

# 1.4

## ROUNDING AND ESTIMATING; ORDER

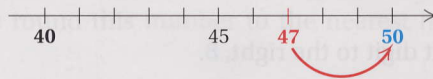
### a Rounding

We round numbers in various situations when we do not need an exact answer. For example, we might round to see if we are being charged the correct amount in a store. We might also round to check if an answer to a problem is reasonable or to check a calculation done by hand or on a calculator.

To understand how to round, we first look at some examples using number lines, even though this is not the way we generally do rounding.

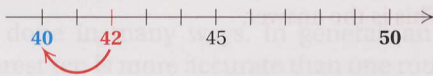
**EXAMPLE 1** Round 47 to the nearest ten.

Here is a part of a number line; 47 is between 40 and 50. Since 47 is closer to 50, we round up to 50.



**EXAMPLE 2** Round 42 to the nearest ten.

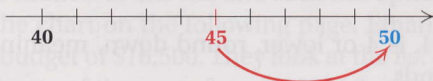
42 is between 40 and 50. Since 42 is closer to 40, we round down to 40.



Do Exercises 1–4.

**EXAMPLE 3** Round 45 to the nearest ten.

45 is halfway between 40 and 50. We could round 45 down to 40 or up to 50. We agree to round up to 50.



When a number is halfway between rounding numbers, round up.

Do Exercises 5–7.

Here is a rule for rounding.

#### ROUNDING WHOLE NUMBERS

To round to a certain place:

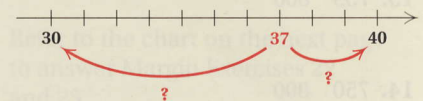
- Locate the digit in that place.
- Consider the next digit to the right.
- If the digit to the right is 5 or higher, round up. If the digit to the right is 4 or lower, round down.
- Change all digits to the right of the rounding location to zeros.

### Objectives

- Round to the nearest ten, hundred, or thousand.
- Estimate sums and differences by rounding.
- Use  $<$  or  $>$  for  $\square$  to write a true sentence in a situation like 6  $\square$  10.

Round to the nearest ten.

1. 37  $\square$  40



2. 52  $\square$  50

3. 73  $\square$  70

4. 98  $\square$  100

Round to the nearest ten.

5. 35  $\square$  40

6. 75  $\square$  80

7. 85  $\square$  90

Answers on page A-2

Round to the nearest ten.

8. 137    140

9. 473    470

10. 235    240

11. 285    290

Round to the nearest hundred.

12. 641    600

13. 759    800

14. 750    800

15. 9325    9300

Round to the nearest thousand.

16. 7896    8000

17. 8459    8000

18. 19,343    19,000

19. 68,500    69,000

Answers on page A-2

## Study Tips

### USE ABBREVIATIONS

If you take notes and have trouble keeping up with your instructor, use abbreviations to speed up your work. Consider standard abbreviations like “Ex” for “Example,” “ $\approx$ ” for “is approximately equal to,” “ $\therefore$ ” for “therefore,” and “ $\Rightarrow$ ” for “implies.” Feel free to create your own abbreviations as well.

**EXAMPLE 4** Round 6485 to the nearest ten.

a) Locate the digit in the tens place, 8.

$$\begin{array}{cccc} 6 & 4 & 8 & 5 \\ & & \uparrow & \end{array}$$

b) Consider the next digit to the right, 5.

$$\begin{array}{cccc} 6 & 4 & 8 & 5 \\ & & \uparrow & \end{array}$$

c) Since that digit, 5, is 5 or higher, round 8 tens up to 9 tens.

d) Change all digits to the right of the tens digit to zeros.

$$6490 \leftarrow \text{This is the answer.}$$

**EXAMPLE 5** Round 6485 to the nearest hundred.

a) Locate the digit in the hundreds place, 4.

$$\begin{array}{cccc} 6 & 4 & 8 & 5 \\ & \uparrow & & \end{array}$$

b) Consider the next digit to the right, 8.

$$\begin{array}{cccc} 6 & 4 & 8 & 5 \\ & \uparrow & & \end{array}$$

c) Since that digit, 8, is 5 or higher, round 4 hundreds up to 5 hundreds.

d) Change all digits to the right of hundreds to zeros.

$$6500 \leftarrow \text{This is the answer.}$$

**EXAMPLE 6** Round 6485 to the nearest thousand.

a) Locate the digit in the thousands place, 6.

$$\begin{array}{cccc} 6 & 4 & 8 & 5 \\ \uparrow & & & \end{array}$$

b) Consider the next digit to the right, 4.

$$\begin{array}{cccc} 6 & 4 & 8 & 5 \\ \uparrow & & & \end{array}$$

c) Since that digit, 4, is 4 or lower, round down, meaning that 6 thousands stays as 6 thousands.

d) Change all digits to the right of thousands to zeros.

$$6000 \leftarrow \text{This is the answer.}$$

Do Exercises 8–19.

### Caution!

7000 is not a correct answer to Example 6. It is incorrect to round from the ones digit over, as follows:

$$6485, \rightarrow 6490, \rightarrow 6500, \rightarrow 7000.$$

Note that 6485 is closer to 6000 than it is to 7000.

We can use the symbol  $\approx$ , read “**is approximately equal to**,” to indicate that we have rounded 6485 to 6490. Thus, in Example 4, we can write

$$6485 \approx 6490.$$

Sometimes rounding involves changing more than one digit in a number.

**EXAMPLE 7** Round 78,595 to the nearest ten.

a) Locate the digit in the tens place, 9.

7 8,5 9 5  
          ↑

b) Consider the next digit to the right, 5.

7 8,5 9 5  
          ↑

c) Since that digit, 5, is 5 or higher, round 9 tens to 10 tens. To carry this out, we think of 10 tens as 1 hundred + 0 tens, and increase the hundreds digit by 1, to get 6 hundreds + 0 tens. We then write 6 in the hundreds place and 0 in the tens place.

d) Change the digit to the right of the tens digit to zero.

7 8,6 0 0 ← This is the answer.

Note that if we round this number to the nearest hundred, we get the same answer.

Do Exercises 20 and 21.

## b Estimating

Estimating can be done in many ways. In general, an estimate made by rounding to the nearest ten is more accurate than one rounded to the nearest hundred, and an estimate rounded to the nearest hundred is more accurate than one rounded to the nearest thousand, and so on.

In the following example, we see how estimation can be used in making a purchase.

**EXAMPLE 8** *Estimating the Cost of an Automobile Purchase.* Ethan and Olivia Benson are shopping for a new car. They are considering a Saturn ION. There are three basic models of this car, and each has options beyond the basic price, as shown in the chart on the following page. Ethan and Olivia have allowed themselves a budget of \$16,500. They look at the list of options and want to make a quick estimate of the cost of model ION·2 with all the options.

Estimate by rounding to the nearest hundred the cost of the ION·2 with all the options and decide whether it will fit into their budget.



20. Round 48,968 to the nearest ten, hundred, and thousand.

48,970; 49,000; 49,000

21. Round 269,582 to the nearest ten, hundred, and thousand.

269,580; 269,600; 270,000

Refer to the chart on the next page to answer Margin Exercises 22 and 23.

22. By eliminating options, find a way that Ethan and Olivia can buy the ION·2 and stay within their \$16,500 budget.

Eliminate the power sunroof and the power package. Answers may vary.

23. Tara and Alex are shopping for a new car. They are considering a Saturn ION·3 and have allowed a budget of \$19,000.

a) Estimate by first rounding to the nearest hundred the cost of an ION·3 with all the options. \$18,300

b) Can they afford this car with a budget of \$19,000? Yes

Answers on page A-2

<b>MODEL ION-1 SEDAN (4 DOOR) 2.2-LITER ENGINE, 4-SPEED AUTOMATIC TRANSMISSION</b>	<b>MODEL ION-2 SEDAN (4 DOOR) 2.2-LITER ENGINE, 5-SPEED MANUAL TRANSMISSION</b>	<b>MODEL ION-3 SEDAN (4 DOOR) 2.2-LITER ENGINE, 5-SPEED MANUAL TRANSMISSION</b>
Base Price: \$12,975	Base Price: \$14,945	Base Price: \$16,470
Each of these vehicles comes with several options. Note that some of the options are standard on certain models. Others are not available for all models.		
Antilock Braking System with Traction Control:	\$400	
Head Curtain Side Air Bags:	\$395	
Power Sunroof (Not available for ION-1):	\$725	
Rear Spoiler (Not available for ION-1):	\$250	
Air Conditioning with Dust and Pollen Filtration (Standard on ION-2 and ION-3):	\$960	
CD/MP3 Player with AM/FM Stereo and 4 Coaxial Speakers (Standard on ION-3):	ION-1—\$510 ION-2—\$220	
Power Package: Power Windows, Power Exterior Mirrors, Remote Keyless Entry, and Cruise Control (Not available for ION-1 and Standard for ION-3):	\$825	

Source: Saturn

24. Estimate the sum by first rounding to the nearest ten. Show your work.

$$\begin{array}{r} 74 \\ 23 \\ 35 \\ + 66 \\ \hline \end{array}$$

$$70 + 20 + 40 + 70 = 200$$

25. Estimate the sum by first rounding to the nearest hundred. Show your work.

$$\begin{array}{r} 650 \\ 685 \\ 238 \\ + 168 \\ \hline \end{array}$$

$$700 + 700 + 200 + 200 = 1800$$

First, we list the base price of the ION-2 and then the cost of each of the options. We then round each number to the nearest hundred and add.

$$\begin{array}{r} 14,945 \\ 400 \\ 395 \\ 725 \\ 250 \\ 220 \\ + 825 \\ \hline \end{array} \qquad \begin{array}{r} 14,900 \\ 400 \\ 400 \\ 700 \\ 300 \\ 200 \\ + 800 \\ \hline \end{array}$$

17,700 ← Estimated answer

Air conditioning is standard on the ION-2, so we do not include that cost. The estimated cost is \$17,700. Since Ethan and Olivia have allowed themselves a budget of \$16,500 for the car, they will need to forgo some options.

Do Exercises 22 and 23 on the preceding page.

**EXAMPLE 9** Estimate this sum by first rounding to the nearest ten:

$$78 + 49 + 31 + 85.$$

We round each number to the nearest ten. Then we add.

$$\begin{array}{r} 78 \\ 49 \\ 31 \\ + 85 \\ \hline \end{array} \qquad \begin{array}{r} 80 \\ 50 \\ 30 \\ + 90 \\ \hline \end{array}$$

250 ← Estimated answer

Do Exercises 24 and 25.

Answers on page A-2

**EXAMPLE 10** Estimate the difference by first rounding to the nearest thousand:  $9324 - 2849$ .

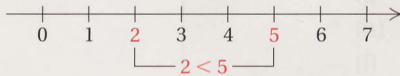
We have

$$\begin{array}{r} 9324 \\ - 2849 \\ \hline \end{array} \quad \begin{array}{r} 9000 \\ - 3000 \\ \hline 6000 \leftarrow \text{Estimated answer} \end{array}$$

Do Exercises 26 and 27.

## C Order

We know that 2 is not the same as 5, that is, 2 is not equal to 5. We express this by the sentence  $2 \neq 5$ . We also know that 2 is less than 5. We symbolize this by the expression  $2 < 5$ . We can see this order on the number line: 2 is to the left of 5. The number 0 is the smallest whole number, so  $0 < a$  for any whole number  $a$ .



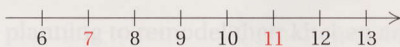
### ORDER OF WHOLE NUMBERS

For any whole numbers  $a$  and  $b$ :

- $a < b$  (read “ $a$  is less than  $b$ ”) is true when  $a$  is to the left of  $b$  on the number line.
- $a > b$  (read “ $a$  is greater than  $b$ ”) is true when  $a$  is to the right of  $b$  on the number line.

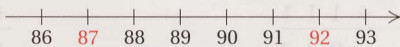
We call  $<$  and  $>$  **inequality symbols**.

**EXAMPLE 11** Use  $<$  or  $>$  for  $\square$  to write a true sentence:  $7 \square 11$ .



Since 7 is to the left of 11 on the number line,  $7 < 11$ .

**EXAMPLE 12** Use  $<$  or  $>$  for  $\square$  to write a true sentence:  $92 \square 87$ .



Since 92 is to the right of 87 on the number line,  $92 > 87$ .

A sentence like  $8 + 5 = 13$  is called an **equation**. It is a *true* equation. The equation  $4 + 8 = 11$  is a *false* equation. A sentence like  $7 < 11$  is called an **inequality**. The sentence  $7 < 11$  is a *true* inequality. The sentence  $23 > 69$  is a *false* inequality.

Do Exercises 28–33.

26. Estimate the difference by first rounding to the nearest hundred. Show your work.

$$\begin{array}{r} 9285 \\ - 6739 \\ \hline \end{array}$$

$$9300 - 6700 = 2600$$

27. Estimate the difference by first rounding to the nearest thousand. Show your work.

$$\begin{array}{r} 23,278 \\ - 11,698 \\ \hline \end{array}$$

$$23,000 - 12,000 = 11,000$$

Use  $<$  or  $>$  for  $\square$  to write a true sentence. Draw a number line if necessary.

28.  $8 \square 12 <$

29.  $12 \square 8 >$

30.  $76 \square 64 >$

31.  $64 \square 76 <$

32.  $217 \square 345 <$

33.  $345 \square 217 >$

Answers on page A-2