

## 10.1.2.2: Subtracting Whole Numbers and Applications

### Learning Objectives

- Subtract whole numbers without regrouping.
- Subtract whole numbers with regrouping.
- Solve application problems using subtraction.

### Introduction

Subtracting involves finding the difference between two or more numbers. It is a method that can be used for a variety of applications, such as balancing a checkbook, planning a schedule, cooking, or travel. Suppose a government official is out of the U.S. on business for 142 days a year, including travel time. The number of days per year she is in the U.S. is the difference of 365 days and 142 days. Subtraction is one way of calculating the number of days she would be in the U.S. during the year.

When subtracting numbers, it is important to line up your numbers, just as with addition. The **minuend** is the greater number from which the lesser number is subtracted. The **subtrahend** is the number that is subtracted from the minuend. A good way to keep minuend and subtrahend straight is that since subtrahend has “subtra” in its beginning, it goes next to the subtraction sign and is the number being subtracted. The **difference** is the quantity that results from subtracting the subtrahend from the minuend. In  $86 - 52 = 34$ , 86 is the *minuend*, 52 is the *subtrahend*, and 34 is the *difference*.

### Subtracting Whole Numbers

When writing a subtraction problem, the minuend is placed above the subtrahend. This can be seen in the example below, where the minuend is 10 and the subtrahend is 7.

#### ✓ Example

$$10 - 7 = ?$$

#### Solution

$$\begin{array}{r} 10 \\ - 7 \\ \hline 3 \end{array}$$

$$10 - 7 = 3$$

When both numbers have more than one digit, be sure to work with one place value at a time, as in the example below.

#### ✓ Example

$$689 - 353 = ?$$

#### Solution

$$\begin{array}{r} 689 \\ - 353 \\ \hline \end{array}$$

First, set up the problem and align the numbers by place value.

$$\begin{array}{r} 689 \\ - 353 \\ \hline 6 \end{array}$$

Then, subtract the digits in the ones place,  $9 - 3$ .

$$\begin{array}{r} 689 \\ - 353 \\ \hline 36 \end{array}$$

Next, subtract the digits in the tens place,  $8 - 5$ .

$$\begin{array}{r} 689 \\ - 353 \\ \hline 336 \end{array}$$

Finally, subtract the digits in the hundreds place, 6 - 3.

$$689 - 353 = 336$$

Lining up numbers by place value becomes especially important when you are working with larger numbers that have more digits, as in the example below.

### ✓ Example

$$9,864 - 743 = ?$$

#### Solution

$$\begin{array}{r} 9864 \\ - 743 \\ \hline \end{array}$$

First, set up the problem and align the numbers by place value.

$$\begin{array}{r} 9864 \\ - 743 \\ \hline 1 \end{array}$$

Then, subtract the digits in the ones place, 4 - 3.

$$\begin{array}{r} 9864 \\ - 743 \\ \hline 21 \end{array}$$

Next, subtract the digits in the tens place, 6 - 4.

$$\begin{array}{r} 9864 \\ - 743 \\ \hline 121 \end{array}$$

Now, subtract the digits in the hundreds place, 8 - 7.

$$\begin{array}{r} 9864 \\ - 743 \\ \hline 9121 \end{array}$$

There is no digit to subtract in the thousands place, so keep the 9.

$$9,864 - 743 = 9,121$$

### ? Exercise

Subtract: 2,489 - 345

- A. 2,144
- B. 1,355
- C. 2,834
- D. 1,134

#### Answer

- A. Correct. You successfully subtracted 345 from 2,489.
- B. Incorrect. You probably did not line up your numbers correctly by place value. The correct answer is 2,144.
- C. Incorrect. You probably added when you should have subtracted. The correct answer is 2,144.
- D. Incorrect. You probably did not subtract correctly in the tens and thousands places. The correct answer is 2,144.

## Subtracting Whole Numbers with Regrouping

You may need to regroup when you subtract. When you **regroup**, you rewrite the number so you can subtract a greater digit from a lesser one.

When you're subtracting, just regroup to the next greater place-value position in the minuend and add 10 to the digit you're working with. As you regroup, cross out the regrouped digit in the minuend and place the new digit above it. This method is demonstrated in the example below.

### ✓ Example

$$3,225 - 476 = ?$$

#### Solution

$$\begin{array}{r} 3225 \\ - 476 \\ \hline \end{array}$$

First, set up the problem and align the digits by place value.

$$\begin{array}{r} 1\ 15 \\ 32\cancel{2}\cancel{5} \\ - 476 \\ \hline 9 \end{array}$$

Since you can't subtract 6 from 5, regroup, so 2 tens and 5 ones become 1 ten and 15 ones. Now you can subtract 6 from 15 to get 9.

$$\begin{array}{r} 1\ 11\ 15 \\ 3\cancel{2}\cancel{2}\cancel{5} \\ - 476 \\ \hline 4\ 9 \end{array}$$

Next, you need to subtract 7 tens from 1 ten. Regroup 2 hundreds as 1 hundred, 10 tens and add the 10 tens to 1 ten to get 11 tens. Now you can subtract 7 from 11 to get 4.

$$\begin{array}{r} 2\ 11\ 11\ 15 \\ \cancel{3}\cancel{2}\cancel{2}\cancel{5} \\ - 476 \\ \hline 7\ 4\ 9 \end{array}$$

To subtract the digits in the hundreds place, regroup 3 thousands as 2 thousands, 10 hundreds and add the 10 hundreds to the 1 hundred that is already in the hundreds place. Now, subtract 4 from 11 to get 7.

$$\begin{array}{r} 2\ 11\ 11\ 15 \\ \cancel{3}\cancel{2}\cancel{2}\cancel{5} \\ - 476 \\ \hline 2\ 7\ 4\ 9 \end{array}$$

Since there is no digit in the thousands place of the subtrahend, bring down the 2 in the thousands place into the answer.

$$3,225 - 476 = 2,749$$

### ? Exercise

Subtract:  $1,610 - 880$

- A. 1,522
- B. 2,490
- C. 730
- D. 620

#### Answer

- A. Incorrect. You probably did not line up the numbers by place value when you were subtracting. The correct answer is 730.
- B. Incorrect. You probably added the numbers instead of subtracting. The correct answer is 730.
- C. Correct. You successfully subtracted 880 from 1,610.
- D. Incorrect. You probably did not regroup correctly. The correct answer is 730.

### Checking Your Work

You can check subtraction by adding the difference and the subtrahend. The sum should be the same as the minuend.

### ✓ Example

Check to make sure that 7 subtracted from 12 is equal to 5.

#### Solution

$$12 - 7 = 5$$

$$\begin{array}{r} 5 \\ + 7 \\ \hline 12 \end{array}$$

Write out the original equation. The minuend is 12, the subtrahend is 7, and the difference is 5.

Next, add the difference, 5, to the subtrahend, 7, which results in the number 12. This confirms that your answer is correct.

The answer of 5 is correct.

Checking your work is very important and should always be performed when time permits.

## Subtracting Numbers Using the Expanded Form

An alternative method to subtract involves writing numbers in expanded form, as shown in the examples below. If you have 4 tens and want to subtract 1 ten, you can just think (4 - 1) tens and get 3 tens. Let's see how that works.

### ✓ Example

$$45 - 12 = ?$$

#### Solution

$$45 = 40 + 5$$

$$12 = 10 + 2$$

Let's write the numbers in expanded form so you can understand what they really mean.

$$\begin{array}{r} 45 = 40 + 5 \\ 12 = 10 + 2 \\ \hline 30 \end{array}$$

For the tens, the minuend is 40, or 4 tens. The subtrahend is 10, or 1 ten. Since  $4 - 1 = 3$ , 4 tens - 1 ten = 3 tens, or 30.

$$\begin{array}{r} 45 = 40 + 5 \\ 12 = 10 + 2 \\ \hline 30 + 3 \end{array}$$

Now, the ones.  $5 - 2 = 3$ . So,  $30 + 3 = 33$ .

$$45 - 12 = 33$$

Now let's use this method in the example below, which asks for the difference of 467 and 284. In the tens place of this problem, you need to subtract 8 from 6. What can you do?

### ✓ Example

$$467 - 284 = ?$$

#### Solution

Step 1: Separate by place value

$$\begin{array}{l} 4 \text{ hundreds} + 6 \text{ tens} + 7 \text{ ones} \\ - 2 \text{ hundreds} + 8 \text{ tens} + 4 \text{ ones} \end{array}$$

Write both the minuend and the subtrahend in expanded form.

Step 2: Identify impossible differences

$$6 - 8 = [ \quad ]$$

Identify differences that are not whole numbers. Since 8 is greater than 6, you won't get a whole number difference.

Step 3: Regroup

$$\begin{array}{r} 3 \text{ hundreds} + 16 \text{ tens} + 7 \text{ ones} \\ - 2 \text{ hundreds} + 8 \text{ tens} + 4 \text{ ones} \\ \hline 1 \text{ hundred} + 8 \text{ tens} + 3 \text{ ones} \end{array}$$

Regroup one of the hundreds from the 4 hundreds into 10 tens and add it to the 6 tens. Now you have 16 tens. Subtracting 8 tens from 16 tens yields a difference of 8 tens.

Step 4: Combine the parts

$$1 \text{ hundred} + 8 \text{ tens} + 3 \text{ ones} = 183$$

Combining the resulting differences for each place value yields a final answer of 183.

$$467 - 284 = 183$$

### ? Exercise

A woman who owns a music store starts her week with 965 CDs. She sells 452 by the end of the week. How many CDs does she have remaining?

- A. 313
- B. 513
- C. 510
- D. 1,417

### Answer

- A. Incorrect. You probably made an error when you were subtracting digits in the hundreds place. The correct answer is 513.
- B. Correct. You successfully subtracted 452 from 965. In expanded form, 513 is 5 hundreds, 1 ten, and 3 ones.
- C. Incorrect. You probably made an error when you were subtracting digits in the ones place. The correct answer is 513.
- D. Incorrect. You probably added instead of subtracted. The correct answer is 513.

### ✓ Example

$$45 - 17 = ?$$

### Solution

$$\begin{array}{l} 45 = 40 + 5 \\ 17 = 10 + 7 \end{array}$$

When you try to subtract 17 from 45, you would first try to subtract 7 from 5. But 5 is less than 7. Let's write the numbers in expanded form so you can see what they really mean.

$$\begin{array}{l} 45 = 30 + 15 \\ 17 = 10 + 7 \end{array}$$

Now, regroup 4 tens as 3 tens and 10 ones. Add the 10 ones to 5 ones to get 15 ones, which is greater than 7 ones, so you can subtract.

$$\begin{array}{r} 45 = 30 + 15 \\ - 17 = 10 + 7 \\ \hline 20 + 8 \end{array}$$

Finally, subtract 7 from 15, and 10 from 30 and add the results:  $20 + 8 = 28$ .

$$45 - 17 = 28$$

## Solve Application Problems Using Subtraction

You are likely to run into subtraction problems in everyday life, and it helps to identify key phrases in a problem that indicate that subtraction is either used or required. The following phrases appear in problem situations that require subtraction.

Phrase or word	Example problem

Less than	The cost of gas is 42 cents per gallon <b>less than</b> it was last month. The cost last month was 280 cents per gallon. How much is the cost of gas this month?
Take away	Howard made 84 cupcakes for a neighborhood picnic. People <b>took away</b> 67 cupcakes. How many did Howard have left?
Decreased by	The temperature was $84^{\circ}$ Fahrenheit in the early evening. It <b>decreased by</b> $15^{\circ}$ overnight. What was the temperature in the morning?
Subtracted from	Jeannie works in a specialty store on commission. When she sells something for \$75, she <b>subtracts</b> \$15 <b>from</b> the \$75 and gives the rest to the store. How much of the sale goes to the store?
The difference	What is <b>the difference</b> between this year's rent of \$1,530 and last year's rent of \$1,450?
Fewer than	The number of pies sold at this year's bake sale was 15 <b>fewer</b> than the number sold at the same event last year. Last year, 32 pies were sold. How many pies were sold this year?

When translating a phrase such as "5 fewer than 39" into a mathematical expression, the order in which the numbers appears is critical. Writing  $5 - 39$  would not be the correct translation. The correct way to write the expression is  $39 - 5$ . This results in the number 34, which is 5 fewer than 39. The chart below shows how phrases with the key words above can be written as mathematical expressions.

Phrase	Expression
three subtracted from six	$6 - 3$
the difference of ten and eight	$10 - 8$
Nine fewer than 40	$40 - 9$
Thirty-nine decreased by fourteen	$39 - 14$
Eighty-five take away twelve	$85 - 12$
Four less than one hundred eight	$108 - 4$

### ✓ Example

**Each year, John is out of the U.S. on business for 142 days, including travel time. The number of days per year he is in the U.S. is the difference of 365 days and 142 days. How many days during the year is John in the U.S.?**

#### Solution

$\begin{array}{r} 365 \\ -142 \\ \hline \end{array}$	The words "the difference of" suggest that you need to subtract to answer the problem. First, write out the problem based on the information given and align numbers by place value, $365 - 142$ .
$\begin{array}{r} 365 \\ -142 \\ \hline 3 \end{array}$	Then, subtract numbers in the ones place, $5 - 2$ .
$\begin{array}{r} 365 \\ -142 \\ \hline 23 \end{array}$	Subtract numbers in the tens place, $6 - 4$ .

$$\begin{array}{r} 365 \\ -142 \\ \hline 223 \end{array}$$

Finally, subtract numbers in the hundreds place, 3-1.

John is in the U.S. for 223 days during the year.

### ? Exercise

To make sure he was paid up for the month on his car insurance, Dave had to pay the difference of the amount on his monthly bill, which was \$289, and what he had paid earlier this month, which was \$132. Write the difference of \$289 and \$132 as a mathematical expression.

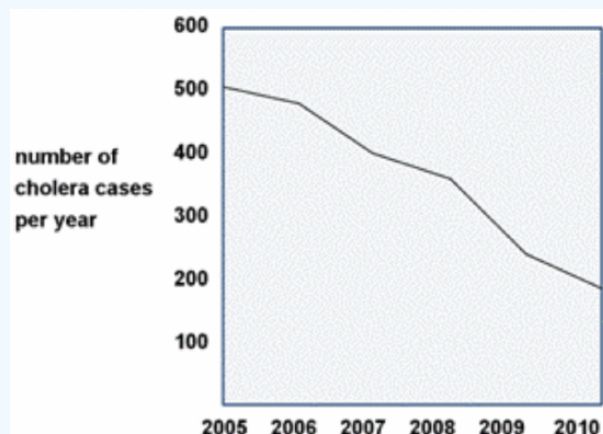
- A. 132-289
- B. 289+132
- C. 132+289
- D. 289-132

### Answer

- A. Incorrect. Dave had paid \$132, so that \$132 can be taken away from the full \$289 he owed for the month. The correct answer is 289-132.
- B. Incorrect. Dave owes the difference of 132 and 289, not the sum of 289 and 132. The correct answer is 289-132.
- C. Incorrect. Dave owes the difference of 132 and 289, not the sum of 132 and 289. The correct answer is 289-132.
- D. Correct. The difference of 289 and 132 can be written as 289-132.

### ✓ Example

An African village is now getting cleaner water than it used to get. The number of cholera cases in the village has declined over the past five years. Using the graph below, determine the difference between the number of cholera cases in 2005 and the number of cases in 2010.



### Solution

$$\begin{array}{r} 500 \\ -200 \\ \hline 300 \end{array}$$

The words “the difference” suggest that you need to subtract to answer the problem.

First, use the graph to find the number of cholera cases per year for the two years: 500 in 2005 and 200 in 2010.

Then write the subtraction problem and align numbers by place value. Subtract the numbers as you usually would.

$$500-200=300 \text{ cases}$$

## Summary

Subtraction is used in countless areas of life, such as finances, sports, statistics, and travel. You can identify situations that require subtraction by looking for key phrases, such as *difference* and *fewer than*. Some subtraction problems require regrouping to the next greater place value, so that the digit in the minuend becomes greater than the corresponding digit in the subtrahend. Subtraction problems can be solved without regrouping, if each digit in the minuend is greater than the corresponding digit in the subtrahend.

In addition to subtracting using the standard algorithm, subtraction can also be accomplished by writing the numbers in expanded form so that both the minuend and the subtrahend are written as the sums of their place values.

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