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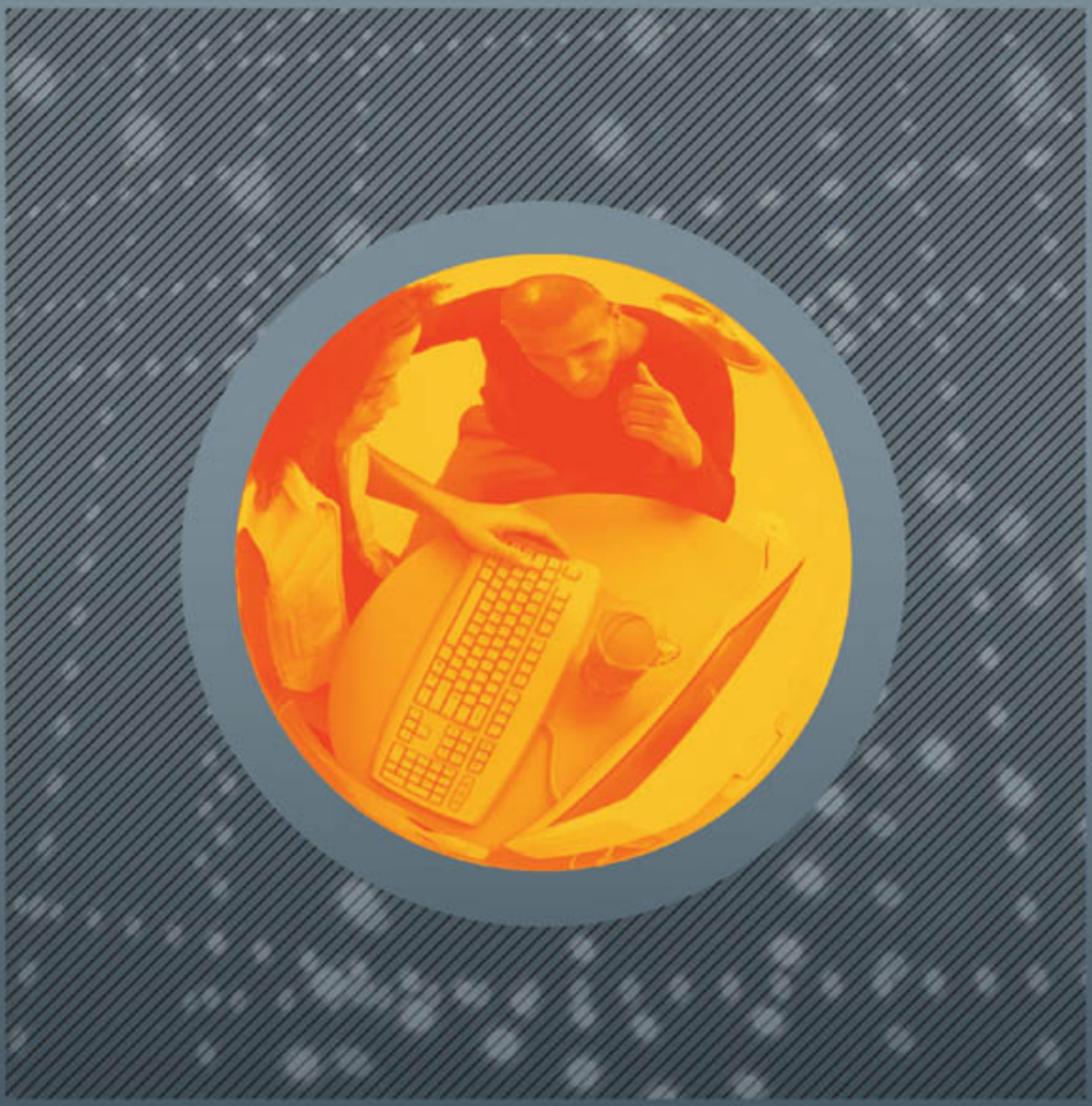

Mathematics for the Trades

Robert A. Carman Hal M. Saunders

Ninth Edition

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Preview

Arithmetic of Whole Numbers

Objective	Sample Problems	
When you finish this chapter you will be able to:		
1. Work with whole numbers.	(a) Write 250,374 in words	_____
	(b) Write in numerical form: "One million, sixty-five thousand, eight"	_____
	(c) Round 214,659 (1) to the nearest ten-thousand	_____
	(2) to the nearest hundred	_____
2. Add and subtract whole numbers.	(a) $67 + 58$	_____
	(b) $7009 + 1598$	_____
	(c) $82 - 45$	_____
	(d) $4035 - 1967$	_____
	(e) $14 + 31 + 59 - 67 + 22 + 37 - 19$	_____
3. Multiply and divide whole numbers.	(a) 64×37	_____
	(b) 305×243	_____
	(c) 908×705	_____
	(d) $2006 \div 6$	_____
	(e) $7511 \div 37$	_____

Name _____

Date _____

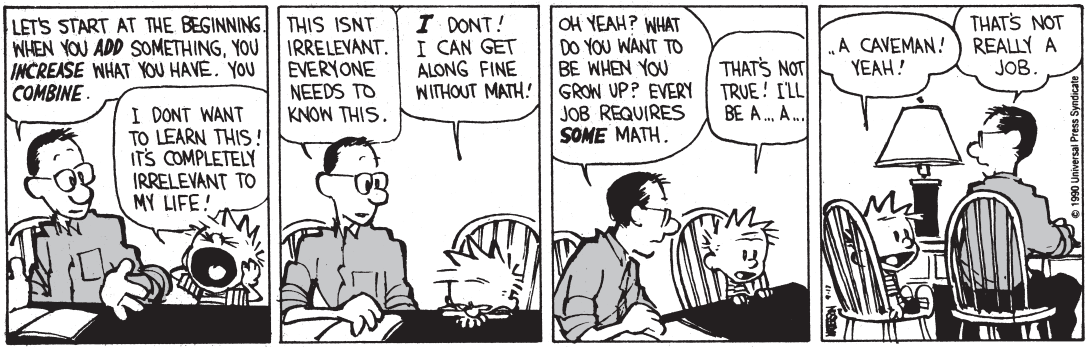
Course/Section _____

Objective	Sample Problems
4. Solve word problems with whole numbers.	**Machine Trades** A metal casting weighs 680 lb; 235 lb of metal is removed during shaping. What is its finished weight? _____
5. Determine factors and prime factors.	(a) List all the factors of 12. _____ (b) Write 12 as a product of its prime factors. _____
6. Use the correct order of operations with addition, subtraction, multiplication, and division.	(a) $6 + 9 \times 3$ _____ (b) $35 - 14 \div 7$ _____ (c) $56 \div 4 \times 2 + 9 - 4$ _____ (d) $(23 - 7) \times 24 \div (12 - 4)$ _____

(Answers to these preview problems are given at the end of this chapter. Also, worked solutions to many of these problems appear in the chapter Summary. Don't peek.)

If you are certain that you can work *all* these problems correctly, turn to the Problem Set for this chapter for a set of practice problems. For those who wish to master this material with the greatest success, turn to Section 1 and begin to work there.

Arithmetic of Whole Numbers



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1 Working with Whole Numbers
2 Subtraction of Whole Numbers
3 Multiplication of Whole Numbers
4 Division of Whole Numbers
5 Order of Operations

The average person a century ago used numbers to tell time, count, and keep track of money. Today, most people need to develop technical skills based on their ability to read, write, and work with numbers in order to earn a living. Although we live in an age of computers and calculators, much of the simple arithmetic used in industry, business, and the skilled trades is still done mentally or by hand. In fact, most trade and technical areas require you to *prove* that you can do the calculations by hand before you can get a job.

In the first part of this book we take a practical, how-to-do-it look at basic arithmetic: addition, subtraction, multiplication, and division, including fractions, decimal numbers, negative numbers, powers, and roots. Once we are past the basics, we will show you how to use a calculator to do such calculations. There are no quick and easy formulas here, but we do provide a lot of help for people who need to use mathematics in their daily work.

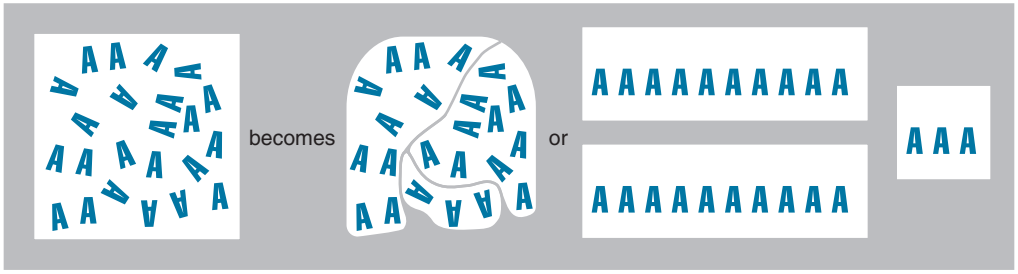
1 Working with Whole Numbers

The simplest numbers are the whole numbers—the numbers we use for counting the number of objects in a group. The whole numbers are 0, 1, 2, 3, . . ., and so on.

Example 1

How many letters are in the collection shown in the margin?

We counted 23. Notice that we can count the letters by grouping them into sets of ten:



2 tens + 3 ones

20 + 3 or 23

Expanded Form

Mathematicians call this the *expanded form* of a number. For example,

46 = 40 + 6 = 4 tens + 6 ones

274 = 200 + 70 + 4 = 2 hundreds + 7 tens + 4 ones

305 = 300 + 5 = 3 hundreds + 0 tens + 5 ones

Only ten numerals or number symbols—0, 1, 2, 3, 4, 5, 6, 7, 8, and 9—are needed to write any number. These ten basic numerals are called the *digits* of the number. The digits 4 and 6 are used to write 46, the number 274 is a three-digit number, and so on.

→ Your Turn

Write out the following three-digit numbers in expanded form:

(a) 362 = ____ + ____ + ____ = ____ hundreds + ____ tens + ____ ones

(b) 425 = ____ + ____ + ____ = ____ hundreds + ____ tens + ____ ones

(c) 208 = ____ + ____ + ____ = ____ hundreds + ____ tens + ____ ones

→ Solutions

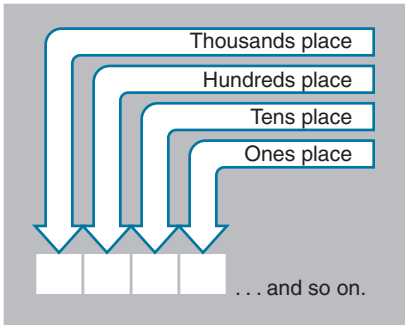
(a) 362 = *300* + *60* + *2* = *3* hundreds + *6* tens + *2* ones

(b) 425 = *400* + *20* + *5* = *4* hundreds + *2* tens + *5* ones

(c) 208 = *200* + *0* + *8* = *2* hundreds + *0* tens + *8* ones

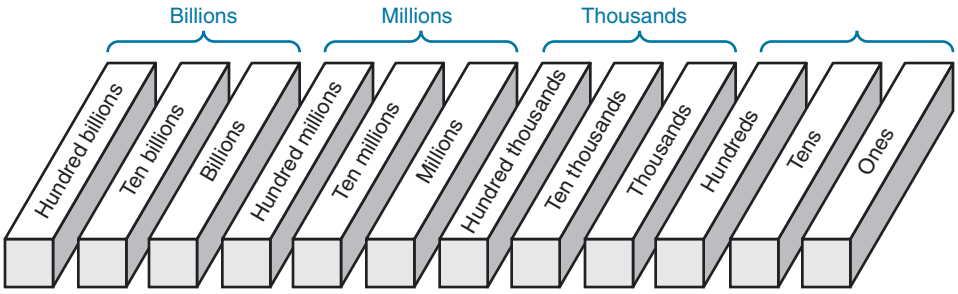
A Closer Look

Notice that the 2 in 362 means something different from the 2 in 425 or 208. In 362 the 2 signifies two ones. In 425 the 2 signifies two tens. In 208 the 2 signifies two hundreds. Ours is a *place-value* system of naming numbers: the value of any digit depends on the place where it is located.



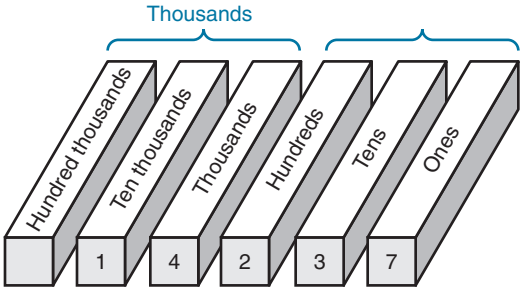
Being able to write a number in expanded form will help you to understand and remember the basic operations of arithmetic—even though you'll never find it on a blueprint or in a technical handbook.

This expanded-form idea is useful especially in naming very large numbers. Any large number given in numerical form may be translated to words by using the following diagram:



Example 2

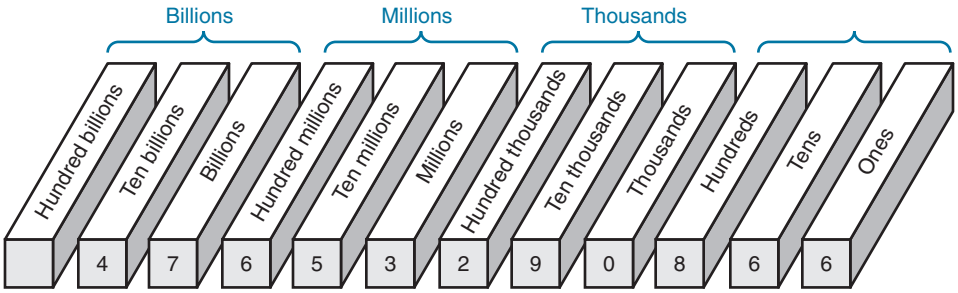
The number 14,237 can be placed in the diagram like this:



and read "fourteen thousand, two hundred thirty-seven."

Example 3

The number 47,653,290,866 becomes



and is read "forty-seven billion, six hundred fifty-three million, two hundred ninety thousand, eight hundred sixty-six."

In each block of three digits read the digits in the normal way ("forty-seven," "six hundred fifty-three") and add the name of the block ("billion," "million"). Notice that the word "and" is not used in naming these numbers.

→ Your Turn

Use the diagram to name the following numbers.

(a) 4072 (b) 1,360,105

(c) 3,000,210 (d) 21,010,031,001

→ Answers

(a) Four thousand, seventy-two

(b) One million, three hundred sixty thousand, one hundred five

(c) Three million, two hundred ten

(d) Twenty-one billion, ten million, thirty-one thousand, one

It is also important to be able to write numbers correctly when you hear them spoken or when they are written in words.

→ More Practice

Read each of the following aloud and then write them in correct numerical form.

(a) Fifty-eight thousand, four hundred six

(b) Two hundred seventy-three million, five hundred forty thousand

(c) Seven thousand, sixty

(d) Nine billion, six million, two hundred twenty-three thousand, fifty-eight

→ Answers

(a) 58,406 (b) 273,540,000

(c) 7060 (d) 9,006,223,058

Addition of Whole Numbers

Adding whole numbers is fairly easy provided that you have stored in your memory a few simple addition facts. It is most important that you be able to add simple one-digit numbers mentally.

The following sets of problems in one-digit addition are designed to give you some practice. Work quickly. You should be able to answer all problems in a set in the time shown.

Problems **One-Digit Addition**

A. Add.

7	5	2	5	8	2	3	8	9	7
3	6	9	7	8	5	6	7	3	6
6	8	9	3	7	2	9	9	7	4
4	5	6	5	7	7	4	9	2	7
9	2	5	8	4	9	6	4	8	8
7	6	5	9	5	5	6	3	2	3
5	6	7	7	5	6	2	3	6	9
8	7	5	9	4	5	8	7	8	8
7	5	9	4	3	8	4	8	5	7
4	9	2	6	8	6	9	4	8	8

Average time = 90 seconds
Record = 35 seconds

B. Add. Try to do all addition mentally.

2	7	3	4	2	6	3	5	9	5
5	3	6	5	7	7	4	7	6	2
4	2	5	8	9	8	4	8	3	8
6	5	4	8	6	9	7	4	8	1
2	4	2	1	8	3	1	9	4	8
7	5	9	9	8	5	6	1	6	7
1	9	3	1	7	2	9	9	8	5
9	9	1	6	9	9	8	5	3	4
2	1	4	3	6	1	2	1	3	7

Average time = 90 seconds
Record = 41 seconds

The answers are given at the end of this chapter.

Rounding Whole Numbers

In many situations a simplified approximation of a number is more useful than its exact value. For example, the accountant for a business may calculate its total monthly revenue as $247,563, but the owner of the business may find it easier to talk about the revenue as "about $250,000." The process of approximating a number is called *rounding*. Rounding numbers comes in handy when we need to make estimates or do "mental mathematics."

A number can be rounded to any desired place. For example, $247,563 is approximately

$247,560 rounded to the nearest ten,
$247,600 rounded to the nearest hundred,
$248,000 rounded to the nearest thousand,
$250,000 rounded to the nearest ten thousand, and
$200,000 rounded to the nearest hundred thousand.

To round a whole number, follow this **step-by-step** process:

Example 4

Round 247,563		to the nearest hundred thousand	to the nearest ten thousand
Step 1	Determine the place to which the number is to be rounded. Mark it on the right with a ∧.	$2 47,563 ∧	$24 7,563 ∧
Step 2	If the digit to the right of the mark is less than 5, replace all digits to the right of the mark with zeros.	$200,000	
Step 3	If the digit to the right of the mark is equal to or larger than 5, increase the digit to the left by 1 and replace all digits to the right with zeros.		$250,000

→ Your Turn

Try these for practice. Round

(a) 73,856 to the nearest thousand

(b) 64 to the nearest ten

(c) 4852 to the nearest hundred

(d) 350,000 to the nearest hundred thousand

(e) 726 to the nearest hundred

→ Solutions

(a) **Step 1** Place a mark to the right of the thousands place. The digit 3 is in the thousands place. 73 856 ∧

Step 2 Does not apply.

Step 3 The digit to the right of the mark, 8, is larger than 5. Increase the 3 to a 4 and replace all digits to the right with zeros. 74,000

(b) **Step 1** Place a mark to the right of the tens place. The digit 6 is in the tens place. 6 4 ∧

Step 2 The digit to the right of the mark, 4, is less than 5. Replace it with a zero. 60

(c) 4900 (d) 400,000 (e) 700

Doing arithmetic with one-digit numbers is very important. It is the key to any mathematical computation—even if you do the work on a calculator. Suppose that you need to find the total time spent on a job by two workers. You need to find the sum

31 hours + 48 hours = _____

Estimating

What is the first step? Start adding digits? Punch in some numbers on your trusty calculator? Rattle your abacus? None of these. The first step is to *estimate* your answer. The most important rule in any mathematical calculation is:

> Know the approximate answer to any calculation before you calculate it.

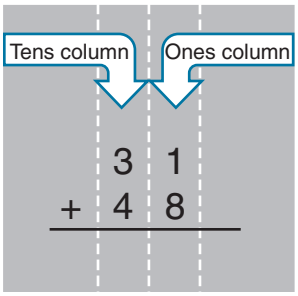
Never do an arithmetic calculation until you know roughly what the answer is going to be. Always know where you are going.

Rounding to the nearest 10 hours, the preceding sum can be estimated as 31 hours + 48 hours or approximately 30 hours + 50 hours or 80 hours, not 8 or 8000 or 800 hours. Having the estimate will keep you from making any major (and embarrassing) mistakes. Once you have a rough estimate of the answer, you are ready to do the arithmetic work.

Calculate 31 + 48 = _____

You don't really need an air-conditioned, solar-powered, talking calculator for that, do you?

You should set it up like this:



1. The numbers to be added are arranged vertically (up and down) in columns.
2. The right end or ones digits are placed in the ones column, the tens digits are placed in the tens column, and so on.

Avoid the confusion of $\begin{array}{r} 31 \\ +\ 48 \end{array}$ or $\begin{array}{r} 31 \\ +\ 48 \end{array}$

Careful Most often the cause of errors in arithmetic is carelessness, especially in simple tasks such as lining up the digits correctly. ◄

Once the digits are lined up the problem is easy.

$$\begin{array}{r} 31 \\ +\ 48 \\ \hline 79 \end{array}$$

Does the answer agree with your original estimate? Yes. The estimate, 80, is roughly equal to the actual sum, 79.

What we have just shown you is called the *guess n' check method* of doing mathematics.

1. **Estimate** the answer using rounded numbers.
2. **Work** the problem carefully.
3. **Check** your answer against the estimate. If they disagree, repeat both steps 1 and 2. The check icon reminds you to check your work.

Most students worry about estimating, either because they won't take the time to do it or because they are afraid they might do it incorrectly. Relax. You are the only one who will know your estimate. Do it in your head, do it quickly, and make it reasonably accurate. Step 3 helps you to find incorrect answers before you finish the problem. The guess n' check method means that you never work in the dark; you always know where you are going.

Note Estimating is especially important in practical math, where a wrong answer is not just a mark on a piece of paper. An error may mean time and money lost. ◄

Your Turn

Here is a slightly more difficult problem:

27 lb + 58 lb = _____

Try it, then check your answer.

Solution

First, estimate the answer. 27 + 58 is roughly
30 + 60 or about 90.
The answer is about 90 lb.

Second, line up the digits in columns.

$$\begin{array}{r} 27 \\ +\,58 \\ \hline \end{array}$$

The numbers to be added, 27 and 58 in this case, are called *addends.*

Third, add carefully.

$$\begin{array}{r} {\scriptstyle 1} \\ 27 \\ +\,58 \\ \hline 85 \end{array}$$

Finally, check your answer by comparing it with the estimate. The estimate 90 lb is roughly equal to the answer 85 lb—at least you have an answer in the right ballpark.

What does that little 1 above the tens digit mean? What really happens when you "carry" a digit? Let's look at it in detail. In expanded notation,

$$\begin{array}{rl} 27 & \rightarrow 2 \text{ tens} + 7 \text{ ones} \\ +\,58 & \rightarrow 5 \text{ tens} + 8 \text{ ones} \\ & = 7 \text{ tens} + 15 \text{ ones} \\ & = 7 \text{ tens} + 1 \text{ ten} + 5 \text{ ones} \\ & = 8 \text{ tens} + 5 \text{ ones} \\ & = 85 \end{array}$$

The 1 that is carried over to the tens column is really a ten.

Learning Help Trades people often must calculate exact answers mentally. To do a problem such as 27 + 58, a trick called "balancing" works nicely. Simply add 2 to the 58 to get a "round" number, 60, and subtract 2 from 27 to balance, keeping the total the same. Therefore, 27 + 58 is the same as 25 + 60, which is easy to add mentally to get 85. ◀

We use the same procedure to add three or more numbers. Estimating and checking become even more important when the problem gets more complicated.

Example 5

To add 536 + 1473 + 875 + 88

Estimate: Rounding each number to the nearest hundred,

500 + 1500 + 900 + 100 = 3000

Step 1 To help avoid careless errors, put the number with the most digits, 1473, on top. Put the number with the fewest digits, 88, on the bottom.

```
  1473
   536
   875
+   88
```

Step 2

```
    2
  1473
   536
   875
+   88      3 + 6 + 5 + 8 = 22      Write 2; carry 2 tens
     2
```

Step 3

```
   22
  1473
   536
   875
+   88      2 + 7 + 3 + 7 + 8 = 27      Write 7; carry 2 tens
    72
```

Step 4

```
  122
  1473
   536
   875
+   88      2 + 4 + 5 + 8 = 19      Write 9; carry 1 ten
   972
```

Step 5

```
  122
  1473
   536
   875
+   88      1 + 1 = 2      Write 2.
  2972
```

Check: The estimate 3000 and the answer 2972 are very close.

More Practice

The following is a short set of problems. Add, and be sure to estimate your answers first. Check your answers with your estimates.

(a) 429 + 738 = _____ (b) 446 + 867 = _____

(c) 2368 + 744 = _____ (d) 409 + 2572 + 3685 + 94 = _____

(e) **Masonry** Three bricklayers working together on a job each laid the following number of bricks in a day: 927, 1143, and 1065. How many bricks did all three lay that day?

Solutions

(a) **Estimate:** Rounding each number to the nearest hundred, 400 + 700 = 1100
Line up the digits:

```
  429
+ 738
```

Calculate:

Step 1
$$\begin{array}{r} {\scriptstyle 1} \\ 429 \\ +\,738 \\ \hline 7 \end{array} \qquad 9 + 8 = 17 \qquad \text{Write 7; carry 1 ten.}$$

Step 2
$$\begin{array}{r} {\scriptstyle 1} \\ 429 \\ +\,738 \\ \hline 67 \end{array} \qquad 1 + 2 + 3 = 6 \qquad \text{Write 6.}$$

Step 3
$$\begin{array}{r} {\scriptstyle 1} \\ 429 \\ +\,738 \\ \hline 1167 \end{array} \qquad 4 + 7 = 11 \qquad \text{Write 11.}$$

Check: The estimate 1100 and the answer 1167 are roughly equal.

(b) **Estimate:** $400 + 900 = 1300$

Calculate:

Step 1
$$\begin{array}{r} {\scriptstyle 1} \\ 446 \\ +\,867 \\ \hline 3 \end{array} \qquad 6 + 7 = 13 \qquad \text{Write 3; carry 1 ten.}$$

Step 2
$$\begin{array}{r} {\scriptstyle 1\,1} \\ 446 \\ +\,867 \\ \hline 13 \end{array} \qquad 1 + 4 + 6 = 11 \qquad \text{Write 1; carry 1 hundred.}$$

Step 3
$$\begin{array}{r} {\scriptstyle 1\,1} \\ 446 \\ +\,867 \\ \hline 1313 \end{array} \qquad 1 + 4 + 8 = 13 \qquad \text{Write 13.}$$

Check: The estimate 1300 and the answer 1313 are roughly equal.

(c) **Estimate:** Rounding each number to the nearest hundred, $2400 + 700 = 3100$

Calculate:
$$\begin{array}{r} {\scriptstyle 1\,1\,1} \\ 2368 \\ +\,744 \\ \hline 3112 \end{array}$$

Check: The estimate 3100 and the answer 3112 are roughly equal.

(d) **Estimate:** $400 + 2600 + 3700 + 100 = 6800$

Calculate:
$$\begin{array}{r} {\scriptstyle 1\,2\,2} \\ 2572 \\ 3685 \\ 409 \\ +\,\,94 \\ \hline 6760 \end{array}$$

Check: The estimate 6800 and the answer 6760 are roughly equal.

(e) In word problems or applications, addition is often used when there are two or more individual quantities and a total must be found. In this case, we have the amounts for the individual bricklayers, and we must find the total number of bricks.

Estimate: $900 + 1100 + 1100 = 3100$

Calculate:
$$\begin{array}{r} {\scriptstyle 1\,1\,1} \\ 927 \\ 1143 \\ +\,1065 \\ \hline 3135 \end{array}$$

Check: The estimate 3100 is roughly equal to the answer 3135.

Estimating answers is a very important part of any mathematics calculation, especially for the practical mathematics used in engineering, technology, and the trades. A successful builder, painter, or repairperson must make accurate estimates of job costs—business success depends on it. If you work in a technical trade, getting and keeping your job may depend on your ability to get the correct answer *every* time.

If you use a calculator to do the actual arithmetic, it is even more important to get a careful estimate of the answer first. If you plug a wrong number into the calculator, accidentally hit a wrong key, or unknowingly use a failing battery, the calculator may give you a wrong answer—lightning fast, but wrong. The estimate is your best insurance that a wrong answer will be caught immediately. Convinced?

UNITS OF MEASURE

Units of measure are important in every trade. Just as you want to make sure that a customer is not thinking in centimeters while you are thinking yards, you will want to make sure that that the measurements required for a project have consistent units.

Type of Measurement	English Units	Metric Units
Length or distance	inch (in.* or ″) foot (ft, or′) yard (yd) mile (mi)	millimeter (mm) centimeter (cm) meter (m) kilometer (km)
Weight	ounce (oz) pound (lb) ton (t)	microgram (μg) milligram (mg) gram (g) kilogram (kg)
Area	square inch (sq in.) square foot (sq ft) square yard (sq yd) acre (a)	square centimeter (sq cm) square meter (sq m) square kilometer (sq km) hectare (ha)
Capacity or volume	pint (pt) quart (qt) gallon (gal) bushel (bu) cubic inch (cu in.) cubic feet (cu ft) cubic yard (cu yd)	cubic centimeter (cu cm, cc) milliliter (mL) liter (L) cubic meter (cu m)
Velocity or speed	miles per hour (mph or mi/hr) beats per minute (bpm) cycles per second (hertz) revolutions per minute (rpm or rev/min)	meters per second (m/sec) kilometers per hour (km/hr)

(*continued*)

Type of Measurement	English Units	Metric Units
Temperature	degrees Fahrenheit (°F)	degrees Celsius (°C)
Power and energy	ohm (Ω) watt (W) volt (V) ampere (A) horsepower (hp)	cubic foot per meter (cfm) kilohertz (kHz) picofarad (pF) kilowatt (kW)
Pressure	pounds per square inch (psi or lb/in.^{2})	pascal (Pa)

*For abbreviations that might be mistaken for a word (e.g., "in" for inches), a period is included at the end of the abbreviation. For abbreviations that would not be mistaken for a word (e.g, "ft"), no period is added.

Now, try the following problems for practice in working with whole numbers.

Exercises 1 Working with Whole Numbers

A. Add.

1. 47 23	2. 27 38	3. 45 35	4. 38 65	5. 75 48
6. 26 98	7. 48 84	8. 67 69	9. 189 204	10. 508 495
11. 684 706	12. 432 399	13. 621 388	14. 747 59	15. 375 486
16. 4237 1288	17. 5076 4385	18. 7907 1395	19. 3785 7643	20. 6709 9006
21. 18745 6972	22. 40026 7085	23. 10674 397	24. 9876 4835	25. 78044 97684
26. 83754 66283 5984	27. 498321 65466 95873 3604	28. 843592 710662 497381 25738		

B. Arrange vertically and add.

1. 487 + 29 + 526 = _____
2. 715 + 4293 + 184 + 19 = _____
3. 1706 + 387 + 42 + 307 = _____
4. 456 + 978 + 1423 + 3584 = _____
5. 6284 + 28 + 674 + 97 = _____
6. 6842 + 9008 + 57 + 368 = _____
7. 322 + 46 + 5984 = _____

8. $7268 + 209 + 178 =$ _____
9. $5016 + 423 + 1075 =$ _____
10. $8764 + 85 + 983 + 19 =$ _____
11. $4 + 6 + 11 + 7 + 14 + 3 + 9 + 6 + 4 =$ _____
12. $12 + 7 + 15 + 16 + 21 + 8 + 10 + 5 + 30 + 17 =$ _____
13. $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 =$ _____
14. $22 + 31 + 43 + 11 + 9 + 1 + 19 + 12 =$ _____
15. $75 + 4 + 81 + 12 + 14 + 65 + 47 + 22 + 37 =$ _____
16. $89{,}652 + 57{,}388 + 6506 =$ _____
17. $443{,}700 + 629{,}735 + 85{,}962 + 6643 =$ _____
18. $784{,}396 + 858{,}390 + 662{,}043 + 965{,}831 + 62{,}654 =$ _____

C. Writing and Rounding Whole Numbers

Write in words.

1.	357	2.	2304	3.	17,092	4.	207,630	5.	2,000,034
6.	10,007	7.	740,106	8.	5,055,550	9.	118,180,018	10.	6709

Write as numbers.

11. Three thousand, six
12. Seventeen thousand, twenty-four
13. Eleven thousand, one hundred
14. Three million, two thousand, seventeen
15. Four million, forty thousand, six
16. Seven hundred twenty million, ten

Round as indicated.

17. 357 to the nearest ten
18. 4386 to the nearest hundred
19. 4386 to the nearest thousand
20. 5386 to the nearest thousand
21. 225,799 to the nearest ten thousand
22. 225,799 to the nearest thousand

D. Applied Problems

1. **Electrical Trades** In setting up his latest wiring job, an electrician cut the following lengths of wire: 387, 913, 76, 2640, and 845 ft. Find the total length of wire used.
2. **Construction** The Acme Lumber Co. made four deliveries of 1-in. by 6-in. flooring: 3280, 2650, 2465, and 2970 fbm. What was the total number of board feet of flooring delivered? (The abbreviation for "board feet" is fbm, which is short for "feet board measure.")
3. **Machine Trades** The stockroom has eight boxes of No. 10 hexhead cap screws. How many screws of this type are in stock if the boxes contain 346, 275, 84, 128, 325, 98, 260, and 120 screws, respectively?
4. **Trades Management** In calculating her weekly expenses, a contractor found that she had spent the following amounts: materials, $13,860; labor, $3854; salaried help, $942; overhead expense, $832. What was her total expense for the week?

5. **Trades Management** The head machinist at Tiger Tool Co. is responsible for totaling time cards to determine job costs. She found that five different jobs this week took 78, 428, 143, 96, and 384 minutes each. What was the total time in minutes for the five jobs?

6. **Roofing** On a home construction job, a roofer laid 1480 wood shingles the first day, 1240 the second, 1560 the third, 1320 the fourth, and 1070 the fifth day. How many shingles did he lay in five days?

7. **Industrial Technology** Eight individually powered machines in a small production shop have motors using 420, 260, 875, 340, 558, 564, 280, and 310 watts each. What is the total wattage used when (a) the total shop is in operation? (b) the three largest motors are running? (c) the three smallest motors are running?

8. **Automotive Trades** A mechanic is taking inventory of oil in stock. He has 24 quarts of 10W-30, 8 quarts of 30W, 42 quarts of 20W-50, 16 quarts of 10W-40, and 21 quarts of 20W-40. How many total quarts of oil does he have in stock?

9. **Construction** The Happy Helper building materials supplier has four piles of bricks containing 1250, 865, 742, and 257 bricks. What is the total number of bricks they have on hand?

10. **Machine Trades** A machinist needs the following lengths of 1-in. diameter rod: 8 in., 14 in., 6 in., 27 in., and 42 in. How long a rod is required to supply all five pieces? (Ignore cutting waste.)

11. **Landscaping** A new landscape maintenance business requires the following equipment:

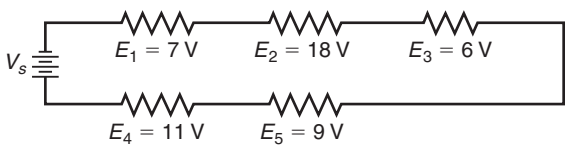
    1 rototiller for $499
    1 gas trimmer for $249
    1 mower for $369
    1 hedge trimmer for $79

    What is the total cost of this equipment?

12. **Electrical Trades** The Radius Electronics Company orders 325 resistors, 162 capacitors, 25 integrated circuit boards, and 68 transistors. Calculate the total number of parts ordered.

13. **Electronics** When resistors are connected in series, the total resistance is the sum of the individual resistors. If resistances of 520, 1160, 49, and 1200 ohms are connected in series, calculate the total resistance.

14. **Electronics** Kirchhoff's law states that the sum of the voltage drops around a closed circuit is equal to the source voltage. $V_s = E_1 + E_2 + E_3 + E_4 + E_5$. Calculate the source voltage V_s for the circuit shown.



15. **Automotive Trades** To balance an engine, a mechanic must know the total weight of a piston assembly, also known as the reciprocating weight of the assembly. A certain piston assembly consisted of a 485-gram piston, a 74-gram wrist-pin, 51 grams of compression and oil rings, and the small end of the connecting rod weighing 146 grams. What is the reciprocating weight of this assembly?

16. **Allied Health** The following standard amounts of food were recorded in one patient's Intake/Output record: one carton of milk, 8 oz; one carton of juice, 8 oz; one bowl of soup, 150 oz; one cup of coffee, 6 oz; one serving of sherbet, 120 oz; one glass of water, 8 oz. Determine the total fluid intake for this patient.

17. **Construction** For working on remote construction sites, GVM Construction needs a generator that can supply a 1400-W (watt) circular saw, an 1800-W table saw, a 600-W hand drill, and a 100-W radio simultaneously. What total wattage does the generator need to supply?

18. **Automotive Trades** The base price for a 2008 BMW 135i Coupe, including destination charge, is $35,675. The cost of "extras" is given as follows:

Item	Cost	Item	Cost
Premium package	$3300	Premium sound	$875
Satellite radio	$ 595	Heated seats	$500
Comfort access system	$ 500	Metallic paint	$475
iPod and USB adaptor	$ 400	HD radio	$350

What would be the total cost if a customer added premium sound, satellite radio, heated seats, metallic paint, and the iPod and USB adaptor?

19. **Sports and Leisure** In the 1988 Olympics in Seoul, South Korea, Jackie Joyner-Kersee (USA) won the gold medal in the heptathlon with a world-record performance. The heptathlon consists of seven separate events performed over two days, and the points for each event are added to determine the total score. Jackie's points (and performances) for each event were:

Day	Event	Performance	Points earned
Day 1	100-meter hurdles	12.69 sec	1172
	High jump	1.86 m	1054
	Shot-put	15.80 m	915
	200-meter dash	22.56 sec	1123
Day 2	Long jump	7.27 m	1264
	Javelin	45.66 m	776
	800-meter run	2 min 8.51 sec	987

(a) How many points did she earn on Day 1?

(b) How many points did she earn on Day 2?

(c) What was Jackie's world-record-setting point total?

E. Calculator Problems

You probably own a calculator and, of course, you are eager to put it to work doing practical math calculations. In this book we include problem sets for calculator

users. These problems are taken from real-life situations and, unlike most textbook problems, involve big numbers and lots of calculations. If you think that having an electronic brain-in-a-box means that you do not need to know basic arithmetic, you will be disappointed. The calculator helps you to work faster, but it will not tell you *what* to do or *how* to do it.

Detailed instruction on using a calculator with whole numbers appears at the end of this chapter.

Here are a few helpful hints for calculator users:

1. Always *estimate* your answer before doing a calculation.
2. *Check* your answer by comparing it with the estimate or by the other methods shown in this book. Be certain that your answer makes sense.
3. If you doubt the calculator (they do break down, you know), put a problem in it whose answer you know, preferably a problem like the one you are solving.

1. **Electronics** An electronics mixing circuit adds two given input frequencies to produce an output signal. If the input frequencies are 35,244 kHz and 61,757 kHz, calculate the frequency of the output signal.
2. **Manufacturing** The following table lists the number of widget fasteners made by each of the five machines at the Ace Widget Co. during the last ten working days.

Day	Machine					Daily Totals
	A	B	C	D	E	
1	347	402	406	527	237	
2	451	483	312	563	316	
3	406	511	171	581	289	
4	378	413	0	512	291	
5	399	395	452	604	342	
6	421	367	322	535	308	
7	467	409	256	578	264	
8	512	514	117	588	257	
9	302	478	37	581	269	
10	391	490	112	596	310	
Machine Total						

(a) Complete the table by finding the number of fasteners produced each day. Enter these totals under the column "Daily Totals" on the right.

(b) Find the number of fasteners produced by each machine during the ten-day period and enter these totals along the bottom row marked "Machine Totals."

(c) Does the sum of the daily totals equal the sum of the machine totals?

3. Add the following as shown.

(a)	(b)	(c)
$ 67429	$216847	$693884
6070	9757	675489
4894	86492	47039
137427	4875	276921
91006	386738	44682
399	28104	560487

(d) $4299 + $137 + $20 + $177 + $63 + $781 + $1008 + $671 = ?

4. **Trades Management** Joe's Air Conditioning Installation Co. has not been successful, and he is wondering if he should sell it and move to a better location. During the first three months of the year his expenses were:

Rent $4260
Supplies $2540
Part-time helper $2100
Transportation $948
Utilities $815
Advertising $750
Miscellaneous $187

His monthly income was:

January $1760
February $2650
March $3325

(a) What was his total expense for the three-month period?

(b) What was his total income for the three-month period?

(c) Now turn your calculator around to learn what Joe should do about this unhappy situation.

5. **Electrical Trades** A mapper is a person employed by an electrical utility company who has the job of reading diagrams of utility installations and listing the materials to be installed or removed by engineers. Part of a typical job list might look like this:

INSTALLATION (in feet of conductor)

Location Code	No. 12 BHD (bare, hard-drawn copper wire)	#TX (triplex)	410 AAC (all-aluminum conductor)	110 ACSR (aluminum-core steel-reinforced conductor)	6B (No. 6, bare conductor)
A3	1740	40	1400		350
A4	1132		5090		2190
B1	500			3794	
B5		87	3995		1400
B6	4132	96	845		
C4		35		3258	2780
C5	3949		1385	1740	705

(a) How many total feet of each kind of conductor must the installer have to complete the job?

(b) How many feet of conductor are to be installed at each of the seven locations?

When you have completed these exercises, check your answers to the odd-numbered problems are at the end of this chapter and then continue with Section 2.

2 Subtraction of Whole Numbers

Subtraction is the reverse of addition.

Addition: $3 + 4 = \square$

Subtraction: $3 + \square = 7$

Written this way, a subtraction problem asks the question: How much must be added to a given number to produce a required amount?

Most often, however, the numbers in a subtraction problem are written using a minus sign (−):

$17 - 8 = \square$ means that there is a number $\square$ such that $8 + \square = 17$

But we should remember that

$8 + 9 = 17$ or $17 - 8 = 9$ ← Difference

The *difference* is the name given to the answer in a subtraction problem.

Solving simple subtraction problems depends on your knowledge of the addition of one-digit numbers.

For example, to solve the problem

$9 - 4 =$ _____

you probably go through a chain of thoughts something like this:

> Nine minus four. Four added to what number gives nine? Five? Try it: four plus five equals nine. Right.

Subtraction problems with small whole numbers will be easy for you if you know your addition tables.

Example 1

Here is a more difficult subtraction problem:

$47 - 23 =$ _____

The **first** step is to estimate the answer—remember?

$47 - 23$ is roughly $50 - 20$ or 30.

The difference, your answer, will be about 30—not 3 or 10 or 300.

The **second** step is to write the numbers vertically as you did with addition. Be careful to keep the ones digits in line in one column, the tens digits in a second column, and so on.

$$\begin{array}{r} 47 \\ -23 \\ \hline \end{array}$$

Notice that the larger number is written above the smaller number.

Once the numbers have been arranged in this way, the difference may be written by performing the following two steps:

Step 1

$$\begin{array}{r} 4\ 7 \\ -2\ 3 \\ \hline \quad 4 \end{array}$$

ones digits: $7 - 3 = 4$

Step 2

$$\begin{array}{r} 4\ 7 \\ -2\ 3 \\ \hline 2\ 4 \end{array}$$

tens digits: $4 - 2 = 2$

The difference is 24, which agrees roughly with our estimate.

Example 2

With some problems it is necessary to rewrite the larger number before the problem can be solved. Let's try this one:

$64 - 37 =$ _____

First, estimate the answer. Rounding to the nearest ten, $64 - 37$ is roughly $60 - 40$ or 20.

Second, arrange the numbers vertically in columns.

$$\begin{array}{r} 64 \\ -37 \end{array}$$

Because 7 is larger than 4 we must "borrow" one ten from the 6 tens in 64. We are actually rewriting 64 (6 tens + 4 ones) as 5 tens + 14 ones. In actual practice our work would look like this:

Step 1

$$\begin{array}{r} 6\ 4 \\ -3\ 7 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 5}\ {\scriptstyle 14} \\ \not{6}\ \not{4} \\ -3\ 7 \\ \hline \quad 7 \end{array}$$

Borrow one ten, change the 6 in the tens place to 5, change 4 to 14, subtract $14 - 7 = 7$.

Step 3

$$\begin{array}{r} {\scriptstyle 5}\ {\scriptstyle 14} \\ \not{6}\ \not{4} \\ -3\ 7 \\ \hline 2\ 7 \end{array}$$

$5 - 3 = 2$ $\quad$ $14 - 7$

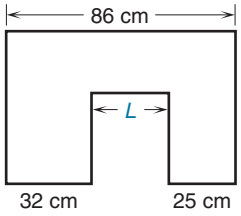
Double-check subtraction problems by adding the answer and the smaller number; their sum should equal the larger number.

Step 4 **Check:**

$$\begin{array}{r} 37 \\ +\ 27 \\ \hline 64 \end{array}$$

Learning Help

If you need to get an exact answer to a problem such as $64 - 37$ mentally, add or subtract to make the smaller number, 37, a "round" number. In this case, add 3 to make it 40. Because we're subtracting, we want the *difference,* not the *total,* to be the same or balance. Therefore, we also add 3 to the 64 to get 67. The problem becomes $64 - 37 = (64 + 3) - (37 + 3) = 67 - 40$. Subtracting a round number is easy mentally: $67 - 40 = 27$. ◀



Problem (e)

Your Turn

Try these problems for practice.

(a) $\begin{array}{r} 71 \\ -39 \\ \hline \end{array}$ (b) $\begin{array}{r} 263 \\ -127 \\ \hline \end{array}$ (c) $\begin{array}{r} 426 \\ -128 \\ \hline \end{array}$ (d) $\begin{array}{r} 902 \\ -465 \\ \hline \end{array}$

(e) Find the missing dimension L in the drawing in the margin.

Solutions

(a) **Estimate:** $70 - 40 = 30$

Step 1

$$\begin{array}{r} 7\ 1 \\ -3\ 9 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 6\ 11} \\ 7\ \not{1} \\ -3\ 9 \\ \hline 3\ 2 \end{array}$$

Borrow one ten from 70,
change the 7 in the tens place to 6,
change the 1 in the ones place to 11.

$11 - 9 = 2$ Write 2

$6 - 3 = 3$ Write 3

The answer 32 is approximately equal to the estimate 30. As a shortcut, mentally add 1 to each number,

$71 - 39 = 72 - 40$

then subtract.

$72 - 40 = 32$

(b) **Estimate:** $260 - 130 = 130$.

Step 1

$$\begin{array}{r} 2\ 6\ 3 \\ -1\ 2\ 7 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 5\ 13} \\ 2\ \not{6}\ \not{3} \\ -1\ 2\ 7 \\ \hline 1\ 3\ 6 \end{array}$$

Borrow one ten from 60,
change the 6 in the tens place to 5,
change the 3 in the ones place to 13.

$13 - 7 = 6$ Write 6

$5 - 2 = 3$ Write 3

$2 - 1 = 1$ Write 1

The answer is approximately equal to the estimate.

(c) **Estimate:** $400 - 100 = 300$

Step 1

$$\begin{array}{r} 4\ 2\ 6 \\ -1\ 2\ 8 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 1\ 16} \\ 4\ \not{2}\ \not{6} \\ -1\ 2\ 8 \\ \hline 8 \end{array}$$

Step 3

$$\begin{array}{r} {\scriptstyle 3\ 11\ 16} \\ \not{4}\ \not{2}\ \not{6} \\ -1\ 2\ 8 \\ \hline 2\ 9\ 8 \end{array}$$

In this case we borrow twice. Borrow one ten from the 20 in 426 and make 16. Then borrow one hundred from the 400 in 426 to make 11 in the tens place.

$16 - 8 = 8$ Write 8

$11 - 2 = 9$ Write 9

$3 - 1 = 2$ Write 2

The answer 298 is approximately equal to the estimate 300.

(d) **Estimate:** $900 - 500 = 400$

Step 1

$$\begin{array}{r} 9\ 0\ 2 \\ -\ 4\ 6\ 5 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 8\ \ 10} \\ 9\ 0\ 2 \\ -\ 4\ 6\ 5 \\ \hline \end{array}$$

Step 3

$$\begin{array}{r} {\scriptstyle 8\ \ 9\ \ 12} \\ 9\ 0\ 2 \\ -\ 4\ 6\ 5 \\ \hline 4\ 3\ 7 \end{array}$$

$12 - 5 = 7$ Write 7

$9 - 6 = 3$ Write 3

$8 - 4 = 4$ Write 4

The answer 437 is roughly equal to the estimate 400.

In problem (d) we first borrow one hundred from 900 to get a 10 in the tens place. Then we borrow one 10 from the tens place to get a 12 in the ones place.

(e) In word problems or applications, we use subtraction whenever we have a total and one of the quantities adding up to that total is missing.

In this drawing, we see that the three smaller horizontal dimensions must add up to the 86-cm length along the top of the drawing. Therefore, the missing dimension is

$L = 86\text{ cm} - 32\text{ cm} - 25\text{ cm}$

Estimate: $80 - 30 - 20 = 30$

Step 1

$$\begin{array}{r} 8\ 6 \\ -\ 3\ 2 \\ \hline 5\ 4 \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 4\ \ 14} \\ 5\ 4 \\ -\ 2\ 5 \\ \hline 2\ 9 \end{array}$$

The missing dimension L is 29 cm. This is very close to our estimate of 30 cm.

Example 3

Let's work through a few examples of subtraction problems involving zero digits.

(a) $400 - 167 = ?$

Step 1

$$\begin{array}{r} 4\ 0\ 0 \\ -\ 1\ 6\ 7 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 3\ \ 10} \\ 4\ 0\ 0 \\ -\ 1\ 6\ 7 \\ \hline \end{array}$$

Step 3

$$\begin{array}{r} {\scriptstyle 3\ \ 9\ \ 10} \\ 4\ 0\ 0 \\ -\ 1\ 6\ 7 \\ \hline 2\ 3\ 3 \end{array}$$

Check

$$\begin{array}{r} 1\ 6\ 7 \\ +\ 2\ 3\ 3 \\ \hline 4\ 0\ 0 \end{array}$$

Do you see in steps 2 and 3 that we have rewritten 400 as $300 + 90 + 10$?

(b) $5006 - 2487 = ?$

Step 1

$$\begin{array}{r} 5\ 0\ 0\ 6 \\ -\ 2\ 4\ 8\ 7 \\ \hline \end{array}$$

Step 2

$$\begin{array}{r} {\scriptstyle 4\ \ 10} \\ 5\ 0\ 0\ 6 \\ -\ 2\ 4\ 8\ 7 \\ \hline \end{array}$$

Step 3

$$\begin{array}{r} {\scriptstyle 4\ \ 9\ \ 10} \\ 5\ 0\ 0\ 6 \\ -\ 2\ 4\ 8\ 7 \\ \hline \end{array}$$

Step 4

$$\begin{array}{r} {\scriptstyle 4\ \ 9\ \ 9\ \ 16} \\ 5\ 0\ 0\ 6 \\ -\ 2\ 4\ 8\ 7 \\ \hline 2\ 5\ 1\ 9 \end{array}$$

Check

$$\begin{array}{r} 2\ 4\ 8\ 7 \\ +\ 2\ 5\ 1\ 9 \\ \hline 5\ 0\ 0\ 6 \end{array}$$

Here is an example involving repeated borrowing.

(c) $24632 - 5718 = ?$

Step 1	Step 2	Step 3	Step 4	Check
2 4 6 3 2	2 4 6 $\not{3}$ 2	2 $\not{4}$ 6 $\not{3}$ 2	$\not{2}$ $\not{4}$ $\not{6}$ $\not{3}$ 2	5 7 1 8
− 5 7 1 8	− 5 7 1 8	− 5 7 1 8	− 5 7 1 8	+ 1 8 9 1 4
	2 12	3 16 2 12	1 13 16 2 12	
	1 4	9 1 4	1 8 9 1 4	2 4 6 3 2

Any subtraction problem that involves borrowing should always be checked in this way. It is very easy to make a mistake in this process.

More Practice

Subtract.

(a) $\begin{array}{r} 85 \\ -\ 28 \\ \hline \end{array}$ (b) $\begin{array}{r} 500 \\ -\ 234 \\ \hline \end{array}$ (c) $\begin{array}{r} 7008 \\ -\ 3605 \\ \hline \end{array}$ (d) $\begin{array}{r} 37206 \\ -\ 4738 \\ \hline \end{array}$

Answers

(a) 57 (b) 266 (c) 3403 (d) 32,468

Now check your progress on subtraction in Exercises 2.

Exercises 2 Subtraction of Whole Numbers

A. Subtract.

1. $\begin{array}{r} 13 \\ -\ 7 \\ \hline \end{array}$	2. $\begin{array}{r} 12 \\ -\ 5 \\ \hline \end{array}$	3. $\begin{array}{r} 8 \\ -\ 6 \\ \hline \end{array}$	4. $\begin{array}{r} 8 \\ -\ 0 \\ \hline \end{array}$	5. $\begin{array}{r} 11 \\ -\ 7 \\ \hline \end{array}$	6. $\begin{array}{r} 16 \\ -\ 7 \\ \hline \end{array}$
7. $\begin{array}{r} 10 \\ -\ 7 \\ \hline \end{array}$	8. $\begin{array}{r} 5 \\ -\ 5 \\ \hline \end{array}$	9. $\begin{array}{r} 12 \\ -\ 9 \\ \hline \end{array}$	10. $\begin{array}{r} 11 \\ -\ 8 \\ \hline \end{array}$	11. $\begin{array}{r} 10 \\ -\ 2 \\ \hline \end{array}$	12. $\begin{array}{r} 14 \\ -\ 6 \\ \hline \end{array}$
13. $\begin{array}{r} 12 \\ -\ 3 \\ \hline \end{array}$	14. $\begin{array}{r} 15 \\ -\ 6 \\ \hline \end{array}$	15. $\begin{array}{r} 9 \\ -\ 0 \\ \hline \end{array}$	16. $\begin{array}{r} 14 \\ -\ 5 \\ \hline \end{array}$	17. $\begin{array}{r} 9 \\ -\ 6 \\ \hline \end{array}$	18. $\begin{array}{r} 11 \\ -\ 5 \\ \hline \end{array}$
19. $\begin{array}{r} 15 \\ -\ 7 \\ \hline \end{array}$	20. $\begin{array}{r} 12 \\ -\ 7 \\ \hline \end{array}$	21. $\begin{array}{r} 13 \\ -\ 6 \\ \hline \end{array}$	22. $\begin{array}{r} 18 \\ -\ 0 \\ \hline \end{array}$	23. $\begin{array}{r} 16 \\ -\ 9 \\ \hline \end{array}$	24. $\begin{array}{r} 12 \\ -\ 4 \\ \hline \end{array}$
25. $\begin{array}{r} 0 \\ -\ 0 \\ \hline \end{array}$	26. $\begin{array}{r} 13 \\ -\ 8 \\ \hline \end{array}$	27. $\begin{array}{r} 17 \\ -\ 9 \\ \hline \end{array}$	28. $\begin{array}{r} 18 \\ -\ 9 \\ \hline \end{array}$	29. $\begin{array}{r} 14 \\ -\ 8 \\ \hline \end{array}$	30. $\begin{array}{r} 16 \\ -\ 8 \\ \hline \end{array}$
31. $\begin{array}{r} 15 \\ -\ 9 \\ \hline \end{array}$	32. $\begin{array}{r} 17 \\ -\ 8 \\ \hline \end{array}$	33. $\begin{array}{r} 14 \\ -\ 9 \\ \hline \end{array}$	34. $\begin{array}{r} 15 \\ -\ 8 \\ \hline \end{array}$	35. $\begin{array}{r} 13 \\ -\ 9 \\ \hline \end{array}$	36. $\begin{array}{r} 12 \\ -\ 8 \\ \hline \end{array}$

B. Subtract.

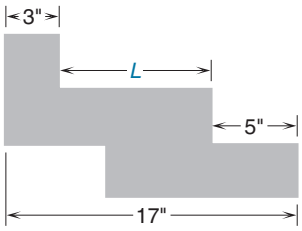
1. $\begin{array}{r} 40 \\ -\ 27 \\ \hline \end{array}$	2. $\begin{array}{r} 78 \\ -\ 49 \\ \hline \end{array}$	3. $\begin{array}{r} 51 \\ -\ 39 \\ \hline \end{array}$	4. $\begin{array}{r} 36 \\ -\ 17 \\ \hline \end{array}$	5. $\begin{array}{r} 42 \\ -\ 27 \\ \hline \end{array}$	6. $\begin{array}{r} 52 \\ -\ 16 \\ \hline \end{array}$
7. $\begin{array}{r} 65 \\ -\ 27 \\ \hline \end{array}$	8. $\begin{array}{r} 46 \\ -\ 17 \\ \hline \end{array}$	9. $\begin{array}{r} 84 \\ -\ 38 \\ \hline \end{array}$	10. $\begin{array}{r} 70 \\ -\ 48 \\ \hline \end{array}$	11. $\begin{array}{r} 34 \\ -\ 9 \\ \hline \end{array}$	12. $\begin{array}{r} 56 \\ -\ 18 \\ \hline \end{array}$
13. $\begin{array}{r} 546 \\ -\ 357 \\ \hline \end{array}$	14. $\begin{array}{r} 409 \\ -\ 324 \\ \hline \end{array}$	15. $\begin{array}{r} 476 \\ -\ 195 \\ \hline \end{array}$	16. $\begin{array}{r} 330 \\ -\ 76 \\ \hline \end{array}$	17. $\begin{array}{r} 504 \\ -\ 96 \\ \hline \end{array}$	18. $\begin{array}{r} 747 \\ -\ 593 \\ \hline \end{array}$

19.	400 127	20.	803 88	21.	632 58	22.	438 409	23.	6218 3409	24.	6084 386
25.	13042 524	26.	57022 980	27.	5007 266	28.	10000 386	29.	48093 500	30.	27004 4582

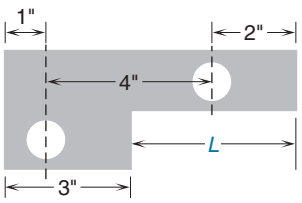
C. Applied Problems

1. **Painting** In planning for a particular job, a painter buys $486 worth of materials. When the job is completed, she returns some unused rollers and brushes for a credit of $27. What was the net amount of her bill?
2. **Construction** How many square feet (sq ft) of plywood remain from an original supply of 8000 sq ft after 5647 sq ft is used?
3. **Welding** A storage rack at the Tiger Tool Company contains 3540 ft of 1-in. stock. On a certain job 1782 ft is used. How much is left?
4. **Welding** Five pieces measuring 26, 47, 38, 27, and 32 cm are cut from a steel bar that was 200 cm long. Allowing for a total of 1 cm for waste in cutting, what is the length of the piece remaining?
5. **Trades Management** Taxes on a group of factory buildings owned by the Ace Manufacturing Company amounted to $875,977 eight years ago. Taxes on the same buildings last year amounted to $1,206,512. Find the increase in taxes.
6. **Trades Management** To pay their bills, the owners of Edwards Plumbing Company made the following withdrawals from their bank account: $72, $375, $84, $617, and $18. If the original balance was $5820, what was the amount of the new balance?
7. **Manufacturing** Which total volume is greater, four drums containing 72, 45, 39, and 86 liters, or three drums containing 97, 115, and 74 liters? By how much is it greater?
8. **Machine Trades** Determine the missing dimension (L) in the following drawings. (In the figures, feet are abbreviated with the ($'$) symbol, and inches are abbreviated with the ($''$) symbol.)

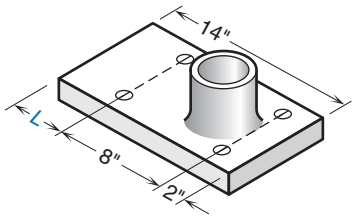
(a)



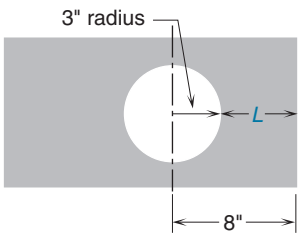
(b)



(c)



(d)

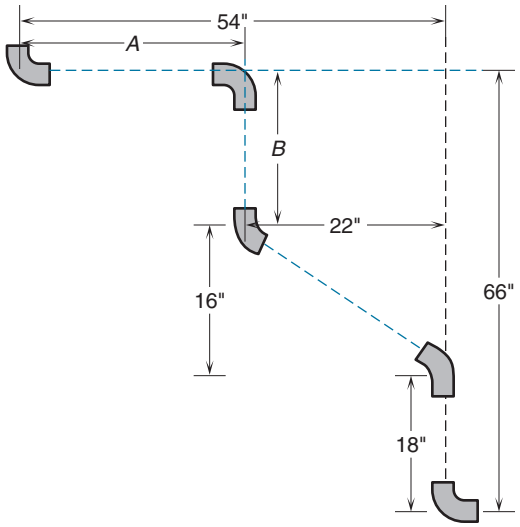


9. **Automotive Trades** A service department began the day with 238 gallons of coolant. During the day 64 gallons were used. How many gallons remained at the end of the day?

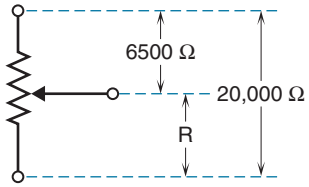
10. **Construction** A truck loaded with rocks weighs 14,260 lb. If the truck weighs 8420 lb, how much do the rocks weigh?

11. **Printing** A press operator has a total of 22,000 impressions to run for a job. If the operator runs 14,250 the first day, how many are left to run?

12. **Plumbing** In the following plumbing diagram, find pipe lengths *A* and *B*.



Problem 12



Problem 13

13. **Electronics** A *potentiometer* is a device that acts as a variable resistor, allowing a resistance to change from 0 ohms to some maximum value. If a 20,000-ohm potentiometer is set to 6500 ohms (Ω) as shown, calculate the resistance *R*.

14. **Allied Health** The white blood cell (WBC) count is an important indicator of health. Before surgery, the WBC count of a patient was 9472. After surgery, his WBC count had dropped to 5786. Calculate the difference in WBC count for this patient.

15. **Electronics** An electronic mixer can produce a signal with frequency equal to the difference between two input signals. If the input signals have frequency 1,350,000 and 850,000 hertz, calculate the difference frequency.

16. **Automotive Trades** A set of tires was rated at 40,000 miles. A car's odometer read 53,216 when the tires were installed and 91,625 when they needed replacing.

    (a) How long did they actually last?

    (b) By how many miles did they miss the advertised rating?

17. **Office Services** A gas meter read 8701 at the beginning of the month and 8823 at the end of the month. Find the difference between these readings to calculate the number of CCF (hundred cubic feet) used.

18. **General Interest** The tallest building in the United States is the Willis Tower (formerly the Sears Tower) in Chicago at 1451 feet. The tallest completed building in the world (as of 2008) is the Taipei 101 in Taipei, Taiwan, at 1671 feet. How much taller is the Taipei 101 than the Willis Tower?

D. Calculator Problems

1. **Plumbing** The Karroll Plumbing Co. has 10 trucks and, for the month of April, the following mileage was recorded on each.

Truck No.	Mileage at Start	Mileage at End
1	58352	60027
2	42135	43302
3	76270	78007
4	40006	41322
5	08642	10002
6	35401	35700
7	79002	80101
8	39987	40122
9	10210	11671
10	71040	73121

Find the mileage traveled by each truck during the month of April and the total mileage of all vehicles.

2. Which sum is greater?

987654321		123456789
87654321		123456780
7654321		123456700
654321		123456000
54321	or	123450000
4321		123400000
321		123000000
21		120000000
1		100000000

3. **Trades Management** If an electrician's helper earns $28,245 per year and she pays $3814 in withholding taxes, what is her take-home pay?

4. **Trades Management** The revenue of the Smith Construction Company for the year is $3,837,672 and the total expenses are $3,420,867. Find the difference, Smith's profit, for that year.

5. **Life Skills** Balance the following checking account record.

Date	Deposits	Withdrawals	Balance
7/1			$6375
7/3		$ 379	
7/4	$1683		
7/7	$ 474		
7/10	$ 487		
7/11		$2373	
7/15		$1990	
7/18		$ 308	
7/22		$1090	
7/26		$ 814	
8/1			*A*

(a) Find the new balance *A*.

(b) Keep a running balance by filling each blank in the balance column.

6. **Construction** A water meter installed by the BetterBilt Construction Company at a work site read 9357 cubic feet on June 1 and 17,824 cubic feet on July 1. How much water did they use during the month of June?

When you have completed these exercises, check your answers to the odd-numbered problems are at the end of this chapter, then turn to Section 3 to study the multiplication of whole numbers.

3 Multiplication of Whole Numbers

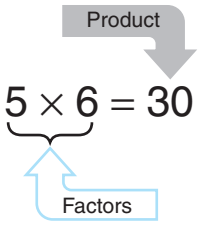
In a certain football game, the West Newton Waterbugs scored five touchdowns at six points each. How many total points did they score through touchdowns? We can answer the question several ways:

1. Count points, ...
2. Add touchdowns, $6 + 6 + 6 + 6 + 6 = ?$

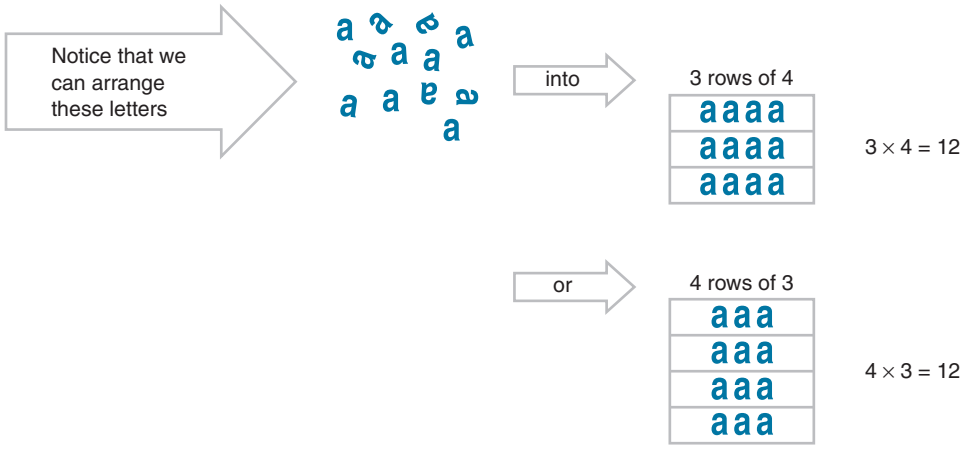
   or
3. Multiply $5 \times 6 = ?$

We're not sure about the mathematical ability of the West Newton scorekeeper, but most people would multiply. Multiplication is a shortcut method of performing repeated addition.

How many points did they score?



In a multiplication problem the *product* is the name given to the result of the multiplication. The numbers being multiplied are the *factors* of the product.



Changing the order of the factors does not change their product. This is called the *commutative* property of multiplication.

To become skillful at multiplication, you must know the one-digit multiplication table from memory. Even if you use a calculator for your work, you need to know the one-digit multiplication table to make estimates and to check your work.

→ Your Turn

Complete the table below by multiplying the number at the top by the number at the side and placing their product in the proper square. We have multiplied $3 \times 4 = 12$ and $2 \times 5 = 10$ for you.

Multiply	2	5	8	1	3	6	9	7	4
1									
7									
5	10								
4					12				
9									
2									
6									
3									
8									

→ Answers

Here is the completed multiplication table:

Multiplication Table

×	2	5	8	1	3	6	9	7	4
1	2	5	8	1	3	6	9	7	4
7	14	35	56	7	21	42	63	49	28
5	10	25	40	5	15	30	45	35	20
4	8	20	32	4	12	24	36	28	16
9	18	45	72	9	27	54	81	63	36
2	4	10	16	2	6	12	18	14	8
6	12	30	48	6	18	36	54	42	24
3	6	15	24	3	9	18	27	21	12
8	16	40	64	8	24	48	72	56	32

Multiplying by Zero and One

Notice that the product of any number and 1 is that same number. For example,

$1 \times 2 = 2$

$1 \times 6 = 6$

or even

$1 \times 753 = 753$

Zero has been omitted from the table because the product of any number and zero is zero. For example,

$$0 \times 2 = 0$$

$$0 \times 7 = 0$$

$$395 \times 0 = 0$$

Problems One-Digit Multiplication

Multiply as shown. Work quickly; you should be able to answer all problems in a set correctly in the time indicated. (These times are for community college students enrolled in a developmental math course.)

A. Multiply.

6	4	9	6	3	9	7	8	2	8
2	8	7	6	4	2	0	3	7	1
6	8	5	5	2	3	9	7	3	1
8	2	9	6	5	3	8	5	6	4
7	5	4	7	4	8	6	9	8	6
4	3	9	7	2	5	7	6	8	4
5	3	5	9	9	6	1	8	4	7
4	0	5	3	9	1	1	6	4	9

Average time = 100 sec
Record = 37 sec

B. Multiply.

2	6	3	5	6	4	4	8	2	7
8	5	3	7	3	5	7	6	6	9
8	0	2	3	1	5	6	9	5	8
4	6	9	8	9	5	4	5	2	9
3	7	5	6	9	2	7	8	9	2
5	7	8	9	4	4	6	8	0	2
5	9	1	8	6	4	9	0	2	7
5	3	7	7	6	3	9	4	1	8

Average time = 100 sec
Record = 36 sec

Check your answers at the end of this chapter.

If you are not able to perform these one-digit multiplications quickly from memory, you should practice until you can do so. A multiplication table is given in the Calculator Appendix. Use it if you need it.

Multiplying by Larger Numbers

The multiplication of larger numbers is based on the one-digit number multiplication table.

Example 1

Consider the problem:

$34 \times 2 =$ _____