3 of water is 62.4 lb, and 1.00 ft = 30.5 cm. Use this information and the fact that 1.00 cm^3 of water has a mass of 1.00 g to find the weight in pounds of a 1.00-kg mass.

65 • The mass of one uranium atom is 4.0×10^{-26} kg. How many uranium atoms are there in 8.0 g of pure uranium?

66 •• During a thunderstorm, a total of 1.4 in. of rain falls. How much water falls on one acre of land? (1 mi^2 = 640 acres.) Express your answer in (*a*) cubic inches, (*b*) cubic feet, (*c*) cubic meters, and (*d*) kilograms. Note that the density of water is 1000 kg/m^3.