LESSON

Reporting with Precision and Accuracy

Common Core Standards

The student is expected to:



Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. Also N-Q.A.1

Mathematical Practices



Language Objective

Show how to determine how many significant digits to report in the results of measurement calculations, such as finding perimeter and area.

ENGAGE

Essential Question: How do you use significant digits when reporting the results of calculations involving measurement?

You use the place value of the last significant digit in the least precise measurement to report a sum or difference. You use the number of significant digits in the least precise measurement to report a product or quotient.

PREVIEW: LESSON PERFORMANCE TASK

View the Engage section online. Discuss how you can find the amount of electricity produced by a field of solar panels if you know how much is produced by one square foot of solar panel. Then preview the Lesson Performance Task. 1.3 Reporting with Precision and Accuracy



Essential Question: How do you use significant digits when reporting the results of calculations involving measurement?



Ø Explore Comparing Precision of Measurements

Numbers are values without units. They can be used to compute or to describe measurements. Quantities are realword values that represent specific amounts. For instance, 15 is a number, but 15 grams is a quantity.

Class

Precision is the level of detail of a measurement, determined by the smallest unit or fraction of a unit that can be reasonably measured.

Accuracy is the closeness of a given measurement or value to the actual measurement or value. Suppose you know the actual measure of a quantity, and someone else measures it. You can find the accuracy of the measurement by finding the absolute value of the difference of the two.

Complete the table to choose the more precise measurement.

Measurement 1	Measurement 2	Smaller Unit	More Precise Measurement
4 g	4.3 g	0.1 g	4.3 g
5.71 oz	5.7 oz	0.01 oz	5.71 oz
4.2 m	422 cm	1 cm	422 cm
7 ft 2 in.	7.2 in.	0.1 in.	7.2 in.

B Eric is a lab technician. Every week, he needs to test the scales in the lab to make sure that they are accurate. He uses a standard mass that is exactly 8.000 grams and gets the following results.

Scale	Mass
Scale 1	8.02 g
Scale 2	7.9 g
Scale 3	8.029 g



Complete each statement:

Module 1

The measurement for Scale

____ is the most precise

because it measures to the nearest _____, which is smaller than the smallest unit measured on the other two scales.



Lesson 3

HARDCOVER PAGES 21-30

Turn to these pages to find this lesson in the hardcover student edition.

© Houghton Mifflin Harcourt Publishing Compan

Name

\bigcirc	Find the accuracy of each of the measurements in Step 1	В.
	Scale 1: Accuracy = $ 8.000 - \frac{8.02}{ 8.000 } = \frac{0.02}{ 8.000 }$	
	Scale 2: Accuracy = $ 8.000 - $ 7.9 $ = $ 0.1	
	Scale 3: Accuracy = $ 8.000 - 8.029 = 0.029$	
	Complete each statement: the measurement for Scale	1 , which is 8.02 grams,
	is the most accurate because $0.02 < 0.029 < 0.1$.	

Reflect

Discussion Given two measurements of the same quantity, is it possible that the more precise measurement is not the more accurate? Why do you think that is so?
 Yes. Possible answer: An electronic measuring device may not be functioning properly, or a device such as a ruler may not have been produced carefully. The person making the measurement may have made a mistake.

S Explain 1 Determining Precision of Calculated Measurements

As you have seen, measurements are reported to a certain precision. The reported value does not necessarily represent the actual value of the measurement. When you measure to the nearest unit, the actual length can be 0.5 unit less than the measured length or less than 0.5 unit greater than the measured length. So, a length reported as 4.5 centimeters could actually be anywhere between 4.45 centimeters and 4.55 centimeters, but not including 4.55 centimeters. It cannot include 4.55 centimeters because 4.55 centimeters reported to the nearest tenth would round *up* to 4.6 centimeters.

Example 1 Calculate the minimum and maximum possible areas. Round your answers to the nearest square centimeter.

(A) The length and width of a book cover are 28.3 centimeters and 21 centimeters, respectively.

Find the range of values for the actual length and width of the book cover.

Minimum length = (28.3 - 0.05) cm and maximum length = (28.3 + 0.05) cm, so 28.25 cm \leq length < 28.35 cm.

Minimum width = (21 - 0.5) cm and maximum width = (21 + 0.5) cm, so 20.5 cm \leq width < 21.5 cm.

Find the minimum and maximum areas.

 $Minimum area = minimum length \cdot minimum width$

 $= 28.25 \text{ cm} \cdot 20.5 \text{ cm} \approx 579 \text{ cm}^2$

Maximum area = maximum length \cdot maximum width

 $= 28.35 \text{ cm} \cdot 21.5 \text{ cm} \approx 610 \text{ cm}^2$

So 579 cm² \leq area < 610 cm².

Module 1

Lesson 3

Mifflin Hard

t Publishing Con

PROFESSIONAL DEVELOPMENT

Integrate Mathematical Practices

This lesson provides an opportunity to address Mathematical Practice **MP.5**, which calls for students to "use tools." By understanding that the measuring tools which measure to the smallest increment are the most precise, while those that provide measurements closest to the actual value are the most accurate, students learn how to select the most precise or most accurate measuring tools for an application.

28

EXPLORE

Comparing Precision of Measurements

AVOID COMMON ERRORS

Students may expect a measurement written with a smaller unit to be more precise than one written with a larger unit, but this is not necessarily true. For example, 0.025 m is more precise than 3 cm because 0.025 m is a measurement to the nearest 0.001 m and 3 cm is a measurement to the nearest 0.01 m.

QUESTIONING STRATEGIES

Is a more precise measurement always a more accurate measurement? Explain. No; a measurement could be very precise (specified to a very small unit) but still be inaccurate (not close to the actual value of the quantity being measured).

EXPLAIN 1

Determining Precision of Calculated Measurements

QUESTIONING STRATEGIES

How do you find the minimum and maximum possible values for the actual length of an object, given a measurement to the nearest unit? Add and subtract half of the measured unit.

Would you get a more precise value for the area of a painting if you measured its dimensions in inches or in centimeters? Explain. Centimeters; a centimeter is smaller than an inch, so the range of possible values for the length and width measurements would be smaller, and as a result the range of possible values for the area would be smaller. B The length and width of a rectangle are 15.5 centimeters and 10 centimeters, respectively.

Find the range of values for the actual length and width of the rectangle.

Minimum length = (15.5 - 0.05) cm and maximum length = (15.5 + 0.05) cm, so $15.45 \le$ length < 15.55. Minimum width = (10 - 0.5) cm and maximum width = (10 + 0.5) cm, so $9.5 \le$ width < 10.5. Find the minimum and maximum areas. Minimum area = minimum length \cdot minimum width = 15.45 cm $\cdot 9.5$ cm ≈ 147 cm²

Maximum area = maximum length \cdot maximum width

$$=$$
 15.55 cm \cdot 10.5 cm \approx 163 cm²

So <u>147</u> $cm^2 \le area < <u>163</u> <math>cm^2$.

Reflect

How do the ranges of the lengths and widths of the books compare to the range of the areas? What does that mean in terms of the uncertainty of the dimensions?
 The range of the areas is much greater than the range of both the length and the width.

The uncertainty in the length and width results in much greater uncertainty in the area.

Your Turn

³ Houghton Mifflin Harcourt Publishing Company

Calculate the minimum and maximum possible areas. Round your answers to the nearest whole square unit.

3. Sara wants to paint a wall. The length
and width of the wall are 2 meters and
1.4 meters, respectively.**4.** A rectangular garden plot measures
15 feet by 22.7 feet.**1.5** $m \le \text{length} < 2.5 \text{ m}$ **22.65** ft $\le \text{length} < 22.75$ ft**1.35** $m \le \text{width} < 1.45 \text{ m}$ **22.65** ft $\le \text{length} < 22.75$ ft**1.35** $m \le \text{width} < 1.45 \text{ m}$ **14.5** ft $\le \text{width} < 15.5$ ftMinimum area = 1.35 $m \cdot 1.5 m \approx 2 \text{ m}^2$ Minimum area = 14.5 ft $\cdot 22.65$ ft ≈ 328 ft²Maximum area = 1.45 $m \cdot 2.5 m \approx 4 \text{ m}^2$ So 328 ft² $\le \text{area} < 353$ ft².

Module 1 29

COLLABORATIVE LEARNING

Peer-to-Peer Activity

Have students work in pairs to find the number of significant digits in 0.0070. One student should find the number of significant digits directly and the other should find the number of non-significant digits and subtract them from the total digits.

Lesson 3

Explain 2 Identifying Significant Digits

Significant digits are the digits in measurements that carry meaning about the precision of the measurement.

Identifying Significant Digits		
Rule	Examples	
All nonzero digits are significant.	55.98 has 4 significant digits.	
	115 has 3 significant digits.	
Zeros between two other significant digits are	102 has 3 significant digits.	
significant.	0.4000008 has 7 significant digits.	
Zeros at the end of a number to the right of a decimal	3.900 has 4 significant digits.	
point are significant.	0.1230 has 4 significant digits.	
Zeros to the left of the first nonzero digit in a decimal	0.00035 has 2 significant digits.	
are <i>not</i> significant.	0.0806 has 3 significant digits.	
Zeros at the end of a number without a decimal point	60,600 has 3 significant digits.	
are assumed to be <i>not</i> significant.	77,000,000 has 2 significant digits.	

Example 2 Determine the number of significant digits in a given measurement.

(A) 6040.0050 m

Significant Digits Rule	Digits	Count
Nonzero digits:	6040.0050	3
Zeros between two significant digits:	6 0 4 0 . 0 0 5 0	4
End zeros to the right of a decimal:	6040.0050	1
L	Total	8

So, 6040.0050 m has 8 significant digits.

B 710.080 cm

	Significant Digits Rule	Digits	Count	
	Nonzero digits:	⑦ ① ○ . ○ ⑧ ○	3	
	Zeros between two significant digits:	7 1 🔘 . 🔘 8 0	2	
	End zeros to the right of a decimal:	710.080	1	
	710.080 cm has6 significa	Total	6	
Modul	e 1	30		Lesson 3

EXPLAIN 2

Identifying Significant Digits

INTEGRATE MATHEMATICAL PRACTICES

Focus on Math Connections

MP.1 Point out that significant digits relate to precision. If two measurements of the same quantity are in the same units, the more precise measurement will have more significant digits. For example, 800.258 m, with six significant digits, is more precise than 800.3 m, with four significant digits.

QUESTIONING STRATEGIES

Houghton Mifflin Harcourt Publishing Company

Why is the first step in identifying significant digits to identify the nonzero digits? All nonzero digits are significant. To determine whether a zero is significant, you look at its position relative to the nonzero digits.

EXPLAIN 3

Using Significant Digits in Calculated Measurements

QUESTIONING STRATEGIES

If you want to calculate the area of a figure to three significant digits, what must be true about the measurements of the figure's dimensions? Why? Each measurement must be precise enough to have at least three significant digits. Calculating the area involves multiplying the dimensions, and the product may not have more significant digits than the factors.

Reflect

5. Critique Reasoning A student claimed that 0.045 and 0.0045 m have the same number of significant digits. Do you agree or disagree?
 Agree. Zeros to the right of the decimal point only count as significant digits if they are

either to the right of the last nonzero digit or between other significant digits.

7. 10,000 ft **one**

Your Turn

© Houghton Mifflin Harcourt Publishing Company • Image Credits: ©Ali Kabas/ Corbis Determine the number of significant digits in each measurement.

6. 0.052 kg two

8. 10.000 ft **five**

S Explain 3 Using Significant Digits in Calculated Measurements

When performing calculations with measurements of different precision, the number of significant digits in the solution may differ from the number of significant digits in the original measurements. Use the rules from the following table to determine how many significant digits to include in the result of a calculation.

Rules for Significant Digits in Calculated Measurements		
Operation		Rule
Addition or Subtraction The sum or difference must be rounded to the same place value as last significant digit of the least precise measurement.		ided to the same place value as last measurement.
Multiplication or Division The product or quotient must have no more significant digits than the least precise measurement.		
A rectangular swimming	pool measures 22.3 feet by 75 feet.	
A rectangular swimming Find the perimeter of th	pool measures 22.3 feet by 75 feet. e swimming pool using the correct	
number of significant digits.		
Perimeter	= sum of side lengths	
	= 22.3 ft + 75 ft + 22.3 ft + 75 ft	
	104 4 6	

The least precise measurement is 75 feet. Its last significant digit is in the ones place. So round the sum to the ones place. The perimeter is 195 ft.

Find the area of the swimming pool using the correct number of significant digits.

Area = length \cdot width

= 194.6 ft

 $= 22.3 \text{ ft} \cdot 75 \text{ ft} = 1672.5 \text{ ft}^2$

The least precise measurement, 75 feet, has two significant digits, so round the product to a number with two significant digits. The area is 1700 ft^2 .

Module 1 **31** Lesson 3

B A rectangular garden plot measures 21 feet by 25.2 feet.

Find the perimeter of the garden using the correct number of significant digits.

Perimeter = sum of side lengths = 21 ft + 25.2 ft + 21 ft + 25.2 ft = 92.4 ft

The least precise measurement is <u>**21 ft**</u>. Its last significant digit is in the ones place. So round the sum to the <u>**ones**</u> place. The perimeter is <u>**92 ft**</u>.

Find the area of the garden using the correct number of significant digits.

Area = length \cdot width = 21 ft \cdot 25.2 ft = 529.2 ft²

The least precise measurement, _____ has ____ significant digit(s), so round to a number with

2 significant digit(s). The area is 530 ft²

Reflect

- 9. In the example, why did the area of the garden and the swimming pool each have two significant digits? In each example, the least precise dimension had two significant digits.
- **10.** Is it possible for the perimeter of a rectangular garden to have more significant digits than its length or width does?

Yes. For example, if the width were 13 ft and the length were 501 ft, the perimeter would

be 1028 ft, and 1028 has 4 significant digits.

Your Turn

Find the perimeter and area of the given object. Make sure your answers have the correct number of significant digits.

 11. A children's sandbox measures 7.6 feet by 8.25 feet. Perimeter = 7.6 ft + 8.25 ft + 7.6 ft + 8.25 ft = 31.7 ft. The perimeter is 31.7 ft. Area = 7.6 ft • 8.25 ft = 62.7 ft². The area is 63 ft².

 12. A rectangular door measures 91 centimeters by 203.2 centimeters. Perimeter = 91 cm + 203.2 cm + 91 cm + 203.2 cm = 588.4 cm. The perimeter is 588 cm. Area = 91 cm • 203.2 ft = 18,491.2 cm². The area is 18,000 cm².

Module 1

32

Lesson 3

Mifflin Harcourt Publishing Compan

DIFFERENTIATE INSTRUCTION

Critical Thinking

Explain that it is sometimes useful to describe the precision of a measurement by finding the possible error as a percentage. For example, a measurement of 4 cm could represent an actual length ranging from 3.5 cm to 4.5 cm. Since 0.5 cm is 12.5% of 4 cm, the measurement has a possible error of $\pm 12.5\%$. On the other hand, a measurement of 1004 cm has a possible error of only $\pm 0.05\%$, since 0.5 cm is only 0.05% of 1004 cm. This difference in percent error reflects the fact that the same absolute error (0.5 cm) matters more when measuring a small object than when measuring a large object.

AVOID COMMON ERRORS

Students often confuse the rules for significant digits in calculations involving addition or subtraction with those for multiplication or division. The *number* of significant digits only matters when multiplying or dividing. One way to recognize that sums must instead be rounded by place value is to vertically align the numbers to be added. The rounded result should not have any nonzero digits in places to the right of the last significant digit of an addend. The same rule applies for subtraction.

EXPLAIN 4

Using Significant Digits in Estimation

AVOID COMMON ERRORS

When estimating, students may apply the rules for significant digits in calculated measurements to the original numbers instead of the rounded numbers. The rules should be applied to whichever numbers are actually used in the calculation.

QUESTIONING STRATEGIES

If you are given several numbers to add, some of which are rounded to the nearest thousand, does it make sense to give an answer to the nearest whole number? Explain. No, that would be too much precision. Since some of the addends have already been rounded, the final answer should also be rounded.

Explain 4 Using Significant Digits in Estimation

Real-world situations often involve estimation. Significant digits play an important role in making reasonable estimates.

A city is planning a classic car show. A section of road 820 feet long will be closed to provide a space to display the cars in a row. In past shows, the longest car was 18.36 feet long and the shortest car was 15.1 feet long. Based on that information, about how many cars can be displayed in this year's show?



Reflect

13. In the example, why wouldn't it be wise to use the length of a shorter car?

Using the length of a shorter car creates a risk of overestimating the number of cars that will fit. **14. Critical Thinking** How else might the number of cars be estimated? Would you expect the estimate to be the same? Explain.

Sample answer: The average length of the

shortest and longest cars could be used.

It is unlikely any two methods would

produce exactly the same estimate.

Your Turn

🗩 Elaborate

Estimate the quantity needed in the following situations. Use the correct number of significant digits.

- **15.** Claire and Juan are decorating a rectangular wall of 433 square feet with two types of rectangular pieces of fabric. One type has an area of 9.4 square feet and the other has an area of 17.2 square feet. About how many decorative pieces can Claire and Juan fit in the given area?
- **16.** An artist is making a mosaic and has pieces of smooth glass ranging in area from 0.25 square inch to 3.75 square inches. Suppose the mosaic is 34.1 inches wide and 50.0



© Houghton Mifflin Harcourt Publishing Company • Image Credits: ©Michae Freeman/Corbis

inches long. About how many pieces of glass will the artist need?



17.	Given two measurements, is it possible that the more accurate measurement is not the more precise? Justify your answer.			
	Yes. Sample answer: Suppose two friends measure a bench. One says the bench is			
	1.25 meters long, and the other says it is 1.5 meters long. If the bench is actually			
	1.48 meters long, the less precise measurement is more accurate.			
18.	What is the relationship between the range of possible error in the measurements used in a calculation and the range of possible error in the calculated measurement?			
	The range of possible error in the calculated values is greater.			
19.	Essential Question Check-In How do you use significant digits to determine how to report a sum or product of two measurements?			
	A sum should be rounded to the same place value as the last significant digit of the least			
	precise measurement. A product should have the same number of significant digits as the			
	least precise measurement.			
Mod	ule 1 34 Lesson 3			

LANGUAGE SUPPORT

Connect Vocabulary

Remind students that significant digits are the digits that carry meaning in measurements. Have students notice the word *significant*. Things that are significant are important. Have students discuss laws or rules that are significant or not significant in their lives. Significant examples may include school rules or household rules. Non-significant rules might include rules or laws that affect people in a different age group.

ELABORATE

INTEGRATE MATHEMATICAL PRACTICES

Focus on Math Connections

MP.1 Many of the measurements in this lesson are in metric units. Explain that the metric system is used by scientists because all the units are related by factors of ten, which simplifies calculations.

SUMMARIZE THE LESSON

How can you determine the number of significant digits to use when reporting the results of calculations based on measurements? The result of adding or subtracting measurements should be rounded to the same place value as the least precise measurement. The result of multiplying or dividing measurements should have the same number of significant digits as the least precise measurement.

EVALUATE



ASSIGNMENT GUIDE

Concepts and Skills	Practice
Explore Comparing Precision of Measurements	Exercises 1–8
Example 1 Determining Precision of Calculated Measurements	Exercises 9–12
Example 2 Identifying Significant Digits	Exercises 13–17
Example 3 Using Significant Digits in Calculated Measurements	Exercises 18–19, 22–24
Example 4 Using Significant Digits in Estimation	Exercises 20–21

🕸 Evaluate: Homework and Practice



Hints and Help
 Extra Practice

1. Choose the more precise measurement from the pair 54.1 cm and 54.16 cm. Justify your answer.

54.16 cm is more precise because 0.01 is smaller than 0.1 cm.

Choose the more precise measurement in each pair.

- **2.** 1 ft; (12 in.) **3.** 5 kg; (5212 g) **4.** 7 m; (7.7 m) **5.** 123 cm; (1291 mm)
- **6.** True or False? A scale that measures the mass of an object in grams to two decimal places is more precise than a scale that measures the mass of an object in milligrams to two decimal places. Justify your answer.

False. Both scales measure to the hundredths place, and 1 mg is smaller than 1 g. So, the scale that measures in milligrams is more precise.

7. Every week, a technician in a lab needs to test the scales in the lab to make sure that they are accurate. She uses a standard mass that is exactly 4 g and gets the following results.



a. Which scale gives the most precise measurement?

Scales 1 and 2 measure to the nearest 0.01 gram, and Scale 3 measures to the nearest 0.001 gram. Scale 3 is the most precise.

b. Which scale gives the most accurate measurement?

Scale 1: |4.000 - 4.05 | = 0.05, Scale 2: |4.000 - 3.98 | = 0.02, Scale 3: |4.000 - 4.021 | = 0.021 Scale 2 is the most accurate.

- **8.** A manufacturing company uses three measuring tools to measure lengths. The tools are tested using a standard unit exactly 7 cm long. The results are as follows.
 - a. Which tool gives the most precise measurement?
 Tool 1 measures to the nearest 0.001 cm,
 Tool 2 to the nearest 0.01 cm,
 and Tool 3 to the nearest 0.1 cm.
 Tool 1 is the most precise.

Description Mifflin Harcourt Publishing Company

Measuring Tool	Length
Tool 1	7.033 cm
Tool 2	6.91 cm
Tool 3	7.1 cm

b. Which tool gives the most accurate measurement?
 Tool 1: |7.000 - 7.033 | = 0.033, Tool 2: |7.000 - 6.91 | = 0.09, Tool 3: |7.000 - 7.1 | = 0.1.
 Tool 1 is the most accurate.

Module 1	35	Lesson 3

Exercise	Depth of Knowledge (D.O.K.)	COMMON CORE Mathematical Practices
1	2 Skills/Concepts	MP.5 Using Tools
2-5	1 Recall of Information	MP.5 Using Tools
6–19	2 Skills/Concepts	MP.5 Using Tools
20-21	2 Skills/Concepts	MP.4 Modeling
22–24	3 Strategic Thinking	MP.3 Logic

Given the following measurements, calculate the minimum and maximum possible areas of each object. Round your answer to the nearest square whole square unit.

9. The length and width of a book cover are 22.2 centimeters and 12 centimeters, respectively.

22.15 cm \leq length < 22.25 cm; 11.5 cm \leq width < 12.5 cm

22.15 cm \cdot 11.5 cm \leq area < 22.25 cm 12.5 cm

So 255 cm² \leq area < 278 cm².

10. The length and width of a rectangle are 19.5 centimeters and 14 centimeters, respectively. **19.45 cm** \leq **length** < **19.55 cm**; **13.5 cm** \leq **width** < **14.5 cm**

19.45 cm \cdot 13.5 cm \leq area < 19.55 cm \cdot 14.5 cm

So 263 cm² \leq area < 283 cm².

11. Chris is painting a wall with a length of 3 meters and a width of 1.6 meters.

2.5 m \leq length < 3.5 m; 1.55 m \leq width < 1.65 m

 $\textbf{2.5 m} \cdot \textbf{1.55 m} \leq \textbf{area} < \textbf{3.5 m} \cdot \textbf{1.65 m}$

So 4 m² \leq area < 6 m².

12. A rectangular garden measures 15 feet by 24.1 feet.

24.05 ft \leq length < 24.15 ft; 14.5 ft \leq width < 15.5 ft

24.05 ft \cdot 14.5 ft \leq area < 24.15 ft \cdot 15.5 ft

So 349 $ft^2 \le area < 374 ft^2$.

Show the steps to determine the number of significant digits in the measurement.

16. 3333.33 g

13. 123.040 m

4 nonzero digits, 1 digit between two nonzero digits, 1 end zero right of the decimal Altogether, 123.040 has 6 significant digits.

14. 0.00609 cm

2 nonzero digits, 1 digit between two nonzero digits, 0 end zero right of the decimal Altogether, 0.00609 has 3 significant digits.

Six significant digits

36

Determine the number of significant digits in each measurement.

15. 0.0070 ft Two significant digits

Module 1

17. 20,300.011 lb Eight significant digits OHOUGHTON Mifflin Harcourt Publishing Com

Lesson 3

QUESTIONING STRATEGIES

Is it possible for one measurement to be more precise than a second measurement even though the second measurement is closer to the actual length? Yes, it is possible for a measurement to be more precise than another that is more accurate.

VISUAL CUES

As students are finding how many significant digits a number has, have them color the significant digits blue and the non-significant digits green. This will make it easier to count the significant digits.

AVOID COMMON ERRORS

Make sure students understand that zeros at the end of a whole number are not usually considered significant digits. For example, 4550 has 3 significant digits, not 4.

JOURNAL

Have students describe one situation in which both accuracy and precision are important, and one in which other priorities might outweigh the expense or effort of obtaining a high degree of accuracy and/or precision. Find the perimeter and area of each garden. Report your answers with the correct number of significant digits.

- 18. A rectangular garden plot measures 13 feet by 26.6 feet. Perimeter = 13 ft + 26.6 ft + 13 ft + 26.6 ft = 79.2 ft. The perimeter is 79 ft. Area = 26.6 ft \cdot 13 ft = 345.8 ft². The area is 350 ft².
- 19. A rectangular garden plot measures 24 feet by 25.3 feet. Perimeter = 24 ft + 25.3 ft + 24 ft + 25.3 ft = 98.6 ft. The perimeter is 99 ft. Area = 24 ft \cdot 25.3 ft = 607.2 ft². The area is 610 ft².
- **20.** Samantha is putting a layer of topsoil on a garden plot. She measures the plot and finds that the dimensions of the plot are 5 meters by 21 meters. Samantha has a bag of topsoil that covers an area of 106 square meters. Should she buy another bag of topsoil to ensure that she can cover her entire plot? Explain.

Yes. The actual dimensions of the plot could be greater than 5 m and 21 m given the precision of Samantha's measurements. The maximum dimensions of the garden plot could be slightly less than 5.5 m by 21.5 m, resulting in a maximum possible area of 118.25 m². In this case, she would need a second bag of topsoil to ensure uniform coverage.

21. Tom wants to tile the floor in his kitchen, which has an area of 320 square feet. In the store, the smallest tile he likes has an area of 1.1 square feet and the largest tile he likes has an area of 1.815 square feet. About how many tiles can be fitted in the given area?

Available Space = Number of Tiles \cdot Area of One Tiles L = number of large tiles; S = number of small tiles $320 = L \cdot 1.815; L = \frac{320}{1.815} \approx 180$ large tiles $320 = S \cdot 1.1; S = \frac{320}{1.1} = 290$ small tiles The average of L and S is $\frac{180 + 290}{2} = 240$. So, on average, about 240 tiles will be needed.

© Houghton Mifflin Harcourt Publishing Company • Image Credits: ©Andrzej (ubik/Shutterstock

Module 1



37

H.O.T. Focus on Higher Order Thinking

22. Communicate Mathematical Ideas Consider the calculation 5.6 mi \div 9s = 0.62222 mi/s. Why is it important to use significant digits to round the answer?

Without rounding, it would imply that the answer is accurate to the hundred-thousandths place.

23. Find the Error A student found that the dimensions of a rectangle were 1.20 centimeters and 1.40 centimeters. He was asked to report the area using the correct number of significant digits. He reported the area as 1.7 cm². Explain the error the student made.

The 0 in each dimension, 1.20 cm and 1.40 cm, is significant, so the answer should be given with three significant digits as 1.68 cm² and not as 1.7 cm².

24. Make a Conjecture Given two values with the same number of decimal places and significant digits, is it possible for the sum or product of the two values to have a different number of decimal places or significant digits than the original values?

Yes, it is possible. For addition, the number of significant digits is determined by the smallest place value of the least precise number. If the sum results in an additional place value added to the left of the decimal point, the sum will have more significant digits than the addends. In multiplication, the number of significant digits is determined by the factor with the smallest number of significant digits. For instance, if you were to multiply 0.3 and 0.6, you would get 0.18. Each factor has 1 significant digit and 1 decimal place, but the product has 2 significant digits and 2 decimal places.

Lesson Performance Task

The sun is an excellent source of electrical energy. A field of solar panels yields 16.22 Watts per square feet. Determine the amount of electricity produced by a field of solar panels that is 305 feet by 620 feet.

Area: 305 ft · 620 ft = 189,100 ft² 189,100 ft² · $\frac{16.22 W}{ft^{2}}$ = 3,067,202 W

The factors are 305, 620, and 16.22, so the product should be rounded to 2 significant digits. So, the field yields 3,100,000 watts, or 3.1 megawatts.

Module 1

EXTENSION ACTIVITY

Have students calculate the minimum and maximum possible area of the field of solar panels, then discuss how the uncertainty in the linear measurements affects the precision of the calculated area.

38

Students should find that because the length is between 615 ft and 625 ft and the width is between 304.5 ft and 305.5 ft, the area is between 187,267.5 ft² and 190,937.5 ft². Although this is a range of more than 3000 square feet, students should recognize that rounding either of these numbers to the correct number of significant digits (two) results in an appropriate estimate of the area (190,000 ft²).

LANGUAGE SUPPORT

Some students may not be familiar with the units in the Lesson Performance Task. W stands for watt, which is a unit of power. To represent large quantities of power, units of megawatts (MW) may be used. One megawatt is equal to one million watts. The unit ft² is read "square feet."

QUESTIONING STRATEGIES

•

What operation do you use when finding area? multiplication

What rule for significant digits should you use when writing the product of the area and the yield? The product must have the same number of significant digits as the least precise measurement.

INTEGRATE MATHEMATICAL PRACTICES

Focus on Math Connections

MP.1 Show how dimensional analysis can help you verify that the result of a calculation is in the correct units. When multiplying length • width • yield, the units are ft • ft • $W/ft^2 = W$, so the result is in watts.

INTEGRATE MATHEMATICAL PRACTICES

Focus on Technology

MP.5 Students may use online calculators or graphing calculators when completing the Lesson Performance Task. Discuss how precision and significant digits are used or ignored by the tools that are available.

Scoring Rubric

2 points: Student correctly solves the problem and explains his/her reasoning. **1 point:** Student shows good understanding of the problem but does not fully solve or explain his/her reasoning.

0 points: Student does not demonstrate understanding of the problem.



Lesson 3