

10.1.2.3: Estimation

Learning Objectives

- Use rounding to estimate sums and differences.
- Use rounding to estimate the solutions for application problems.

Introduction

An **estimate** is an answer to a problem that is close to the solution, but not necessarily exact. Estimating can come in handy in a variety of situations, such as buying a computer. You may have to purchase numerous devices: a computer tower and keyboard for \$1,295, a monitor for \$679, the printer for \$486, the warranty for \$196, and software for \$374. Estimating can help you know *about* how much you'll spend without actually adding those numbers exactly.

Estimation usually requires **rounding**. When you round a number, you find a new number that's close to the original one. A rounded number uses zeros for some of the place values. If you round to the nearest ten, you will have a zero in the ones place. If you round to the nearest hundred, you will have zeros in the ones and tens places. Because these place values are zero, adding or subtracting is easier, so you can find an estimate to an exact answer quickly.

It is often helpful to estimate answers before calculating them. Then if your answer is not close to your estimate, you know something in your problem-solving process is wrong.

Using Rounding to Estimate Sums and Differences

Suppose you must add a series of numbers. You can round each addend to the nearest hundred to estimate the sum.

✓ Example

Estimate the sum $1,472+398+772+164$ by rounding each number to the nearest hundred.

Solution

1, 472 rounds to	1, 500
398 rounds to	400
772 rounds to	800
164 rounds to	200

First, round each number to the nearest hundred.

1, 500
400
800
+ 200
<hr/> 2, 900

Then, add the rounded numbers together.

The estimate is 2,900

In the example above, the exact sum is 2,806. Note how close this is to the estimate, which is 94 greater.

In the example below, notice that rounding to the nearest ten produces a far more accurate estimate than rounding to the nearest hundred. In general, rounding to the lesser place value is more accurate, but it takes more steps.

✓ Example

Estimate the sum $1,472+398+772+164$ by first rounding each number to the nearest ten.

Solution

1, 472 rounds to 1, 470
 398 rounds to 400
 772 rounds to 770
 164 rounds to 160

First, round each number to the nearest ten.

12
 1470
 400
 + 160

 00

Next, add the ones and then the tens. Here, the sum of 7, 7, and 6 is 20. Regroup.

12
 1470
 400
 770
 + 160

 800

Now, add the hundreds. The sum of the digits in the hundreds place is 18. Regroup.

12
 1470
 400
 770
 + 160

 2800

Finally, add the thousands. The sum in the thousands place is 2.

The estimate is 2,800.

Note that the estimate is 2,800, which is only 6 less than the actual sum of 2,806.

? Exercise

In three months, a freelance graphic artist earns \$1,290 for illustrating comic books, \$2,612 for designing logos, and \$4,175 for designing web sites. Estimate how much she earned in total by first rounding each number to the nearest hundred.

- A. \$8,200
- B. \$7,900
- C. \$8,000
- D. \$8,100

Answer

- A. Incorrect. You probably rounded one or more numbers up when you should have rounded them down. The correct answer is \$8,100
- B. Incorrect. You probably rounded one or more numbers down when you should have rounded them up. The correct answer is \$8,100
- C. Incorrect. You probably rounded each number to the nearest thousand instead of to the nearest hundred before adding. The correct answer is \$8,100
- D. Correct. You probably rounded the numbers to \$1,300, \$2,600 and \$4,200 and added them together successfully.

You can also estimate when you subtract, as in the example below. Because you round, you do not need to subtract in the tens or hundreds places.

✓ Example

Estimate the difference of 5,876 and 4,792 by first rounding each number to the nearest hundred.

Solution

5, 876	rounds to	5, 900
4, 792	rounds to	4, 800

First, round each number to the nearest hundred.

5, 900
<u>-4, 800</u>
1, 100

Subtract. No regrouping is needed since each number in the minuend is greater than or equal to the corresponding number in the subtrahend.

The estimate is 1,100.

The estimate is 1,100, which is 16 greater than the actual difference of 1,084.

? Exercise

Estimate the difference of 474,128 and 262,767 by rounding to the nearest thousand.

- A. 212,000
- B. 211,000
- C. 737,000
- D. 447,700

Answer

- A. Incorrect. You probably rounded 474,128 up to 475,000 when you should have rounded it down to 474,000. The correct answer is 211,000.
- B. Correct. You most likely rounded the numbers to 474,000 and 263,000 and subtracted successfully.
- C. Incorrect. You probably added instead of subtracted. The correct answer is 211,000.
- D. Incorrect. You probably used 26,300 instead of 263,000 as the number that you subtracted from 474,000. The correct answer is 211,000.

Solving Application Problems by Estimating

Estimating is handy when you want to be sure you have enough money to buy several things.

✓ Example

When buying a new computer, you find that the computer tower and keyboard cost \$1,295, the monitor costs \$679, the printer costs \$486, the 2-year warranty costs \$196, and a software package costs \$374. Estimate the total cost by first rounding each number to the nearest hundred.

Solution

1, 295	rounds to	1, 300
679	rounds to	700
486	rounds to	500
196	rounds to	200
374	rounds to	400

First, round each number to the nearest hundred.

$$\begin{array}{r}
 2 \\
 1300 \\
 700 \\
 500 \\
 200 \\
 + 400 \\
 \hline
 3,100
 \end{array}$$

Add.
After adding all of the rounded values, the estimated answer is \$3,100.

The total cost is approximately \$3,100.

Estimating can also be useful when calculating the total distance one travels over several trips.

✓ Example

James travels 3,247 meters to the park, then travels 582 meters to the store. He then travels 1,634 meters back to his house. Find the total distance traveled by first rounding each number to the nearest ten.

Solution

$$\begin{array}{lll}
 3247 & \text{rounds to} & 3250 \\
 582 & \text{rounds to} & 580 \\
 1634 & \text{rounds to} & 1630
 \end{array}$$

First, round each number to the nearest ten.

$$\begin{array}{r}
 1 \\
 3250 \\
 580 \\
 + 1630 \\
 \hline
 60
 \end{array}$$

Adding the numbers in the tens place gives 16, so you need to regroup.

$$\begin{array}{r}
 11 \\
 3250 \\
 580 \\
 + 1630 \\
 \hline
 460
 \end{array}$$

Adding the numbers in the hundreds place gives 14, so regroup.

$$\begin{array}{r}
 11 \\
 3250 \\
 580 \\
 + 1630 \\
 \hline
 5,460
 \end{array}$$

Adding the numbers in the thousands place gives 5.

The total distance traveled was approximately 5,460

In the example above, the final estimate is 5,460 meters, which is 3 less than the actual sum of 5,463 meters.

Estimating is also effective when you are trying to find the difference between two numbers. Problems dealing with mountains like the example below may be important to a meteorologist, a pilot, or someone who is creating a map of a given region. As in other problems, estimating beforehand can help you find an answer that is close to the exact value, preventing potential errors in your calculations.

✓ Example

One mountain is 10,496 feet high and another mountain is 7,421 feet high. Find the difference in height by first rounding each number to the nearest 100.

Solution

10, 496 rounds to 10, 500
7, 421 rounds to 7, 400

$$\begin{array}{r} 10,500 \\ - 7,400 \\ \hline 3,100 \end{array}$$

First, round each number to the nearest hundred.

Then, align the numbers and subtract.

The final estimate is 3,100, which is 25 greater than the actual value of 3,075.

The estimated difference in height between the two mountains is 3,100 feet.

? Exercise

A space shuttle traveling at 17,581 miles per hour decreases its speed by 7,412 miles per hour. Estimate the speed of the space shuttle after it has slowed down by rounding each number to the nearest hundred.

- A. 10,100 miles per hour
- B. 10,200 miles per hour
- C. 25,000 miles per hour
- D. 25,100 miles per hour

Answer

- A. Incorrect. You probably rounded the subtrahend up or the minuend down. You should have rounded the subtrahend of 7,412 down to 7,400 and the minuend of 17,581 up to 17,600. The correct answer is 10,200.
- B. Correct. You correctly rounded both numbers and subtracted them successfully.
- C. Incorrect. You probably added when you should have subtracted. The correct answer is 10,200
- D. Incorrect. You probably rounded incorrectly and added when you should have subtracted. The correct answer is 10,200

Summary

Estimation is very useful when an exact answer is not required. You can use estimation for problems related to travel, finances, and data analysis. Estimating is often done before adding or subtracting by rounding to numbers that are easier to think about. Following the rules of rounding is essential to the practice of accurate estimation.

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