Rounding During Division

In some division problems this process of dividing will never result in a zero remainder. At some point the answer must be rounded.

To round answers in a division problem, first continue the division so that your answer has one place more than the rounded answer will have, then round it. For example, in the division problem

$4.7 \div 1.8 = ?$

to get an answer rounded to one decimal place, first, divide to two decimal places:

$4.7 \div 1.8 = 2.61\ldots$

then round back to one decimal place:

$4.7 \div 1.8 = 2.6$ rounded

YOUR TURN

For the following problem, divide and round your answer to two decimal places.

$6.84 \div 32.7 =$ _____

Careful now.

SOLUTION

$32.7\overline{)6.8.4}$

$$
\begin{array}{rl}
.209 & \text{Carry the answer to three decimal places.} \\
327.\overline{)68.400} & \text{Notice that two zeros must be attached to the dividend.} \\
\underline{65\ 4}\downarrow\downarrow & 2 \times 327 = 654 \\
3\ 000 & \\
\underline{2\ 943} & 9 \times 327 = 2943
\end{array}
$$

0.209 rounded to two decimal places is 0.21.

$6.84 \div 32.7 = 0.21$ rounded to two decimal places

$32.7 \times 0.21 = 6.867$, which is approximately equal to 6.84. (The check will not be exact because we have rounded.)

The ability to round numbers is especially important for people who work in the practical, trade, or technical areas. You will need to round answers to practical problems if they are obtained "by hand" or with a calculator. Rounding is discussed in more detail in Chapter 5.

Averages

Suppose that you needed to know the diameter of a steel connecting pin. As a careful and conscientious worker, you would probably measure its diameter several times with a micrometer, and you might come up with a sequence of numbers like this (in inches):

1.3731, 1.3728, 1.3736, 1.3749, 1.3724, 1.3750

What is the actual diameter of the pin? The best answer is to find the **average** value or **arithmetic mean** of these measurements.

$$\text{Average} = \frac{\text{sum of the measurements}}{\text{number of measurements}}$$

For the preceding problem,

$$\text{Average} = \frac{1.3731 + 1.3728 + 1.3736 + 1.3749 + 1.3724 + 1.3750}{6}$$

$$= \frac{8.2418}{6} = 1.3736333\ldots$$

$$= 1.3736 \quad \text{rounded to four decimal places}$$

When you calculate the average of a set of numbers, the usual rule is to round the answer to the same number of decimal places as the least precise number in the set—that is, the one with the fewest decimal digits. If the numbers to be averaged are all whole numbers, the average will be a whole number.

EXAMPLE

The average of 4, 6, 4, and 5 is $\frac{19}{4} = 4.75$ or 5 when rounded.

If one number of the set has fewer decimal places than the rest, round off to agree with the least precise number.

EXAMPLE

The average of 2.41, 3.32, 5.23, 3.51, 4.1, and 4.12 is

$\frac{22.69}{6} = 3.78166\ldots$ and this answer should be rounded to 3.8 to agree in precision with the least precise number, 4.1. (We will learn more about precision in Chapter 5.)

To avoid confusion, we will usually give directions for rounding.

YOUR TURN

Try it. Find the average for each of these sets of numbers.

(a) 8, 9, 11, 7, 5

(b) 0.4, 0.5, 0.63, 0.2

(c) 2.35, 2.26, 2.74, 2.55, 2.6, 2.31

SOLUTIONS

(a) $\text{Average} = \frac{8 + 9 + 11 + 7 + 5}{5} = \frac{40}{5} = 8$

(b) $\text{Average} = \frac{0.4 + 0.5 + 0.63 + 0.2}{4} = \frac{1.73}{4} = 0.4324 \approx 0.4$ rounded

(c) $\text{Average} = \frac{2.35 + 2.26 + 2.74 + 2.55 + 2.6 + 2.31}{6}$

$= \frac{14.81}{6} = 2.468333\ldots$

≈ 2.5 rounded to agree in precision with 2.6, the least precise number in the set. (The symbol $\approx$ means "approximately equal to.")

Now turn to Exercises 3-2 for a set of problems on the multiplication and division of decimal numbers.

Exercises 3-2

Multiplication and Division of Decimals

A. Multiply or divide as shown.

1. 0.01×0.001	2. 10×2.15	3. 0.04×100
4. 0.3×0.3	5. 0.7×1.2	6. 0.005×0.012
7. 0.003×0.01	8. 7.25×0.301	9. 2×0.035
10. $0.2 \times 0.3 \times 0.5$	11. $0.6 \times 0.6 \times 6.0$	12. $2.3 \times 1.5 \times 1.05$
13. $3.618 \div 0.6$	14. $3.60 \div 0.03$	15. $4.40 \div 0.22$
16. $6.5 \div 0.05$	17. $0.0405 \div 0.9$	18. $0.378 \div 0.003$
19. $3 \div 0.05$	20. $10 \div 0.001$	21. $4 \div 0.01$
22. $2.59 \div 70$	23. $44.22 \div 6.7$	24. $104.2 \div 0.0320$
25. $484 \div 0.8$	26. 6.05×2.3	27. 0.0027×1.4
28. $0.0783 \div 0.27$	29. $0.00456 \div 0.095$	30. $800 \div 0.25$
31. $324 \div 0.0072$	32. $0.08322 \div 228$	33. $0.0092 \div 115$
34. 0.047×0.024	35. 0.0056×0.065	36. $0.02 \times 0.06 \times 0.04$
37. $0.008 \times 0.4 \times 0.03$	38. 123.4×0.45	39. 0.062×27.5

B. Round the following numbers as indicated.

1. 42.875 (Two decimal places)	2. 0.5728 (Nearest tenth)
3. 6.54 (One decimal place)	4. 117.6252 (Three decimal places)
5. 79.135 (Nearest hundredth)	6. 1462.87 (Nearest whole number)
7. 3.64937 (Four decimal places)	8. 19.4839 (Nearest hundredth)
9. 0.2164 (Nearest thousandth)	10. 56.826 (Two decimal places)

C. Divide and round as indicated.

Round to two decimal digits.

1. $10 \div 3$	2. $5 \div 6$	3. $2.0 \div 0.19$
4. $3 \div 0.081$	5. $0.023 \div 0.19$	6. $12.3 \div 4.7$
7. $2.37 \div 0.07$	8. $6.5 \div 1.31$	

Round to the nearest tenth.

9. $100 \div 3$	10. $21.23 \div 98.7$	11. $1 \div 4$
12. $100 \div 9$	13. $0.006 \div 0.04$	14. $1.008 \div 3$

Round to three decimal places.

15. $10 \div 70$	16. $0.09 \div 0.402$	17. $0.091 \div 0.0014$
18. $3.41 \div 0.257$	19. $6.001 \div 2.001$	20. $123.21 \div 0.1111$

D. Word Problems

1. **Painting and Decorating** A spray painting outfit is advertised for \$579. It can also be bought "on time" for 24 payments of \$28.50 each. How much extra do you pay by purchasing it on the installment plan?
2. If the telephone rates between Zanzibar and Timbuctou are \$3.10 for the first minute and \$1.25 for each additional minute, what will be the cost of an 11-minute telephone call?

3. **Metalworking** Find the average weight of five castings that weigh 17.0, 21.0, 12.0, 20.6, and 23.4 lb.

4. **Office Services** If you work $8\frac{1}{4}$ hours on Monday, 10.1 hours on Tuesday, 8.5 hours on Wednesday, 9.4 hours on Thursday, $6\frac{1}{2}$ hours on Friday, and 4.2 hours on Saturday, what is the average number of hours worked per day?

5. **Machine Technology** For the following four machine parts, find *W*, the number of pounds per part; *C*, the cost of the metal per part; and *T*, the total cost.

Metal Parts	Number of Inches Needed	Number of Pounds per Inch	Cost per Pound	Pounds (*W*)	Cost per Part (*C*)
A	44.5	0.38	\$0.98		
B	122.0	0.19	\$0.89		
C	108.0	0.08	\$1.05		
D	9.5	0.32	\$2.15		

6. **Machine Technology** How much does 15.7 sq ft of No. 16 gauge steel weigh if 1 sq ft weighs 2.55 lb?

7. **Building Construction** A 4-ft by 8-ft sheet of $\frac{1}{4}$-in. plywood has an area of 32 sq ft. If the weight of $\frac{1}{4}$-in. plywood is 1.5 lb/sq ft (pounds per square foot), what is the weight of the sheet?

8. **Manufacturing** Each inch of 1-in.-diameter cold-rolled steel weighs 0.22 lb. How much would a piece weigh that was 38 in. long?

9. **Welding** A truck can carry a load of 5000 lb. Assuming that it could be cut to fit, how many feet of steel beam weighing 32.6 lb/ft (pounds per foot) can the truck carry?

10. **Fire Protection** One gallon of water weighs 8.34 lb. How much weight is added to a fire truck when its tank is filled with 750 gallons of water?

11. **Electrician** Voltage values are often stated in millivolts [1 millivolt (mV) equals 0.001 volt] and must be converted to volts to be used in Ohm's law. If a voltage is given to be 75 mV, how many volts is this?

12. **Industrial Technology** An industrial engineer must estimate the cost of building a storage tank. The tank requires 208 sq ft of material at \$7.29 per square foot. It also requires 4.5 hours of labor at \$26.40 per hour plus 1.6 hours of labor at \$19.60 per hour. Find the total cost of the tank.

13. **Sheet Metal Technology** How many sheets of metal are in a stack 5.00 in. high if each sheet is 0.0149 in. thick?

14. **Metalworking** A casting weighs 3.68 lb. How many castings are contained in a load weighing 5888.00 lb?

15. A barrel partially filled with liquid fertilizer weighs 267.75 lb. The empty barrel weighs 18.00 lb, and the fertilizer weighs 9.25 lb per gallon. How many gallons of fertilizer are in the barrel?

16. **Construction** A four-foot width of $\frac{1}{4}$-inch gypsum costs \$5.23. Using this material, how much would it cost to drywall a room with 52 ft of total wall width?

17. **Construction** A room addition requires 320 sq ft of wood floor. Hardwood costs \$4.59 per sq ft, while laminate costs \$2.79 per sq ft. What is the total difference in cost between the two types of flooring?

18. **Electronics** The Happy Hacker electronics warehouse purchases 660 stereo adaptors, which are then packed in sets of three selling for \$3.95 per set. Calculate the total income from the sale of these adaptors.

19. **Electronics** An oscillator is a device that generates an ac signal at some specified frequency. If the oscillator's output frequency is 7500 cycles per second (hertz), how many cycles does it generate in a 0.35-sec interval?

E. Calculator Problems

1. Divide. $9.87654321 \div 1.23456789$.

   Notice anything interesting? (Divide it out to eight decimal digits.) You should be able to get the correct answer even if your calculator will not accept a nine-digit number.

2. Divide. (a) $\frac{1}{81}$ (b) $\frac{1}{891}$ (c) $\frac{1}{8991}$

   Notice a pattern? (Divide them out to about eight decimal places.)

3. **Metalworking** The outside diameter of a steel casting is measured six times at different positions with a digital caliper. The measurements are 4.2435, 4.2426, 4.2441, 4.2436, 4.2438, and 4.2432 in. Find the average diameter of the casting.

4. **Printing** To determine the thickness of a sheet of paper, five batches of 12 sheets each are measured with a digital micrometer. The thickness of each of the five batches of 12 is 0.7907, 0.7914, 0.7919, 0.7912, and 0.7917 mm. Find the average thickness of a single sheet of paper.

5. **Building Construction** The John Hancock Towers office building in Boston had a serious problem when it was built: When the wind blew hard, the pressure caused its windows to pop out! The only reasonable solution was to replace all 10,344 windows in the building at a cost of \$6,000,000. What was the replacement cost per window? Round to the nearest dollar.

6. **Food Services** In purchasing food for his chain of burger shops, José pays \$3.85 per pound for cheese to be used in cheeseburgers. He calculates that an order of 5180 lb will be enough for 165,000 cheeseburgers.

   (a) How much cheese will he use on each cheeseburger? (Round to three decimal places.)

   (b) What is the cost, to the nearest cent, of the cheese used on a cheeseburger?

7. **Plumbing** The pressure in psi (pounds per square inch) in a water system at a point 140.8 ft below the water level in a storage tank is given by the formula

$$P = \frac{62.4 \text{ lb per cu ft} \times 140.8 \text{ ft} \times 0.43}{144 \text{ sq in. per sq ft}}$$

   Find P to the nearest tenth.

8. **Office Services** A carpet cleaner charges \$48 for two rooms and \$98 for five rooms. Suppose a two-room job contained 350 sq ft and a five-room job

contained 850 sq ft. Calculate the difference in cost per square foot between these two jobs. (Round to the nearest tenth of a cent.)

9. **Electronics** Radar operates by broadcasting a high-frequency radio wave pulse that is reflected from a target object. The reflected signal is detected at the original source. The distance of the object from the source can be determined by multiplying the speed of the pulse by the elapsed time for the round trip of the pulse. A radar signal traveling at 186,000 miles per second is reflected from an object. The signal has an elapsed round trip time of 0.0001255 sec. Calculate the distance of the object from the radar antenna.

10. **Plumbing** Normal air pressure at sea level is about 14.7 psi. Additional pressure exerted by a depth of water is given by the formula

    Pressure in psi $\approx 0.434 \times$ depth of water in ft

    Calculate the total pressure on the bottom of a diving pool filled with water to a depth of 12 ft.

When you have finished these exercises, check your answers in the Appendix, then continue in Section 3-3.

3-3 DECIMAL FRACTIONS

Since decimal numbers are fractions, they may be used, as fractions are used, to represent a part of some quantity. For example, recall that

"$\frac{1}{2}$ of 8 equals 4" means $\frac{1}{2} \times 8 = 4$

and therefore,

"0.5 of 8 equals 4" means $0.5 \times 8 = 4$

The word *of* used in this way indicates multiplication, and decimal numbers are often called "decimal fractions."

It is very useful to be able to convert any number from fraction form to decimal form. Simply divide the top by the bottom of the fraction. If the division has no remainder, the decimal number is called a *terminating* decimal.

EXAMPLE

$\frac{5}{8} = \underline{\quad ? \quad}$

$$\begin{array}{r} .625 \\ 8\overline{)5.000} \\ 4\,8 \\ \hline 20 \\ 16 \\ \hline 40 \\ 40 \\ \hline 0 \end{array}$$

← Attach as many zeros as needed.

← Zero remainder; therefore, the decimal terminates or ends.

$\frac{5}{8} = 0.625$

If the decimal does not terminate, you may round it to any desired number of decimal digits.

EXAMPLE

$\frac{2}{13} = \frac{?}{}$

$$
\begin{array}{r}
.1538 \\
13\overline{)2.0000} \leftarrow \text{Attach zeros.} \\
\underline{13} \\
70 \\
\underline{65} \\
50 \\
\underline{39} \\
110 \\
\underline{104} \\
6 \leftarrow \text{Remainder is not equal to zero.}
\end{array}
$$

$\frac{2}{13} = 0.154$ rounded to three decimal places

YOUR TURN

Convert the following fractions to decimal form and round if necessary to two decimal places.

(a) $\frac{4}{5}$ (b) $\frac{2}{3}$ (c) $\frac{17}{7}$ (d) $\frac{5}{6}$ (e) $\frac{7}{16}$ (f) $\frac{5}{9}$

SOLUTIONS

(a) $\frac{4}{5} = \frac{?}{}$

$$
\begin{array}{r}
.8 \\
5\overline{)4.0}
\end{array}
$$

$\frac{4}{5} = 0.8$

(b) $\frac{2}{3} = \frac{?}{}$

$$
\begin{array}{r}
.666\ldots \\
3\overline{)2.000} \\
\underline{18} \\
20 \\
\underline{18} \\
20 \\
\underline{18} \\
2
\end{array}
$$

$\frac{2}{3} = 0.67$ rounded to two decimal places

Notice that in order to round to *two* decimal places, we must carry the division out to at least *three* decimal digits.

(c) $\frac{17}{7} = \frac{?}{}$

$$
\begin{array}{r}
2.428 \\
7\overline{)17.000} \\
\underline{14} \\
30 \\
\underline{28} \\
20 \\
\underline{14} \\
60 \\
\underline{56} \\
4
\end{array}
$$

$\frac{17}{7} = 2.43$ rounded to two decimal digits

(d) $\frac{5}{6} = \underline{\quad ? \quad}$

$$
\begin{array}{r}
.833\ldots \\
6\overline{)5.000} \\
\underline{48} \\
20 \\
\underline{18} \\
20 \\
\underline{18} \\
2
\end{array}
$$

$\frac{5}{6} = 0.83$ rounded to two decimal places

(e) $\frac{7}{16} = \underline{\quad ? \quad}$

$$
\begin{array}{r}
.4375 \\
16\overline{)7.0000} \\
\underline{64} \\
60 \\
\underline{48} \\
120 \\
\underline{112} \\
80 \\
\underline{80} \\
0
\end{array}
$$

$\frac{7}{16} = 0.4375$ or 0.44 rounded to two decimal digits

(f) $\frac{5}{9} = \underline{\quad ? \quad}$

$$
\begin{array}{r}
.55 \\
9\overline{)5.00} \\
\underline{45} \\
50 \\
\underline{45} \\
5
\end{array}
$$

$\frac{5}{9} = 0.555\ldots$ or 0.56 rounded

Repeating Decimals Decimal numbers that do not terminate will repeat a sequence of digits. This type of decimal number is called a *repeating* decimal. For example,

$$\frac{1}{3} = 0.3333\ldots$$

where the three dots are read "and so on," and they tell us that the digit 3 continues without end.

Similarly, $\frac{2}{3} = 0.6666\ldots$ and $\frac{3}{11}$ is

$$
\begin{array}{r}
.2727 \\
11\overline{)3.0000} \\
\underline{22} \\
80 \\
\underline{77} \\
30 \\
\underline{22} \\
80 \\
\underline{77} \\
3
\end{array}
$$

← The remainder 3 is equal to the original dividend. This tells us that the decimal quotient repeats itself.

$$\frac{3}{11} = 0.272727\ldots$$

If you did the division in problem (c) with a calculator, you may have noticed that

$\frac{17}{7} = 2.\overbrace{428571}\overbrace{428571}\ldots$ The digits 428571 repeat endlessly.

Mathematicians often use a shorthand notation to show that a decimal repeats.

Write $\frac{1}{3} = 0.\overline{3}$ or $\frac{2}{3} = 0.\overline{6}$

where the bar means that the digits under the bar repeat endlessly.

$\frac{3}{11} = 0.\overline{27}$ means $0.272727\ldots$ and $\frac{17}{7} = 2.\overline{428571}$

YOUR TURN

Write $\frac{41}{33}$ as a repeating decimal using the "bar" notation.

SOLUTION

$$\begin{array}{r} 1.24 \\ 33\overline{)41.00} \\ \underline{33} \\ 80 \\ \underline{66} \\ 140 \\ \underline{132} \\ 8 \end{array}$$

These remainders are the same, so we know that further division will produce a repeat of the digits 24 in the answer.

$\frac{41}{33} = 1.242424\ldots = 1.\overline{24}$

Terminating Decimals

Some fractions are used so often in practical work that it is important for you to know their decimal equivalents as shown on p. 132.

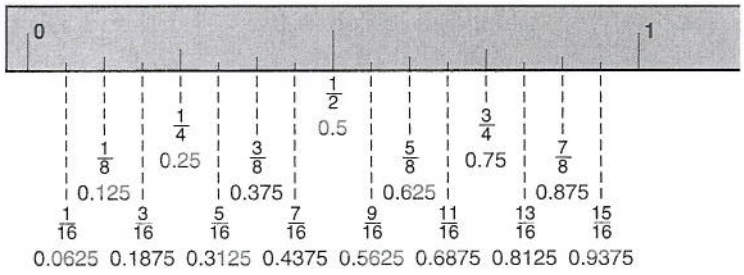
PROBLEMS

Quick now, without looking at the table, fill in the blanks in the problems shown.

$\frac{1}{2} =$ _____	$\frac{3}{4} =$ _____	$\frac{3}{8} =$ _____	$\frac{7}{8} =$ _____
$\frac{1}{4} =$ _____	$\frac{5}{8} =$ _____	$\frac{3}{16} =$ _____	$\frac{7}{16} =$ _____
$\frac{1}{8} =$ _____	$\frac{5}{16} =$ _____	$\frac{9}{16} =$ _____	$\frac{13}{16} =$ _____
$\frac{1}{16} =$ _____	$\frac{11}{16} =$ _____	$\frac{15}{16} =$ _____	

Check your work against the table when you are finished, then turn to p. 133 and continue.

DECIMAL–FRACTION EQUIVALENTS



1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1.	1.

PROBLEMS

Convert each of the following fractions into decimal form.

(a) $\frac{95}{100}$ (b) $\frac{1}{20}$ (c) $\frac{7}{10}$ (d) $\frac{4}{1000}$ (e) $\frac{11}{1000}$

(f) $\frac{327}{10000}$ (g) $\frac{473}{1000}$ (h) $\frac{3}{50}$ (i) $\frac{1}{25}$

(j) $\frac{27}{64}$ in. (to the nearest thousandth of an inch)

ANSWERS

(a) 0.95 (b) 0.05 (c) 0.7 (d) 0.004 (e) 0.011

(f) 0.0327 (g) 0.473 (h) 0.06 (i) 0.04 (j) 0.422 in.

You will do many of these calculations more quickly if you remember that dividing by a multiple of ten is equivalent to shifting the decimal point to the left. To divide by a multiple of ten, move the decimal point to the left as many digits as there are zeros in the multiple of ten. For example,

$\underbrace{\frac{95}{100}}_{\text{Two zeros}} = \underbrace{0.95}_{\text{Move the decimal point two digits to the left}}$

and

$\underbrace{\frac{11}{1000}}_{\text{3 zeros}} = \underbrace{0.011}_{\text{Move the decimal point three digits to the left}}$

HOW TO WRITE A REPEATING DECIMAL AS A FRACTION

A repeating decimal is one in which some sequence of digits is endlessly repeated. For example, $0.333\ldots = 0.\overline{3}$ and $0.272727\ldots = 0.\overline{27}$ are repeating decimals. The bar over the number is a shorthand way of showing that those digits are repeated.

What fraction is equal to $0.\overline{3}$? To answer this, form a fraction with numerator equal to the repeating digits and denominator equal to a number formed with the same number of 9s.

$0.\overline{3} = \frac{3}{9} = \frac{1}{3}$

$0.\overline{27} = \frac{27}{99} = \frac{3}{11}$ Two digits in $0.\overline{27}$; therefore, use 99 as the denominator.

$0.\overline{123} = \frac{123}{999} = \frac{41}{333}$ Three digits in $0.\overline{123}$; therefore, use 999 as the denominator.

This procedure works only when *all* of the decimal part repeats.

Now turn to Exercises 3-3 for a set of problems on decimal fractions.

Exercises 3-3

Decimal Fractions

A. Write as decimal numbers. (Round to two decimal digits if necessary.)

1. $\frac{1}{4}$	2. $\frac{2}{3}$	3. $\frac{3}{4}$	4. $\frac{2}{5}$
5. $\frac{4}{5}$	6. $\frac{5}{6}$	7. $\frac{2}{7}$	8. $\frac{4}{7}$
9. $\frac{6}{7}$	10. $\frac{3}{8}$	11. $\frac{6}{8}$	12. $\frac{1}{10}$
13. $\frac{3}{10}$	14. $\frac{2}{12}$	15. $\frac{5}{12}$	16. $\frac{3}{16}$
17. $\frac{6}{16}$	18. $\frac{9}{16}$	19. $\frac{13}{16}$	20. $\frac{3}{20}$
21. $\frac{7}{32}$	22. $\frac{13}{20}$	23. $\frac{11}{24}$	24. $\frac{39}{64}$
25. $\frac{3}{100}$	26. $\frac{213}{1000}$	27. $\frac{19}{1000}$	28. $\frac{17}{50}$

B. Calculate in decimal form. (Round to agree with the number of decimal digits in the decimal number.)

1. $2\frac{3}{5} + 1.785$	2. $\frac{1}{5} + 1.57$	3. $3\frac{7}{8} - 2.4$
4. $1\frac{3}{16} - 0.4194$	5. $2\frac{1}{2} \times 3.15$	6. $1\frac{3}{25} \times 2.08$
7. $3\frac{4}{5} \div 2.65$	8. $3.72 \div 1\frac{1}{4}$	9. $2.76 + \frac{7}{8}$
10. $16\frac{3}{4} - 5.842$	11. $3.14 \times 2\frac{7}{16}$	12. $1.17 \div 1\frac{3}{32}$

C. Practical Problems

1. **Pharmacy** If one tablet of calcium pantothenate contains 0.5 gram, how much is contained in $2\frac{3}{4}$ tablets? How many tablets are needed to make up 2.6 grams?

2. **Building Construction** Estimates of matched or tongue-and-groove (T & G) flooring—stock that has a tongue on one edge—must allow for the waste from milling. To allow for this waste, $\frac{1}{4}$ of the area to be covered must be added to the estimate when 1-in. by 4-in. flooring is used. If 1-in. by 6-in. flooring is used, $\frac{1}{6}$ of the area must be added to the estimate. (*Hint:* The floor is a rectangle. Area of a rectangle = length × width.)

   (a) A house has a floor size 28 ft long by 12 ft wide. How many square feet of 1-in. by 4-in. T & G flooring will be required to lay the floor?

   (b) A motel contains 12 units or rooms, and each room is 22 ft by 27 ft or 594 sq ft. In five rooms the builder is going to use 4-in. stock and in the other seven rooms 6-in. stock—both being T & G. How many square feet of each size will be used?

   (c) A contractor is building a motel with 24 rooms. Eight rooms will be 16 ft by 23 ft, nine rooms 18 ft by 26 ft, and the rest of the rooms 14 ft by 20 ft. How much did she pay for flooring, using 1-in. by 4-in. T & G at $3450 per 1000 sq ft?

3. **Carpentry** If a carpenter lays $10\frac{1}{2}$ squares of shingles in $4\frac{1}{2}$ days, how many squares does he do in one day?

4. **Machine Technology** A bearing journal measures 1.996 in. If the standard readings are in $\frac{1}{32}$-in. units, what is its probable standard size as a fraction?

5. **Upholstering** Complete the following invoice for upholstery fabric.

   (a) $5\frac{1}{4}$ yd @ \$12.37 per yd = _____

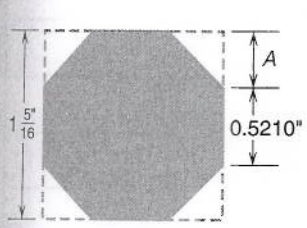
   (b) $23\frac{3}{4}$ yd @ \$16.25 per yd = _____

   (c) $31\frac{5}{6}$ yd @ \$9.95 per yd = _____

   (d) $16\frac{2}{3}$ yd @ \$17.75 per yd = _____

   Total _____

6. **Building Construction** A land developer purchased a piece of land containing 437.49 acres. He plans to divide it into a 45-acre recreational area and lots of $\frac{3}{4}$ acre each. How many lots will he be able to form from this piece of land?



Problem 7

7. **Machine Technology** Find the corner measurement A needed to make an octagonal end on a square bar as shown in the diagram.

8. **Auto Mechanics** A cylinder is normally $3\frac{7}{16}$ in. in diameter. It is rebored 0.040 in. larger. What is the size of the rebored cylinder? (Give your answer in decimal form.)

9. Plumbers deal with measurements in inches and common fractions of an inch, while surveyors use feet and decimal fractions of a foot. Often one trade needs to interpret the measurements of the other.

   (a) **Surveying** A drain has a run of 52 ft at a grade of $\frac{1}{8}$ in./ft. The high end of the drain has an elevation of 126.70 ft. What is the elevation at the low end?

   (b) **Plumbing** The elevation at one end of a lot is 84.25 ft, and the elevation at the other end is 71.70 ft. Express the difference in elevation in feet and inches and round to the nearest $\frac{1}{8}$ in.

10. **Plumbing** To fit a 45° connection, a plumber can approximate the diagonal length by multiplying the offset length by 1.414. Find the diagonal length of a 45° fitting if the offset length is $13\frac{11}{16}$ in. Express the answer as a fraction to the nearest $\frac{1}{16}$ in.

D. Calculator Problems

1. **Sheet Metal Technology** In the table on page 136 the first column lists the U.S. Standard sheet metal gauge number. These tables were at one time used to give the equivalent sheet metal thickness in fractions of an inch, as shown in the second column. Today, these thicknesses are listed as decimal numbers. Complete column three to reflect this change. Round to the nearest thousandth of an inch.

2. **Building Construction** Calculate the total cost of the following building materials.

8024 sq ft of flooring	@ \$3248.75 per 1000 sq ft	_____
1825 ft of 16-ft siding	@ \$1125.50 per 100 ft	_____
24,390 bricks	@ \$328 per 1000	_____
19,200 sq ft of shingles	@ \$42.95 per 100 sq ft	_____
	Total	_____

3. **Office Services** Machine helpers at the CALMAC Tool Co. earn $10.72 per hour. The company pays time and one-half for hours over 40 per week. Sunday hours are paid at double time. How much would you earn if you worked the following hours: Monday, 9; Tuesday, 8; Wednesday, $9\frac{3}{4}$; Thursday, 8; Friday, $10\frac{1}{2}$; Saturday, $5\frac{1}{4}$; Sunday, $4\frac{3}{4}$?

When you have finished these exercises, check your answers in the Appendix, and then turn to Problem Set 3 for practice working with decimal numbers.

Gauge No.	Fraction Thickness (in.)	Decimal Thickness (in.)	Gauge No.	Fraction Thickness (in.)	Decimal Thickness (in.)
7-0	$\frac{1}{2}$		14	$\frac{5}{64}$	
6-0	$\frac{15}{32}$		15	$\frac{9}{128}$	
5-0	$\frac{7}{16}$		16	$\frac{1}{16}$	
4-0	$\frac{13}{32}$		17	$\frac{9}{160}$	
3-0	$\frac{3}{8}$		18	$\frac{1}{20}$	
2-0	$\frac{11}{32}$		19	$\frac{7}{160}$	
0	$\frac{5}{16}$		20	$\frac{3}{80}$	
1	$\frac{9}{32}$		21	$\frac{11}{320}$	
2	$\frac{17}{64}$		22	$\frac{1}{32}$	
3	$\frac{1}{4}$		23	$\frac{9}{320}$	
4	$\frac{15}{64}$		24	$\frac{1}{40}$	
5	$\frac{7}{32}$		25	$\frac{7}{320}$	
6	$\frac{13}{64}$		26	$\frac{3}{160}$	
7	$\frac{3}{16}$		27	$\frac{11}{640}$	
8	$\frac{11}{64}$		28	$\frac{1}{64}$	
9	$\frac{5}{32}$		29	$\frac{9}{640}$	
10	$\frac{9}{64}$		30	$\frac{1}{80}$	
11	$\frac{1}{8}$		31	$\frac{7}{640}$	
12	$\frac{7}{64}$		32	$\frac{13}{1280}$	
13	$\frac{3}{32}$		—	—	—

PROBLEM SET 3

Decimal Numbers

Answers are in the Appendix.

A. Write in words.

1. 0.91
2. 0.84
3. 23.164
4. 63.219
5. 9.3
6. 3.45
7. 10.06
8. 15.037

Write as decimal numbers.

9. Seven hundredths
10. Eighteen thousandths
11. Two hundred and eight tenths
12. Sixteen and seventeen hundredths
13. Sixty-three and sixty-three thousandths
14. One hundred ten and twenty-one thousandths
15. Five and sixty-three ten-thousandths
16. Eleven and two hundred eighteen ten-thousandths

B. Add or subtract as shown.

1. $4.39 + 18.8$
2. $18.8 + 156.16$
3. $\$7.52 + \$11.77$
4. $26 + 0.06$
5. $3.68 - 1.74$
6. $\$12.46 - \$8.51$
7. $104.06 - 15.80$
8. $16 - 3.45$
9. $264.3 + 12.804$
10. $0.232 + 5.079$
11. $165.4 + 73.61$
12. $245.94 + 7.07$
13. $116.7 - 32.82$
14. $4.07 - 0.085$
15. $0.42 + 1.452 + 31.8$
16. $\frac{1}{2} + 4.21$
17. $3\frac{1}{5} + 1.08$
18. $1\frac{1}{4} - 0.91$
19. $3.045 - 1\frac{1}{8}$
20. $8.1 + 0.47 - 1\frac{4}{5}$

Name

Date

Course/Section

C. Calculate as shown.

1. 0.004×0.02
2. 0.06×0.05
3. 1.4×0.6
4. 3.14×12
5. $0.2 \times 0.6 \times 0.9$
6. 5.3×0.4
7. 6.02×3.3
8. $3.224 \div 2.6$
9. $187.568 \div 3.04$
10. $0.078 \div 0.3$
11. $0.6 \times 3.15 \times 2.04$
12. $3.78 + 4.1 \times 6.05$
13. $0.008 - 0.001 \div 0.5$
14. $3.1 \times 4.6 - 2.7 \div 0.3$
15. $\dfrac{4.2 + 4.6 \times 1.2}{2.73 \div 21 + 0.41}$
16. $\dfrac{7.2 - 3.25 \div 1.3}{3.5 + 5.7 \times 4.0 - 2.8}$
17. $1.2 + 0.7 \times 2.2 + 1.6$
18. $1.2 \times 0.7 + 2.2 \times 1.6$

Round to two decimal digits.

19. $0.007 \div 0.03$
20. $3.005 \div 2.01$
21. $17.8 \div 6.4$
22. $0.0041 \div 0.019$
23. 0.0371
24. 16.8449

Round to three decimal places.

25. $0.04 \div 0.076$
26. $234.1 \div 465.8$
27. $17.6 \div 0.082$
28. $0.051 \div 1.83$
29. 27.0072
30. 1.1818

Round to the nearest tenth.

31. $0.08 \div 0.053$
32. $3.05 \div 0.13$
33. $18.76 \div 4.05$
34. $0.91 \div 0.97$
35. 47.233
36. 123.7666

D. Write as a decimal number.

1. $\frac{1}{16}$
2. $\frac{7}{8}$
3. $\frac{5}{32}$
4. $\frac{7}{16}$
5. $\frac{11}{8}$
6. $1\frac{3}{4}$
7. $2\frac{11}{20}$
8. $1\frac{1}{6}$
9. $2\frac{2}{3}$
10. $1\frac{1}{32}$
11. $2\frac{5}{16}$

Write in decimal form, calculate, round to two decimal digits.

12. $4.82 \div \frac{1}{4}$
13. $11.5 \div \frac{3}{8}$
14. $1\frac{3}{16} \div 0.62$
15. $2\frac{3}{4} \div 0.035$
16. $0.45 \times 2\frac{1}{8}$
17. $0.068 \times 1\frac{7}{8}$

E. Practical Problems

1. **Machine Technology** A $\frac{5}{16}$-in. bolt weighs 0.43 lb. How many bolts are there in a 125-lb keg?

2. **Metalworking** Twelve equally spaced holes are to be drilled in a metal strip $34\frac{1}{4}$-in. long, with 2 in. remaining on each end. What is the distance, to the nearest hundredth of an inch, from center to center of two consecutive holes?

3. **Plumbing** A plumber finds the length of pipe needed to complete a bend by performing the following multiplication:

   Length needed = 0.01745 × (radius of the bend) × (angle of bend)

   What length of pipe is needed to complete a 35° bend with a radius of 16 in.?

4. **Printing** During the first six months of the year the Busy Bee Printing Co. spent the following amounts on paper:

January	$870.16	February	$590.12	March	$376.77
April	$400.09	May	$906.45	June	$389.21

   What is the average monthly expenditure for paper?

5. **Machine Technology** The *feed* of a drill is the distance it advances with each revolution. If a drill makes 310 rpm and drills a hole 2.125 in. deep in 3.25 minutes, what is the feed? Round to four decimal places.

$$\left(\textit{Hint: } \text{Feed} = \frac{\text{total depth}}{(\text{rpm}) \times (\text{time of drilling in minutes})}.\right)$$

6. **Electrical Technology** The resistance of an armature while it is cold is 0.208 ohm. After running for several minutes, the resistance increases to 1.340 ohms. Find the increase in resistance of the armature.

7. **Painting and Decorating** The Ace Place Paint Co. sells paint in steel drums each weighing 36.4 lb empty. If 1 gallon of paint weighs 9.06 lb, what is the total weight of a 50-gallon drum of paint?

8. **Electrical Technology** The diameter of No. 12 bare copper wire is 0.08081 in., and the diameter of No. 15 bare copper wire is 0.05707 in. How much larger is No. 12 wire than No. 15 wire?

9. **Machine Technology** What is the decimal equivalent of each of the following drill bit diameters?

   (a) $\frac{3}{16}$ in. (b) $\frac{5}{32}$ in. (c) $\frac{3}{8}$ in. (d) $\frac{13}{64}$ in.

10. What is the closest fractional equivalent in 16ths of an inch of the following dimensions? (*Hint:* Use the table on page 132.)

    (a) 0.185 in. (b) 0.127 in. (c) 0.313 in. (d) 0.805 in.

11. **Sheet Metal Technology** The following table lists the thickness in inches of several sizes of sheet steel:

U.S. Gauge	Thickness (in.)
35	0.0075
30	0.0120
25	0.0209
20	0.0359
15	0.0673
10	0.1345
5	0.2092

(a) What is the difference in thickness between 30 gauge and 25 gauge sheet?

(b) What is the difference in thickness between seven sheets of 25 gauge and four sheets of 20 gauge sheet?

(c) What length of $\frac{3}{16}$-in.-diameter rivet is needed to join one thickness of 25 gauge sheet to a strip of $\frac{1}{4}$-in. stock? Add $1\frac{1}{2}$ times the diameter of the rivet to the length of the rivet to ensure that the rivet is long enough that a proper rivet head can be formed.

(d) What length of $\frac{5}{32}$-in. rivet is needed to join two sheets of 20 gauge sheet steel? (Don't forget to add the $1\frac{1}{2}$ times rivet diameter.)

12. **Building Construction** When the owners of the Better Builder Co. completed a small construction job, they found that the following expenses had been incurred: labor, \$972.25; gravel, \$86.77; sand, \$39.41; cement, \$280.96; and bricks, \$2204.35. What total bill should they give the customer if they want to make \$225 profit on the job?

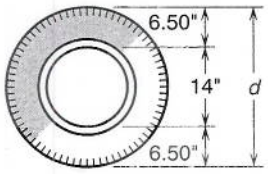
13. **Building Construction** One lineal foot of 12-in. I-beam weighs 25.4 lb. What is the length of a beam that weighs 444.5 lb?

14. **Sheet Metal Technology** To determine the average thickness of a metal sheet, a sheet metal worker measures it at five different locations. His measurements are 0.0401, 0.0417, 0.0462, 0.0407, and 0.0428 in. What is the average thickness of the sheet?

15. **Drafting** A dimension in a technical drawing is given as $2\frac{1}{2}$ in. with a tolerance of ± 0.025 in. What are the maximum and minimum permissible dimensions written in decimal form?

16. **Auto Mechanics** The four employees of the Busted Body Shop earned the following amounts last week: \$811.76, \$796.21, \$808.18, and \$876.35. What is the average weekly pay for the employees of the shop?

17. **Electrical Technology** If 14-gauge Romex cable sells for 19 cents per foot, what is the cost of 1210 ft of this cable?



Problem 20

18. **Electrical Technology** In Lucy's first week as an electrician, she earned \$1593.75 for 37.5 hours of work. What is her hourly rate of pay?

19. **Welding** A welder finds that 2.1 cu ft of acetylene gas is needed to make one bracket. How much gas will be needed to make 27 brackets?

20. **Auto Mechanics** What is the outside diameter d of a 6.50×14 tire? (See the figure.)

21. **Metalworking** How many 2.34-in. spacer blocks can be cut from a 2-in. by 2-in. square bar 48 in. long? Allow $\frac{1}{4}$ in. waste for each saw cut.

22. **Auto Mechanics** At the Fixum Auto Shop, a mechanic is paid \$22.50 per hour for a motor overhaul and is allotted 23 hours of labor time for the job. The mechanic completes that job in 18.5 hours, but he is still paid as if he had worked for 23 hours. Calculate his actual hourly compensation under these circumstances.

23. **Machine Technology** A machinist estimates the following times for fabricating a certain part: 0.6 hour for setup, 2.4 hours of turning, 5.2 hours of milling, 1.4 hours of grinding, and 1.8 hours of drilling. What is the total time needed to make the part?

24. **Printing** A 614-page book was printed on paper specified as 0.00175 in. thick and finished with a cover 0.165 in. thick. What was the total thickness of the bound book? (Be sure to count the cover twice and remember that there are two pages of the book for every one sheet of paper.)

25. **Printing** A certain type sets at an average of 14 characters to the inch. How many lines will it take to set 4325 characters to a width of 6 in.?

26. **Fire Protection** One gallon of water weighs approximately 8.34 lb. When sent to a particularly rough terrain, a Forestry Service truck is allowed to carry only 1.5 tons of weight. How many gallons of water can it carry? (1 ton = 2000 pounds.)

27. **Plumbing** To construct a certain pipe system, the following material is needed:

6 90° elbows at $1.19 each
5 tees at $0.74 each
3 couplings at $0.68 each
4 pieces of pipe each 6 ft long
6 pieces of pipe each 2 ft long
4 pieces of pipe each 1.5 ft long

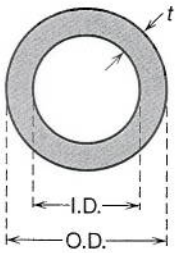
The pipe is schedule 40 1-in. PVC pipe, costing $0.22 per linear foot. Find the total cost of the material for the system.

28. **Masonry** A tile setter purchases the following supplies for the day:

One bag of thin-set mortar @	$5.97 per bag.
44 sq ft of tile @	$2.25 per sq ft
One gallon of grout @	$16.97 per gallon
2 tubes of caulk @	$2.89 per tube
One container of grout sealer @	$24.77 per container
3 containers of grout and tile cleaner @	$5.99 per container
4 scrub pads @	$2.57 each
One trowel @	$3.65 each
2 packages of tile spacers @	$1.97 each
One grout bag @	$2.49 each
One grout float @	$9.45 each

What is the total cost of these items before tax is added?

29. **Auto Mechanics** One way in which the owner of an auto shop evaluates the success of his business is to keep track of "production per square foot." To calculate this indicator, he divides total revenue by the area (in square feet) of his shop. Last year, a 2260-sq-ft shop generated total revenue of $586,435. This year, the shop expanded to 2840 sq ft and generated total revenue of $734,592. During which year was the production per square foot the greater and by how much?



Problem 30

30. **Plumbing** The inside diameter (I.D.) and outside diameter (O.D.) of a pipe are shown in the figure. The wall thickness of the pipe is the dimension labeled t. Calculate the wall thickness of schedule 120 pipe if its I.D. is 0.599 in. and its O.D. is 1.315 in.

Using a Calculator, III: Decimals

To perform addition, subtraction, multiplication, and division of decimal numbers on a calculator, use the same procedures outlined in Chapter 1, and press the [·] key to enter the decimal point.

EXAMPLE

To calculate 243.78 + 196.1 × 2.75 use the keystroke sequence

243 [·] 78 [+] 196 [·] 1 [×] 2 [·] 75 [=] → 783.055