AchieveMath

Student Book

Volume 1

Name:

Catapult Learning™

Unit 1:

Square Roots, Cube Roots, and Irrational Numbers

Catapult Learning™

Catapult Learning™

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Garden Challenge

Part 1: Use **square tiles** to model the described garden. Then write two expressions to represent the area.

1. Michelle helps build a garden at her school that is 12 feet on each side. What is its area?

a. Multiplication expression: _____

b. Exponential expression: _____

c. The area of Michelle's garden is _____ square feet.

2. Theo builds a small garden in his yard. It is 7 feet on each side. What is the area?

a. Multiplication expression: _____

b. Exponential expression: _____

c. The area of Theo's garden is _____ square feet.

3. Luna builds a garden that is 10 feet on each side. What is the area of her garden?

a. Multiplication expression: _____

b. Exponential expression: _____

c. The area of Luna's garden is _____ square feet.

Part 2: Answer the questions. Use **square tiles** to help.

4. Henry builds a square garden that is 11.7 feet on one side. Is the area of his garden a perfect square? How do you know?

_____

_____

5. Amelia builds a tiny garden on her apartment balcony that is 1 foot on each side. Is the area of her garden a perfect square? How do you know?

_____

_____

Flower Power

Review the example problem. Then complete the table by writing two equations, one with multiplication and one with exponents, that tell how big the area is. You may use **square tiles** to help.

Example

Some people in the city have decided to grow flower gardens. Raj makes a square garden. He measured one side of his garden and found that it was 2 feet long. What is the area of Raj's garden?

Step 1

Use the formulas for the area of a square.

$A = s \times s$

$A = s^2$

Step 2

Substitute the given side length in the formula.

$A = 2 \times 2$

$A = 2^2$

Step 3

Multiply.

$A = 2 \times 2 = 4$

$A = 2^2 = 4$

The area of the garden is 4 square feet.

Person	**Side Length** (in feet)	**Equations**	**Area**
Levi	3		
Freya	8		
Landon	11		
Lilly	16		
Noah	5		
Lincoln	9		
Lorelei	15		
Wyatt	4		
Astrid	13		
Naomi	14		

Lesson 1 Exit Ticket

Part 1: Use **square tiles** to model the described garden. Then write two expressions to represent the area.

1. Finn helps build a community garden that is 4 feet on each side. What is its area?

Multiplication expression: _____

Exponential expression: _____

The area of the community garden is _____ square feet.

2. Sofia wants to build a square garden in her backyard. She has a small yard, and the garden cannot be wider than 6 feet. What will be the area of her garden?

Multiplication expression: _____

Exponential expression: _____

The area of the Sofia's garden is _____ square feet.

Part 2: Answer the questions. Use **square tiles** to help.

3. Elliott builds a garden that has a length of 6 feet and a width of 7 feet. Is the area of his garden a perfect square? How do you know?

_____

_____

_____

_____

4. Ophelia builds a garden that has a length of 8 feet and a width of 8 feet. Is the area of her garden a perfect square? How do you know?

_____

_____

_____

_____

Extra Practice: Perfect Squares

Part 1: Match the side length to the area of a square with that side length.

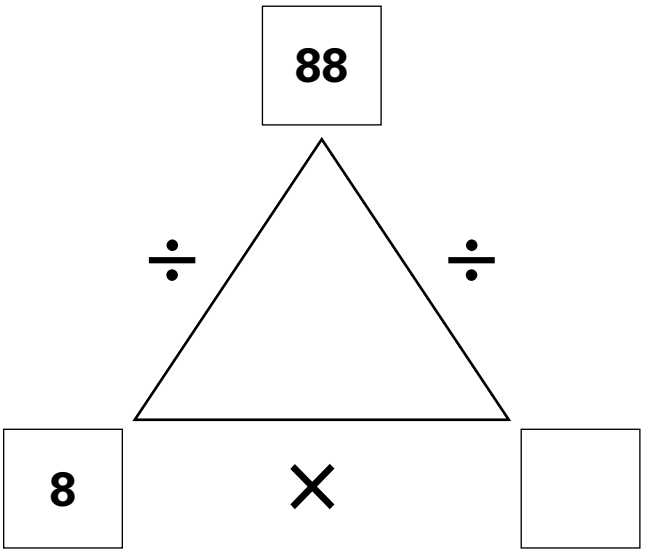
10 meters	36 square meters
6 meters	64 square meters
9 meters	81 square meters
8 meters	100 square meters

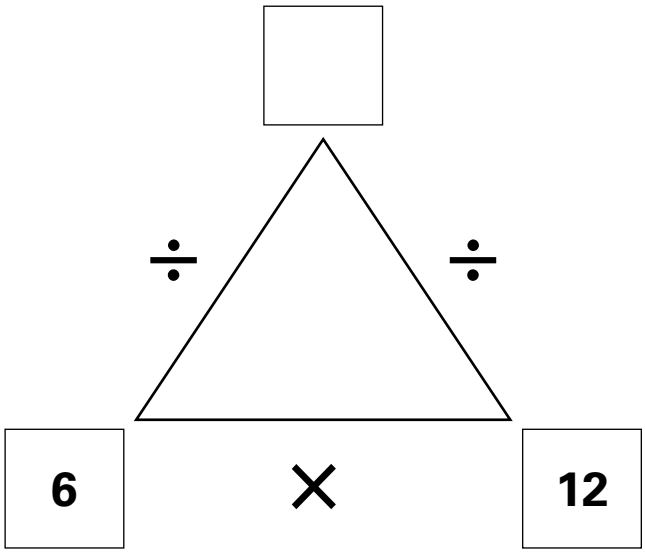
Part 2: Complete the exponential equations to find the perfect squares. Then, color in the perfect squares in the grid. Use **square tiles** to help.

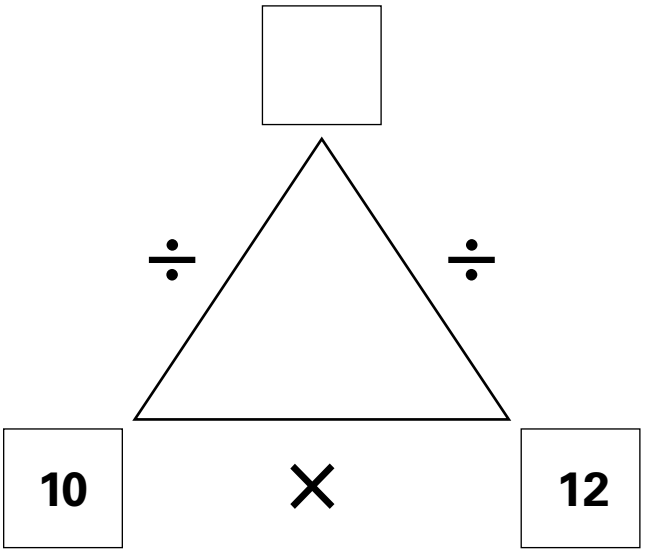
1^2 = _____	8^2 = _____	15^2 = _____	6^2 = _____
12^2 = _____	13^2 = _____	5^2 = _____	10^2 = _____
3^2 = _____	16^2 = _____	7^2 = _____	14^2 = _____
9^2 = _____	2^2 = _____	11^2 = _____	4^2 = _____

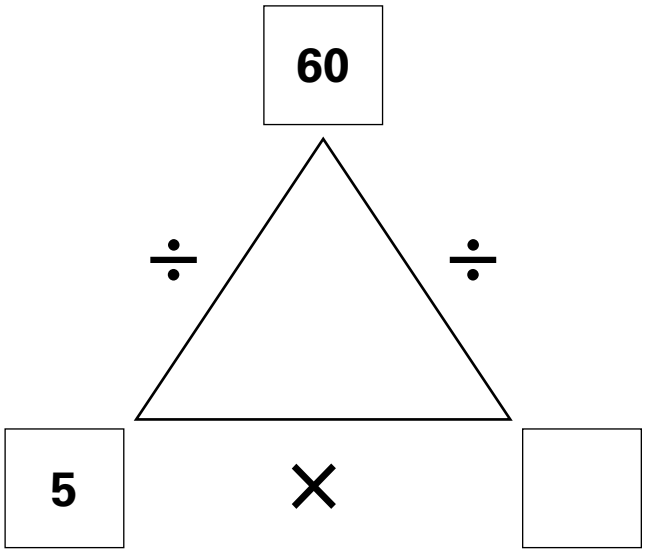
1	3	4	7	9	11	14	16	20	25
32	36	40	45	49	52	60	64	81	84
92	96	100	110	115	121	124	132	135	144
169	172	175	196	200	208	225	248	256	264

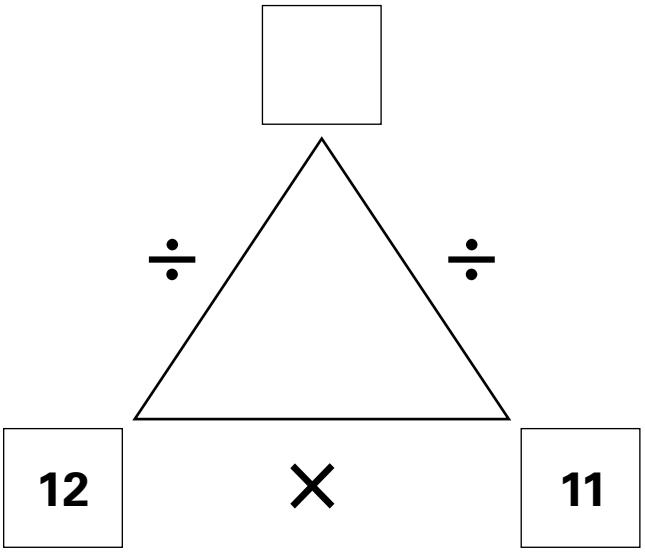
Number Triangles

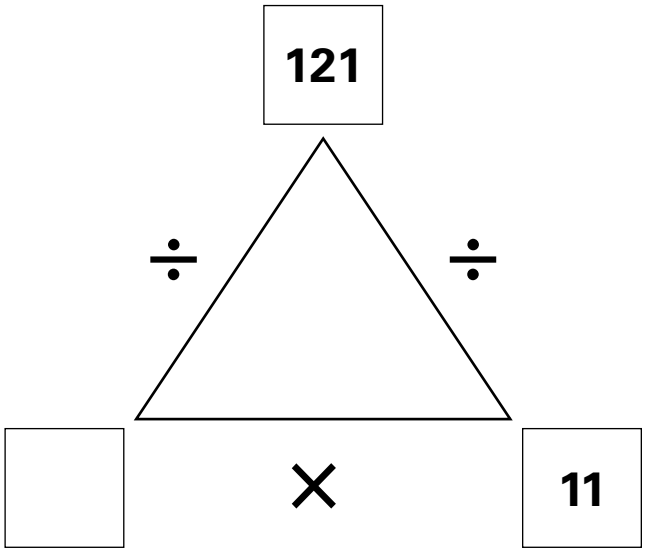




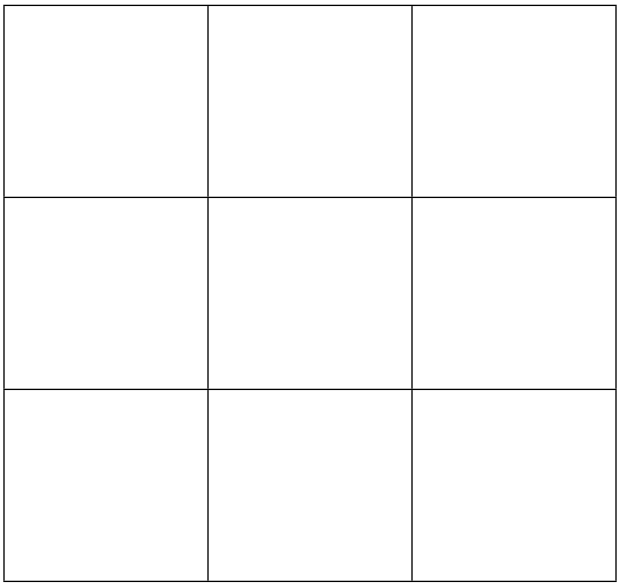


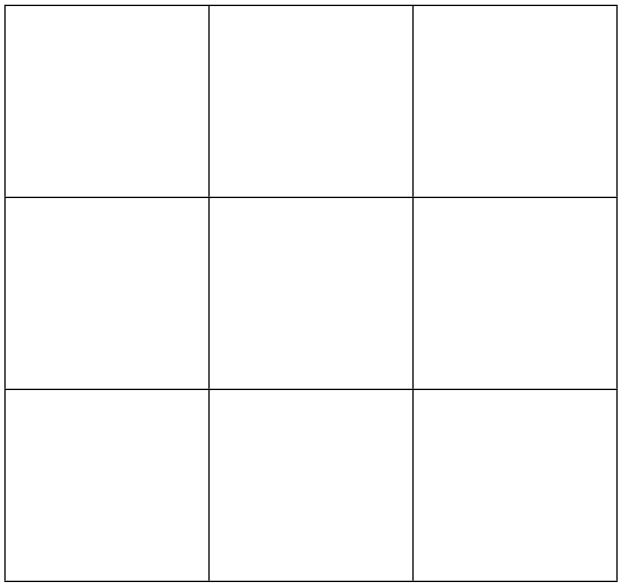


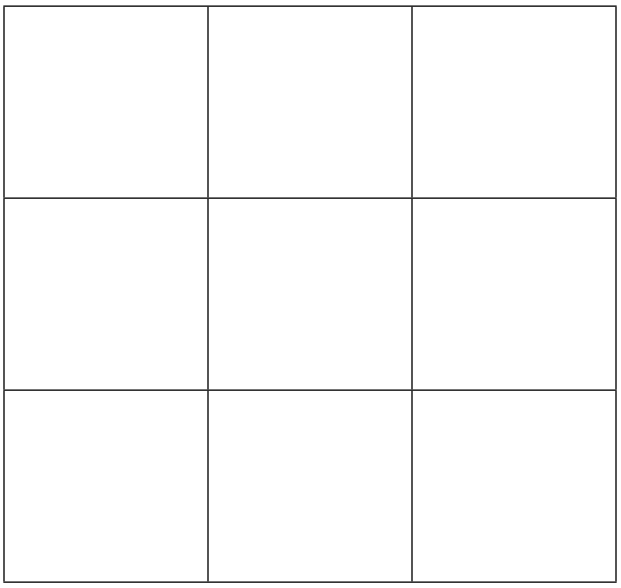


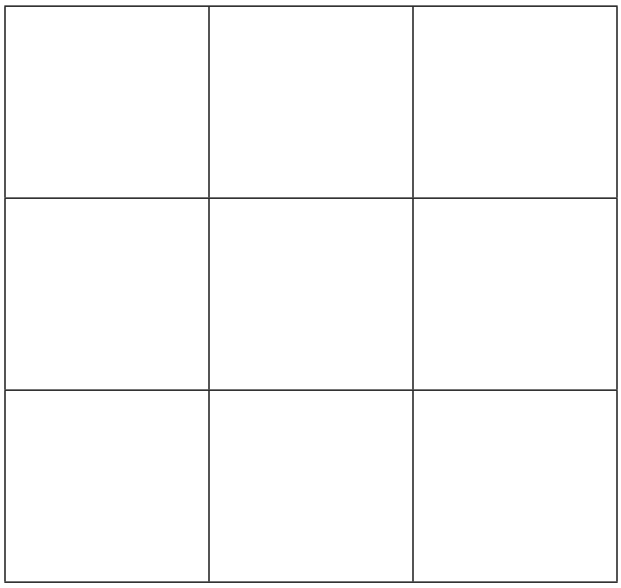


Square Root Bingo Playing Cards









Square Root Bingo
Number Cards

1^2	2^2	3^2	4^2
5^2	6^2	7^2	8^2
9^2	10^2	11^2	12^2
13^2	14^2	15^2	16^2

Mosaic Madness

Gabe's classmates are also making mosaics for the ceramics class final project. Draw each mosaic on **graph paper**. Then complete the equations.

1. Rhianna uses 49 one-inch tiles to make her square mosaic. What is the length of one side of her mosaic?

_____ = $s \times s$ _____ = s^2 $\sqrt{\_\_\_\_\_} = \sqrt{s^2}$ $\sqrt{\_\_\_\_\_}$ = _____

The side length of Rhianna's mosaic is _____ inches.

2. Simon uses 121 one-inch tiles to make his square mosaic. What is the length of one side of his mosaic?

_____ = $s \times s$ _____ = s^2 $\sqrt{\_\_\_\_\_} = \sqrt{s^2}$ $\sqrt{\_\_\_\_\_}$ = _____

The side length of Simon's mosaic is _____ inches.

3. Donald uses 196 one-inch tiles to make his square mosaic. What is the length of one side of his mosaic?

_____ = $s \times s$ _____ = s^2 $\sqrt{\_\_\_\_\_} = \sqrt{s^2}$ $\sqrt{\_\_\_\_\_}$ = _____

The side length of Donald's mosaic is _____ inches.

4. Zoë uses 36 one-inch tiles to make her square mosaic. What is the length of one side of her mosaic?

_____ = $s \times s$ _____ = s^2 $\sqrt{\_\_\_\_\_} = \sqrt{s^2}$ $\sqrt{\_\_\_\_\_}$ = _____

The side length of Zoë's mosaic is _____ inches.

Art Display

Review the example problem. Then find the square root of each number.

Example

Calvin and Veronica are displaying paintings for the art show. Each display will be a square. Calvin's display is **81** square feet. Veronica's display is **92** square feet. How wide will each of their displays be?

Step 1	**Step 2**
Decide whether the given area is a perfect square. **81** is a perfect square because $9 \times 9 = \mathbf{81}$. **92** is a *not* a perfect square because no integer multiplied by itself equals **92**.	Write an equation for the side length. Simplify the square root for perfect squares. $\sqrt{81} = 9$ Calvin's display will be 9 feet wide. $\sqrt{\mathbf{92}} = \sqrt{\mathbf{92}}$ Veronica's display will be $\sqrt{\mathbf{92}}$ feet wide.

1. $\sqrt{64}$ = _____

2. $\sqrt{144}$ = _____

3. $\sqrt{98}$ = _____

4. $\sqrt{108}$ = _____

5. $\sqrt{88}$ = _____

6. $\sqrt{32}$ = _____

7. $\sqrt{100}$ = _____

8. $\sqrt{225}$ = _____

9. $\sqrt{103}$ = _____

10. $\sqrt{256}$ = _____

11. $\sqrt{1}$ = _____

12. $\sqrt{224}$ = _____

13. $\sqrt{253}$ = _____

14. $\sqrt{4}$ = _____

15. $\sqrt{77}$ = _____

16. $\sqrt{48}$ = _____

17. $\sqrt{169}$ = _____

18. $\sqrt{81}$ = _____

19. $\sqrt{167}$ = _____

20. $\sqrt{56}$ = _____

Lesson 2 Exit Ticket

Part 1: Use **square tiles** or **graph paper** to model each mosaic. Then complete the equations.

1. Francia uses 169 one-inch tiles to make her square mosaic. What is the length of one side of her mosaic?

$\_\_\_\_\_ = s \times s$ $\quad$ $\_\_\_\_\_ = s^2$ $\quad$ $\sqrt{\_\_\_\_\_} = \sqrt{s^2}$ $\quad$ $\sqrt{\_\_\_\_\_} = \_\_\_\_\_$

The side length of Francia's mosaic is _____ inches.

2. Jason uses 81 one-inch tiles to make his square mosaic. What is the length of one side of his mosaic?

$\_\_\_\_\_ = s \times s$ $\quad$ $\_\_\_\_\_ = s^2$ $\quad$ $\sqrt{\_\_\_\_\_} = \sqrt{s^2}$ $\quad$ $\sqrt{\_\_\_\_\_} = \_\_\_\_\_$

The side length of Jason's mosaic is _____ inches.

Part 2: Find the square root of each number.

3. $\sqrt{204}$ = _____

4. $\sqrt{25}$ = _____

5. $\sqrt{4}$ = _____

6. $\sqrt{120}$ = _____

7. $\sqrt{16}$ = _____

Extra Practice: Squares Galore!

State whether each of the following sentences is true or false.

1. A square root is always a whole number. _____

2. Taking the square root of a number is the same as dividing the number by two. _____

3. The symbol used to indicate a square root is called the radical sign. _____

4. A square root is the opposite of a squared number. _____

5. When using an array to model the square root of a perfect square, you will never have tiles left over. _____

Shade each radical expression that is equal to an integer. Use **square tiles** or **graph paper** to help.

$\sqrt{85}$	$\sqrt{106}$	$\sqrt{169}$	$\sqrt{72}$
$\sqrt{36}$	$\sqrt{25}$	$\sqrt{96}$	$\sqrt{64}$
$\sqrt{148}$	$\sqrt{121}$	$\sqrt{200}$	$\sqrt{225}$
$\sqrt{115}$	$\sqrt{48}$	$\sqrt{49}$	$\sqrt{176}$

Square Root Cards

$\sqrt{4}$	$\sqrt{9}$
$\sqrt{16}$	$\sqrt{25}$
$\sqrt{36}$	$\sqrt{49}$
$\sqrt{64}$	$\sqrt{81}$

Square Root Cards

$\sqrt{100}$	$\sqrt{121}$
$\sqrt{144}$	$\sqrt{169}$
$\sqrt{196}$	$\sqrt{225}$
$\sqrt{256}$	

Square Root Cards

2	3
4	5
6	7
8	9

Square Root Cards

10	11
12	13
14	15
16	

Box Bonanza

Use **linking cubes** to model each cube. Then answer the questions and write an equation using an exponent.

1. Spencer buys his mom chocolate candies for a gift. He packs the candies in a cube-shaped box. He measures one edge of the box and finds that it is 3 inches long.

What is the length of the box? _____

What is the width of the box? _____

What is the height of the box? _____

What is the volume of the box? _____

Exponential equation: _____

2. Spencer buys his brother a keychain. He puts it in a cube-shaped box that has an edge that is 2 inches long.

What is the length of the box? _____

What is the width of the box? _____

What is the height of the box? _____

What is the volume of the box? _____

Exponential equation: _____

3. Spencer buys his grandmother a ring and puts it in a cube-shaped box. His grandmother loves math and when she sees the box, she measures one edge and finds that it is 1 inch long. "A perfect cube!" she exclaims. Explain why Spencer's grandmother would describe the box as a perfect cube.

_____

_____

_____

_____

_____

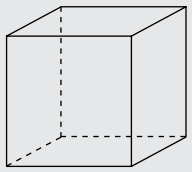
_____

Aquariums

Review the example problem. Then write the expressions to represent the volume of the aquarium shown.

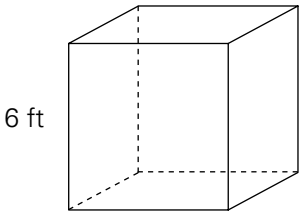
Example

Carmen's grandpa has a cube-shaped aquarium that Carmen loves to look at. The aquarium has the edge length shown. What is the volume of the aquarium?



Step 1	**Step 2**	**Step 3**
Use the edge length to write a multiplication equation to represent the volume. $V = e \times e \times e$ $V = \mathbf{5} \times \mathbf{5} \times \mathbf{5}$	Use the edge length to write an exponential equation to represent the volume. $V = e^3$ $V = \mathbf{5}^3$	Multiply to find the volume. $V = \mathbf{5} \times \mathbf{5} \times \mathbf{5}$ $V = \mathbf{5}^3$ $V = 125$ The volume of Grandpa's aquarium is 125 cubic feet.

1. Carmen goes to the city's aquarium and looks at the seahorses. Look at the tank below. What is the volume of the seahorse tank?

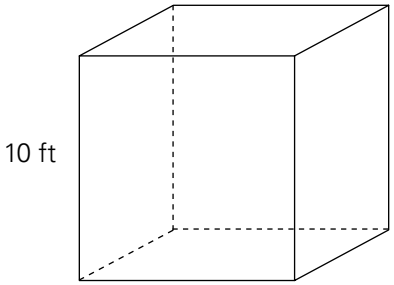


Multiplication expression: $V =$ _____

Exponential expression: $V =$ _____

The volume of the seahorse tank is _____.

2. Carmen loves to look at the little sharks in the big tank at the aquarium. Look at the tank below. What is the volume of the shark tank?



Multiplication expression: $V =$ _____

Exponential expression: $V =$ _____

The volume of the shark tank is _____.

Lesson 3 Exit Ticket

Part 1: Use **linking cubes** to model each cube. Then answer the questions.

1. Spencer buys his dad a little musical snow globe for a gift. He packs the globe in a cube-shaped box. He measures one edge of the box and finds that it is 4 inches long.

What is the length of the box? _____

What is the width of the box? _____

What is the height of the box? _____

What is the volume of the box? _____

What is 4 cubed? _____

2. Spencer cubes 3.333 and rounds the answer to 37. Is 37 a perfect cube? How do you know?

_____

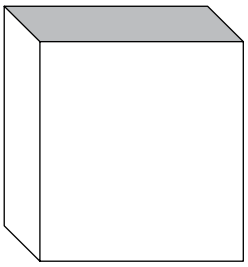
_____

_____

Part 2: Write the expression to represent the volume of the cubes shown.

3.

8 ft



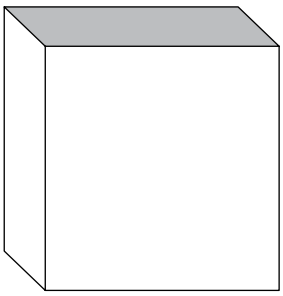
Multiplication expression: V = _____

Exponential expression: V = _____

The volume of the cube is _____

4.

9 ft



Multiplication expression: V = _____

Exponential expression: V = _____

The volume of the cube is _____

Extra Practice: Food Containers

Willow bought a set of cube-shaped containers to hold different snacks in her pantry. She made a list of the volume she needs for each snack:

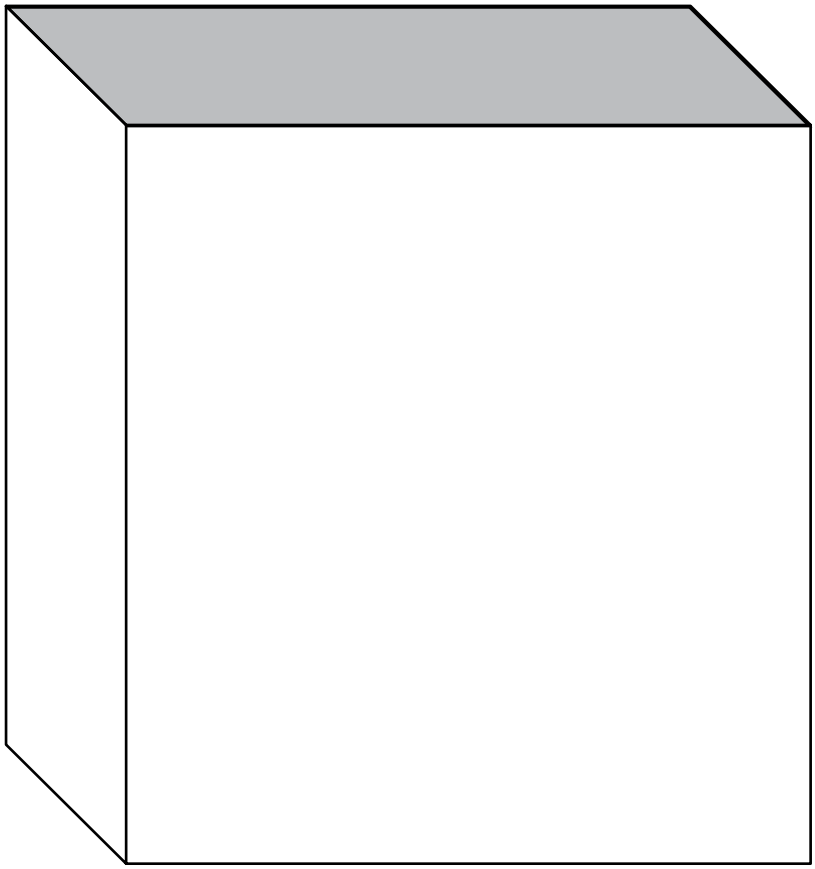
- Dried apricots: 325 cubic inches
- Pretzels: 475 cubic inches
- Raisins: 60 cubic inches
- Coconut chips: 25 cubic inches
- Cheese puffs: 1,000 cubic inches
- Popcorn: 725 cubic inches
- Granola: 210 cubic inches

The table shows the side length of the different containers. Complete the table by writing a multiplication and an exponential equation to find the volume. Then write the name of the snack that best fits in that container.

Container Side Length (Inches)	**Multiplication Equation**	**Exponential Equation**	**Snack**
8			
3			
4			
7			
10			
6			
9			

Nine-Inch Cube

9 in.



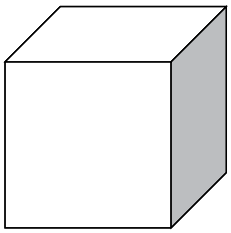
Exponent Race

1	8	27	64	125	216

Comfy Cubes

Label the edge lengths of each cube. Use factoring or **linking cubes** to solve.

1. $V = 8$ cubic inches.

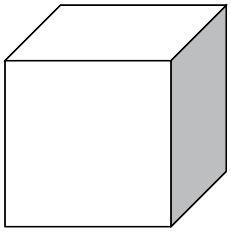


Height: _____ in.

Width: _____ in.

Length: _____ in.

2. $V = 512$ cubic inches.

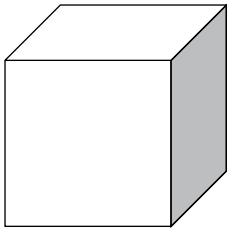


Height: _____ in.

Width: _____ in.

Length: _____ in.

3. $V = 64$ cubic inches

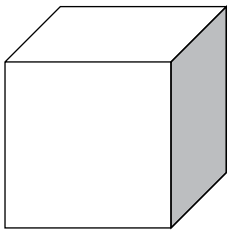


Height: _____ in.

Width: _____ in.

Length: _____ in.

4. $V = 1$ cubic inch



Height: _____ in.

Width: _____ in.

Length: _____ in.

Build a Box

Review the example problem. Then, use factoring to find the cube roots.

Example

Ronnie builds beautiful, small cube boxes out of different kinds of wood. A customer has asked for a specially made box to have a volume of **343** cubic inches. What will the edge length of this box be?

Step 1	Step 2	Step 3	Step 4
Factor the volume. Look for a factor that appears three times to make the product. **343** = 7 × 49 **343** = 7 × 7 × 7 **343** is a perfect cube.	Write a cube root equation for perfect cubes. $\sqrt[3]{\mathbf{343}} = 7$	Find the edge length of the cube. The edge length of this special box will be 7 inches.	Leave the cube root of non-perfect squares as the cube root of the number. 17 is not a perfect cube. $\sqrt[3]{17} = \sqrt[3]{17}$

1. Ronnie's most popular wooden box has a volume of 512 cubic inches. What is the cube root of 512?

$\sqrt[3]{512}$ = _____ Is 512 a perfect cube? _____

2. Ronnie's largest wooden box has a volume of 1,000 cubic inches. What is the cube root of 1,000?

$\sqrt[3]{1{,}000}$ = _____ Is 1,000 a perfect cube? _____

3. Ronnie's least popular box has a volume of 650 cubic inches. What is the cube root of 650?

$\sqrt[3]{650}$ = _____ Is 650 a perfect cube? _____

4. Ronnie's smallest wooden box has a volume of 139 cubic inches. What is the cube root of 139?

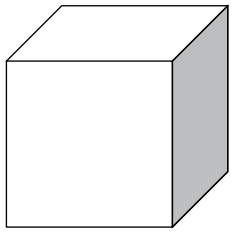
$\sqrt[3]{139}$ = _____ Is 139 a perfect cube? _____

Lesson 4 Exit Ticket

Part 1: Label the edge lengths of the cube. Use factoring or **linking cubes** to solve.

1. $V = 27$ cubic inches.

Height: _____ in.

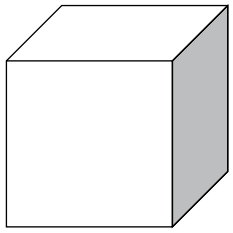


Width: _____ in.

Length: _____ in.

2. $V = 216$ cubic inches.

Height: _____ in.



Width: _____ in.

Length: _____ in.

Part 2: Find the cube root and complete the equation. If the cube is a perfect cube, write the cube root as an integer. If the cube is not a perfect cube, write the cube root using cube root notation.

3. $\sqrt[3]{729}$ = _____

4. $\sqrt[3]{96}$ = _____

5. $\sqrt[3]{125}$ = _____

6. $\sqrt[3]{600}$ = _____

Extra Practice: Gargantuan Games

Part 1: Label the following sentences true or false.

1. The number 125 is not a perfect cube. _____

2. The cube root of a perfect cube is an integer. _____

3. Taking the cube root and cubing a number are opposite operations. _____

4. The symbol for a cube root and a square root is the same. _____.

5. You can use cube roots to find the edge length of a cube given just the volume because all edge length in a cube are the same length.? _____

Part 2: Draw a circle around the perfect cubes and write the cube root. Draw a square around the cube roots that are not perfect.

6.

$\sqrt[3]{27}$ $\sqrt[3]{60}$

$\sqrt[3]{81}$ $\sqrt[3]{729}$ $\sqrt[3]{100}$

$\sqrt[3]{64}$

$\sqrt[3]{512}$ $\sqrt[3]{144}$

$\sqrt[3]{216}$

$\sqrt[3]{32}$

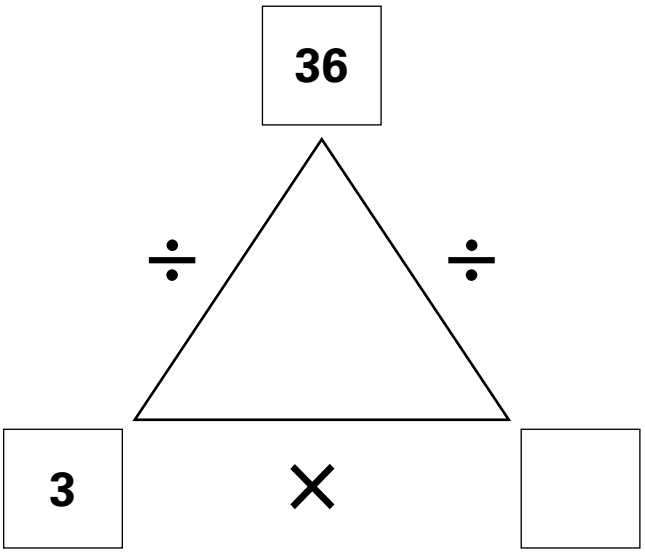
Part 3: Use factoring to find the edge length and answer the questions.

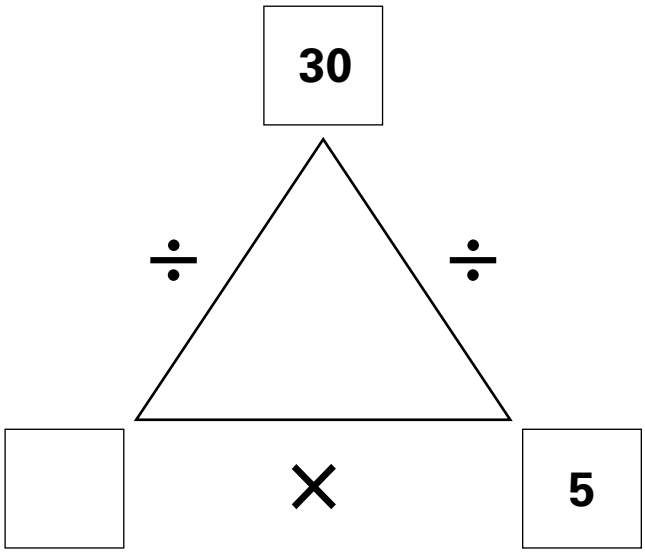
7. At Gargantuan Games, they have developed a new game that will fit in a box with a volume of 729 cubic inches. What is the edge length of the box?

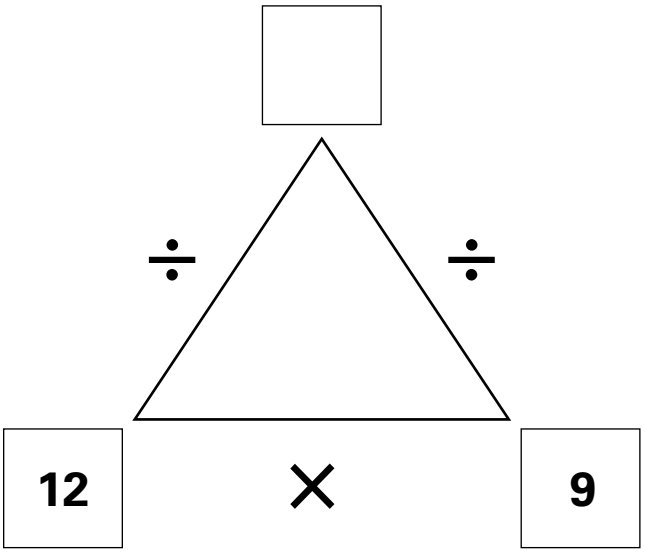
a. Write an equation to represent the problem. _____

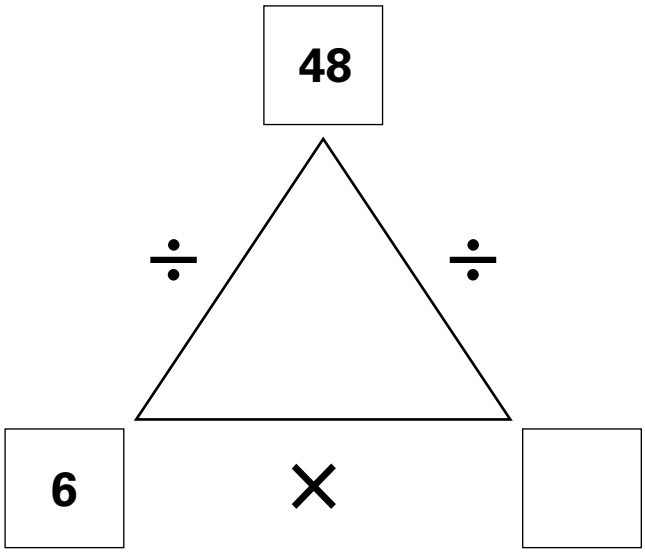
b. The edge length of the new game box is _____ inches.

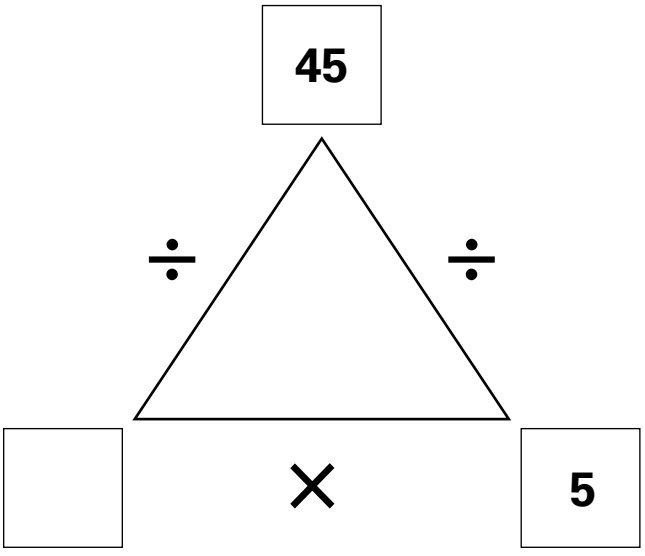
Number Triangles

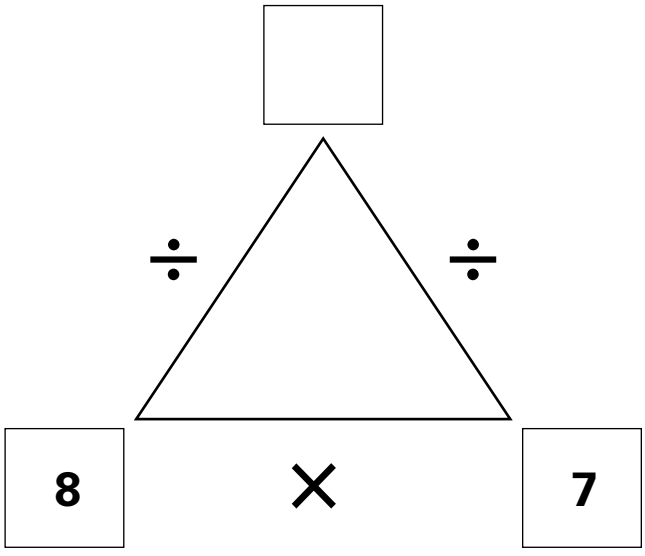








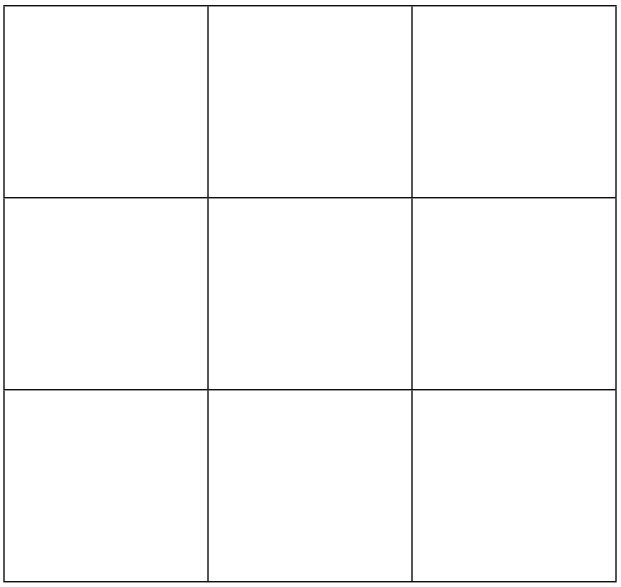


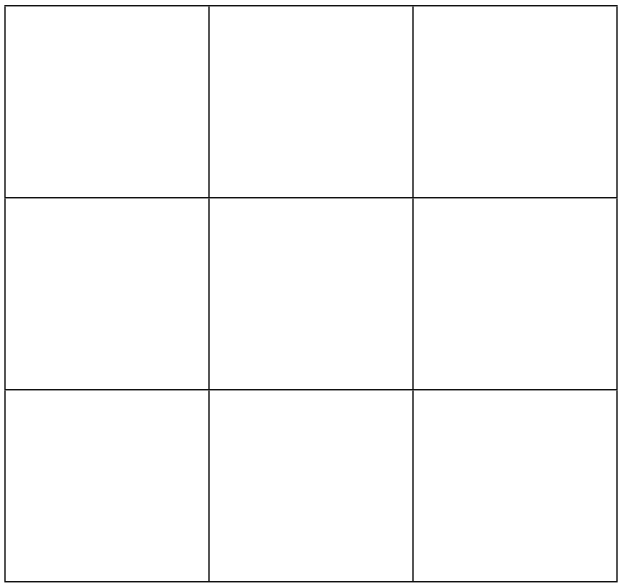


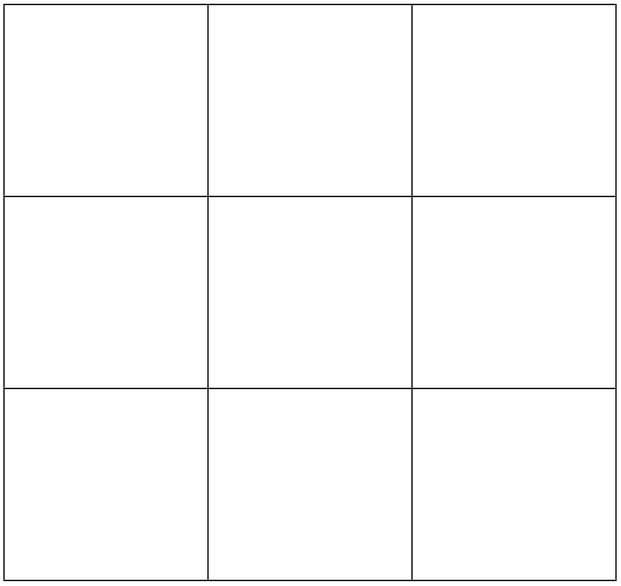
Cube Root Bingo
Number Expressions

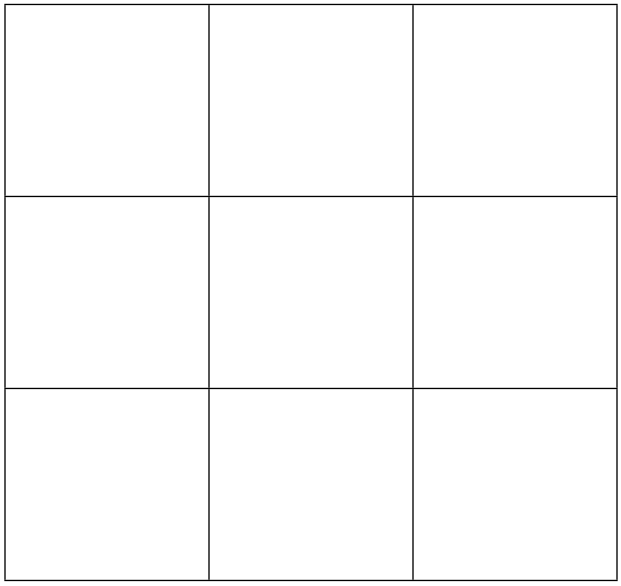
$\sqrt[3]{1}$	$\sqrt[3]{8}$
$\sqrt[3]{27}$	$\sqrt[3]{64}$
$\sqrt[3]{125}$	$\sqrt[3]{216}$
$\sqrt[3]{343}$	$\sqrt[3]{512}$
$\sqrt[3]{729}$	$\sqrt[3]{1{,}000}$

Cube Root Bingo Playing Cards









Perfect or Not Cards

$\sqrt[3]{10}$	$\sqrt[3]{64}$	$\sqrt[3]{27}$
$\sqrt[3]{25}$	$\sqrt[3]{144}$	$\sqrt[3]{216}$
$\sqrt[3]{30}$	$\sqrt[3]{1{,}000}$	$\sqrt[3]{75}$
$\sqrt[3]{729}$	$\sqrt[3]{343}$	$\sqrt[3]{12}$
$\sqrt[3]{512}$	$\sqrt[3]{18}$	$\sqrt[3]{96}$

Allowance

Part 1: Sasha and his dad make a deal for other tasks Sasha can get an allowance for. Convert each fraction of a dollar to a decimal. Then identify the fraction as terminating or repeating.

Task	Fraction of a Dollar	Decimal Equivalent	Terminating or Repeating Decimal?
take out a garbage bag	$\frac{3}{8}$		
feed the guinea pig a meal	$\frac{5}{13}$		
make the bed	$\frac{1}{2}$		
vacuum one room	$\frac{5}{6}$		
put away one piece of clean laundry	$\frac{3}{4}$		

Part 2: For each number, explain how you know it is a rational number.

1. 124 _____

2. $-0.\overline{235}$ _____

3. –67 _____

4. $1\frac{5}{8}$ _____

5. 19.42 _____

Keep on Converting

Review the example problem. Then convert the fractions to decimals and indicate whether they are terminating or repeating.

Example

Sasha's glad he had practice converting fractions to decimals, because in school the next day he must convert $\frac{11}{20}$ and $\frac{-2}{9}$ to decimals and decide whether they are terminating or repeating. What strategies can he use to convert these fractions? What kind of decimals are they?

Step 1

Determine whether it makes sense to use equivalent fractions or division to convert.

The denominator of $\frac{11}{20}$ is a multiple factor of 100, so it makes sense to use equivalent fractions.

The denominator of $\frac{-2}{9}$ is not a factor of 10, 100, or 1,000, so it makes sense to divide.

Step 2

Convert each fraction to a decimal.

$$\frac{11}{20} = \frac{11 \times 5}{20 \times 5} = \frac{55}{100} = 0.55$$

$$9\overline{)-2.000} = -0.222\ldots$$

$$\begin{array}{r} -1\,800 \\ 200 \\ -180 \\ 20 \\ -18 \\ 2 \end{array}$$

$9 \div -2 = -0.\overline{2}$

Step 3

Describe the decimals as terminating or repeating.

0.55 has exactly two digits to the right of the decimal point. It is a terminating decimal.

$-0.\overline{2}$ has an infinite number of 2s to the right of the decimal point. It is a repeating decimal.

1. $\frac{1}{3} =$ _____ The decimal is terminating/repeating.

2. $-\frac{444}{1{,}000} =$ _____ The decimal is terminating/repeating.

3. $\frac{5}{8} =$ _____ The decimal is terminating/repeating.

4. $-\frac{5}{74} =$ _____ The decimal is terminating/repeating.

Lesson 5 Exit Ticket

Convert each fraction to a decimal and indicate whether it is terminating or repeating. Then explain how you know the numbers are rational.

	Fraction	Decimal Equivalent	Terminating or Repeating Decimal?
1.	$\frac{7}{8}$		
2.	$-\frac{1}{3}$		
3.	$\frac{7}{11}$		
4.	$\frac{3}{5}$		
5.	$-\frac{5}{12}$		

6. How do you know all the decimals above are rational numbers?

Extra Practice: Matching

Match each fraction to the equivalent decimal. Then write each decimal in the appropriate column in the chart and answer the question.

1. $-\frac{2}{3}$ 0.2

2. $5\frac{1}{4}$ –5.6

3. $\frac{1}{5}$ 5.25

4. $-5\frac{3}{5}$ $5.\overline{4}$

5. $\frac{6}{7}$ –0.375

6. $-\frac{3}{8}$ $-0.\overline{6}$

7. $5\frac{4}{9}$ $0.\overline{857142}$

8.

Terminating Decimals	Repeating Decimals

9. Are all the numbers on this page rational numbers? How do you know?

Rational Game Cards

$\frac{2}{9}$	$\frac{2}{7}$	$\frac{2}{5}$
$\frac{4}{10}$	$\frac{1}{7}$	$\frac{6}{8}$
$\frac{4}{5}$	$\frac{7}{8}$	$\frac{7}{10}$
$\frac{1}{6}$	$\frac{8}{9}$	$\frac{1}{4}$
$\frac{3}{7}$	$\frac{3}{4}$	$\frac{6}{10}$

Dog Park Designs

Part 1: Other people in the community submit designs for the new dog park. Complete the chart to show the exact side length based on each dog park's area. Then state whether the side length is a rational or irrational number. Finally, answer the question.

	Area of Square Dog Park (square yards)	Side Length (yards)	Rational or Irrational?
1.	30		
2.	42		
3.	36		
4.	50		
5.	64		

6. What is the difference between rational numbers and irrational numbers?

Part 2: Write each number in the appropriate side of the diagram.

$-\frac{1}{6}$ 61 $\sqrt{49}$ 61.16 $\sqrt{44}$ $\sqrt[3]{27}$ $\sqrt[3]{25}$

Rational Numbers	Irrational Numbers

Building a Shed

Review the example problem. Then answer the questions.

Example

Valeria decides to build a storage shed at the dog park. The shed is a cube with a volume of **24** cubic yards. How tall is the shed? Is this value a rational or irrational number?

Step 1

The height of the shed is the edge length of a cube. Write an equation to represent the edge length of the cube.

$e = \sqrt[3]{V}$ $e = \sqrt[3]{\mathbf{24}}$

Step 2

Decide whether the volume is a perfect cube number.

You cannot make a cube with exactly **24** linking cubes. There is no number you can raise to the third power and get **24**.

24 is not a perfect cube number.

Step 3

Describe the height of the shed as rational or irrational.

The height is $\sqrt[3]{\mathbf{24}}$, so it is the cube root of a non-perfect cube number and not an irrational number.

1. Valeria changes the shed design to be a cube with a volume of 33 cubic yards.

a. How wide is the shed? The shed is _____ yards wide.

b. Is this value a rational or irrational number? Explain how you know.

_____

_____

2. Valeria changes the shed design to be a cube with a volume of 125 cubic yards.

a. How wide is the shed? The shed is _____ yards wide.

b. Is this value a rational or irrational number? Explain how you know.

_____

_____

Lesson 6 Exit Ticket

Complete the chart to show the exact side length for each dog park's area and state whether the side length is a rational or irrational number. Then answer the questions.

	Area of Square Dog Park (square yards)	**Side Length** (yards)	**Rational or Irrational?**
1.	18		
2.	44		
3.	49		
4.	60		
5.	81		

6. Write each number in the appropriate side of the diagram.

$\sqrt[3]{49}$ 45.54 $\sqrt{72}$ –15 $\sqrt[3]{64}$ $\frac{2}{9}$ $\sqrt{121}$

Rational Numbers	**Irrational Numbers**

7. One of the following numbers is rational, and one is irrational. Which is which, and how do you know?

$\sqrt{27}$ $\sqrt[3]{27}$

The rational number is _____. I know this because _____

_____

_____

The irrational number is _____. I know this because _____

_____

_____

Extra Practice: Irrational Numbers

Part 1: Name three irrational numbers that can be expressed as square roots and three irrational numbers that can be expressed as cube roots.

1. Square roots: _____

_____

2. Cube roots: _____

_____

Part 2: Use words from the word bank to complete the paragraph.

Word Bank

fraction	irrational	non-perfect cubes
non-perfect squares	non-repeating	non-terminating
ratio	repeating	terminating

There are several differences between rational and irrational numbers. A rational number can be written as the _____ of two integers. When a rational number is in decimal form, the decimal either is _____ or _____ .

An _____ number does not have an equivalent _____.

In decimal form an irrational number is _____ and _____.

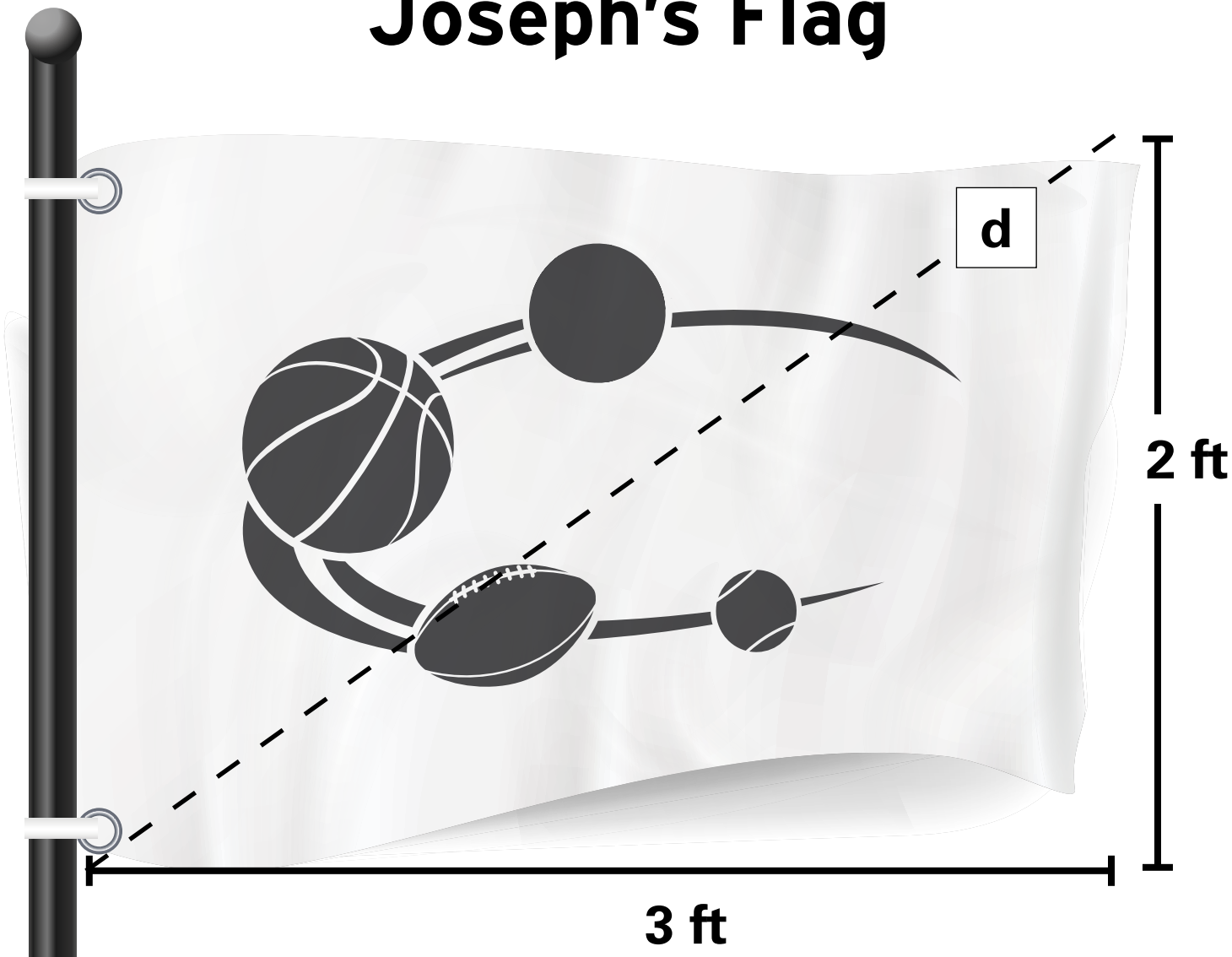
The square roots of _____ and the cube roots of _____ are irrational numbers.

Part 3: Circle the irrational numbers.

$\sqrt[3]{125}$ $\sqrt[3]{49}$ $\sqrt{72}$

$\sqrt{48}$ $\sqrt{144}$ $\sqrt[3]{63}$

Joseph's Flag



Irrational Sort

$\sqrt{1}$	$\sqrt[3]{8}$	$\sqrt{27}$	$\sqrt[3]{4}$
$\sqrt{619}$	$\sqrt[3]{765}$	$\sqrt{9}$	$\sqrt[3]{64}$
$\sqrt{125}$	$\sqrt[3]{16}$	773	$\sqrt[3]{542}$
$\sqrt{25}$	$\sqrt[3]{216}$	$\sqrt{343}$	$\sqrt[3]{36}$

Irrational Sort

$\sqrt{81}$	$\sqrt[3]{915}$	$\sqrt{49}$	$\sqrt[3]{512}$
$\sqrt{729}$	$\sqrt[3]{64}$	$\sqrt{353}$	$\sqrt[3]{286}$
$\sqrt{100}$	$\sqrt[3]{1,000}$	$\sqrt{8}$	$\sqrt[3]{121}$
$\sqrt{779}$	$\sqrt[3]{917}$	$\sqrt{144}$	$\sqrt[3]{27}$

Almost Square

Part 1: Complete each sentence. Estimate **to the nearest tenth.**

1. 70 is between the perfect squares 64 and _____ so $\sqrt{70}$ is between 8 and _____. A good estimate of $\sqrt{70}$ is 8.4, because _____

_____.

2. 149 is between the perfect squares _____ and 169, so $\sqrt{149}$ is between _____ and 13. A good estimate of $\sqrt{149}$ is _____, because _____

_____.

3. 222 is between the perfect squares _____ and _____ so $\sqrt{222}$ is between _____ and _____. A good estimate of $\sqrt{222}$ is _____, because _____

_____.

4. 107 is between the perfect squares _____ and _____ so $\sqrt{107}$ is between _____ and _____. A good estimate of $\sqrt{107}$ is _____, because _____

_____.

5. 7 is between the perfect squares _____ and _____ so $\sqrt{7}$ is between _____ and _____. A good estimate of $\sqrt{7}$ is _____, because _____

_____.

Part 2: Choose one of the non-perfect square numbers from Part 1. Use guess and check to estimate the square root to the nearest hundredth.

Was your estimate in Part 1 close to your estimate in Part 2?

_____

_____

Floor Space

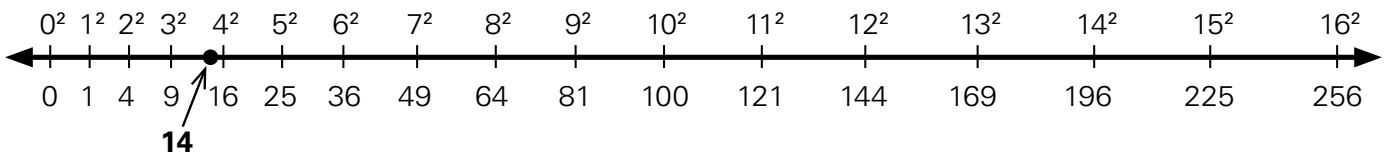
Review the example problem. Then use guess and check to estimate the given square root to the nearest hundredth. Use a **perfect square number line** and show your work.

Example

Ms. Stevens has a square classroom. The floor has an area of **14** square meters, so the side length of the floor is $\sqrt{\mathbf{14}}$ meters. Estimate $\sqrt{\mathbf{14}}$ to the nearest hundredth.

Step 1

Locate **14** between the closest perfect square numbers.



14 is between the perfect squares 9 and 16.

Step 2

Make a first guess to estimate $\sqrt{\mathbf{14}}$. Then check your guess. Is it too high or too low?

14 is closer to 16 than it is to 9. So, $\sqrt{\mathbf{14}}$ is closer to 4 than it is to 3.

First guess: $\sqrt{\mathbf{14}} \approx 3.7$ Check: $3.7^2 = 13.69$

13.69 is less than **14,** so my first guess is too low.

Step 3

Make a second guess to estimate $\sqrt{\mathbf{14}}$. Then check your guess. Is it too high or too low?

Second guess: $\sqrt{\mathbf{14}} \approx 3.8$ Check: $3.8^2 = 14.44$

14.44 is greater than **14,** so my second guess is too high.

Step 4

Make a final estimate to the nearest hundredths place, based on your first two guesses.

$\sqrt{\mathbf{14}}$ is greater than 3.7 but less than 3.8, so my final estimate is between these two numbers: 3.72.

1. $\sqrt{38} \approx$ _____

2. $\sqrt{147} \approx$_____

3. $\sqrt{184} \approx$ _____

4. $\sqrt{117} \approx$ _____

Lesson 7 Exit Ticket

Part 1: Complete each sentence. Estimate to the nearest tenth.

1. 26 is between the perfect squares _____ and _____, so $\sqrt{26}$ is between _____ and _____.

A good estimate of $\sqrt{26}$ is _____, because _____

_____.

2. 201 is between the perfect squares _____ and _____, so $\sqrt{201}$ is between _____

and _____. A good estimate of $\sqrt{201}$ is _____, because _____

_____.

Part 2: Use guess and check to estimate the given square root to the nearest hundredth. Use a **perfect square number line** and show your work.

3. $\sqrt{251} \approx$ _____

4. $\sqrt{98} \approx$ _____

Extra Practice: Estimate Match

Part 1: Match each square root to the most reasonable estimate.

$\sqrt{7}$	13.42
$\sqrt{54}$	9.9
$\sqrt{98}$	2.24
$\sqrt{128}$	7.87
$\sqrt{143}$	2.65
$\sqrt{180}$	15.62
$\sqrt{5}$	11.31
$\sqrt{244}$	6.08
$\sqrt{37}$	11.96
$\sqrt{62}$	7.35

Part 2: Use guess and check to estimate the given square root to the nearest hundredth. Use a **perfect square number line** and show your work.

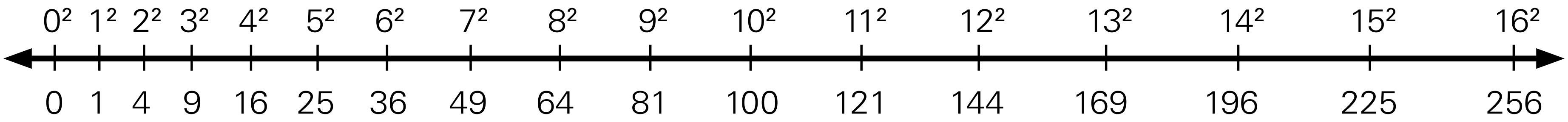
1. $\sqrt{18} \approx$ _____

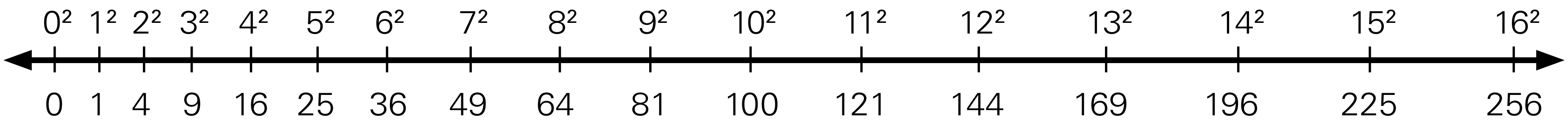
2. $\sqrt{32} \approx$ _____

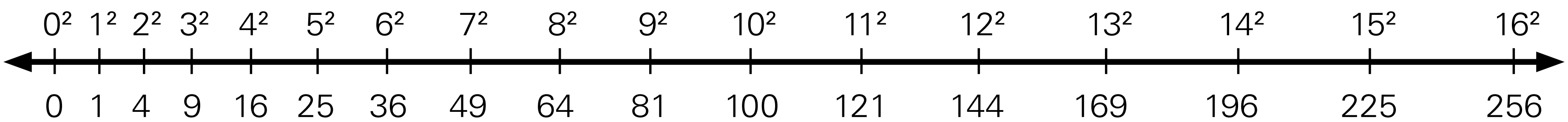
3. $\sqrt{51} \approx$ _____

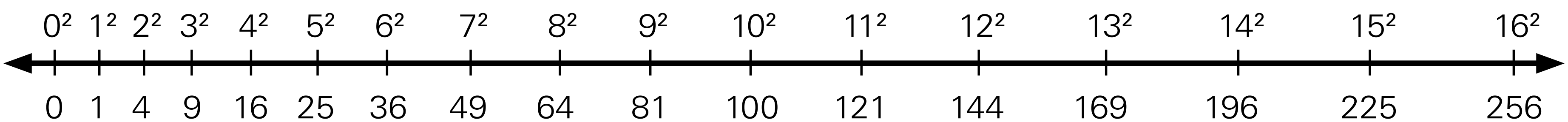
4. $\sqrt{72} \approx$ _____

Perfect Square Number Lines

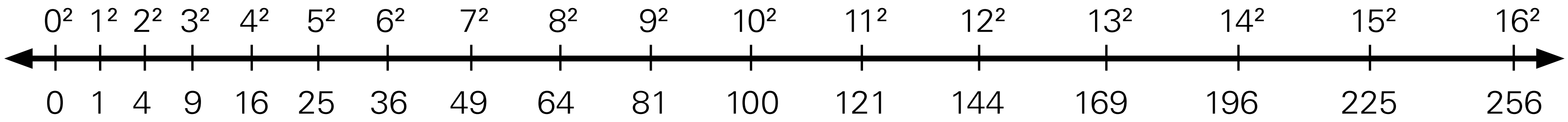


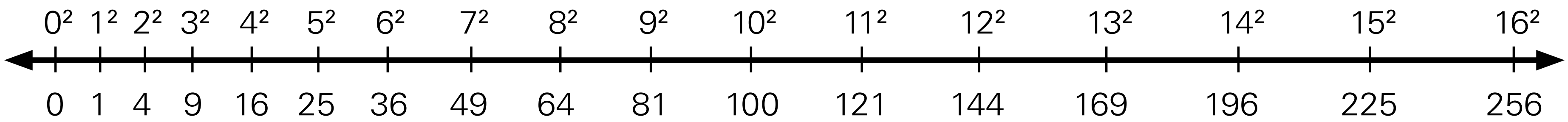


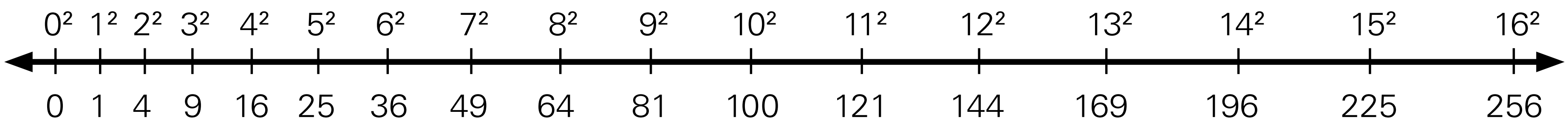


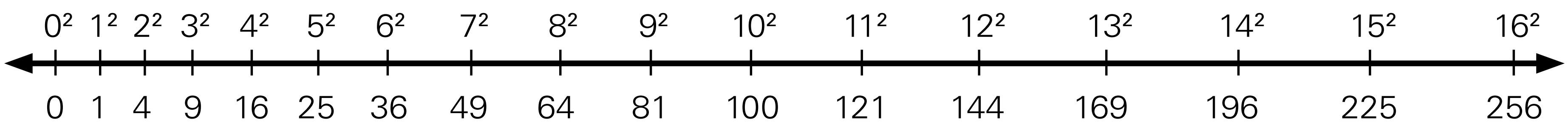


Perfect Square Number Lines





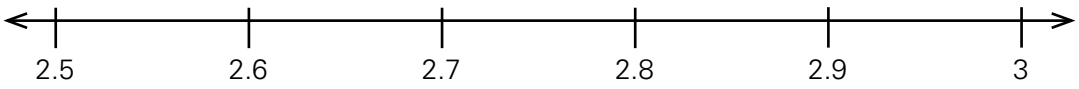




The Order of Things

Complete the chart for Mr. Nielson's The Order of Things question for Monday. Then plot the decimals and Mr. Nielson's numbers on the number line. Write two inequalities comparing Mr. Nielson's numbers—one greatest to least and one least to greatest.

Mr. Nielson's Number	Decimal Equivalent or Estimate
$2\frac{2}{3}$	
$\sqrt{8}$	
2.6	
$2\frac{7}{10}$	
2.78	



Mr. Nielson's numbers, greatest to least: _____

Mr. Nielson's numbers, least to greatest: _____

Tuesday's Numbers

Review the example problem. Then order the numbers given on the number line and write a comparison statement.

Example

Tuesday's The Order of Things question is a breeze for Janine, but it has her friend Phoebe stumped. The first two numbers are **2 ½** and $\sqrt{7}$. Which number has the least value?

Step 1

Convert rational numbers to decimal form.

2 ½ is a rational number. $2\frac{1}{2} = 2\frac{5}{8} = 2.5$

Step 2

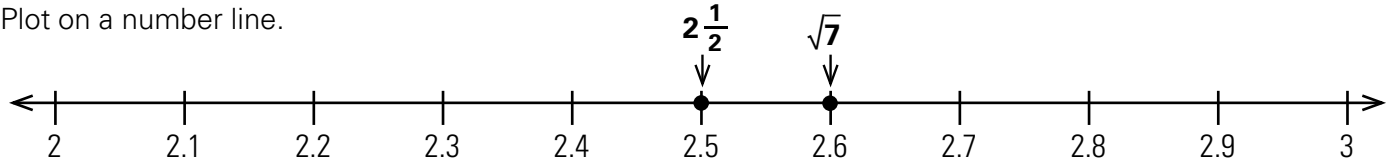
Estimate irrational numbers to the nearest tenth.

$\sqrt{7}$ is an irrational number.

7 is about halfway between the perfect cubes 4 and 9, but a little closer to 9.
So, $\sqrt{7}$ is a little more than halfway between 2 and 3. $\sqrt{7} \approx 2.6$

Step 3

Plot on a number line.

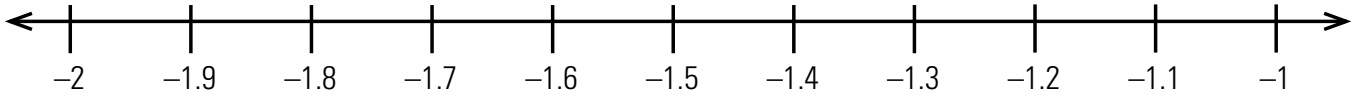


Step 4

Write a comparison statement using a greater than symbol.

$\sqrt{7} > 2\frac{1}{2}$ The number with the least value is **2 ½**.

1. Tuesday's other numbers are $-\sqrt{3}$, $-1\frac{8}{9}$, and $-1.\overline{7}$. Calculate equivalent decimals and show your work. Then order Tuesday's numbers on the number line.



2. Write a comparison statement with greater than symbols to order the three numbers.

Lesson 8 Exit Ticket

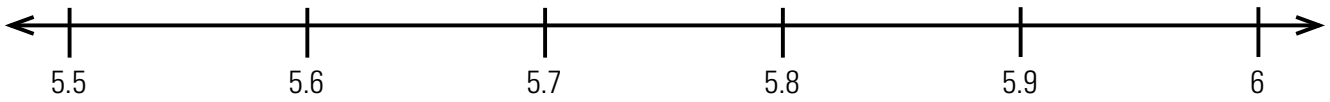
On Wednesday Mr. Nielson lists these numbers below for his students to order.

1. Complete the chart by finding the decimal equivalent or estimate. Write rational numbers to the *nearest tenth* and irrational numbers to the *nearest hundredth.*

Mr. Nielson's Numbers	Decimal Equivalent or Estimate
$\sqrt{32}$	
$5\frac{5}{6}$	
5.85	
$\sqrt[3]{216}$	
$5\frac{3}{4}$	

2. Write a comparison statement with greater than symbols to order the decimals.

3. Plot the numbers from the chart on the number line.



4. Write a comparison statement with greater than symbols to order the numbers from the final round of the activity.

Extra Practice: Order by Color

Part 1: Find the decimal equivalent of each number. Shade the box of the greatest number orange, the next greatest number yellow, the next greatest number green, and the least number blue.

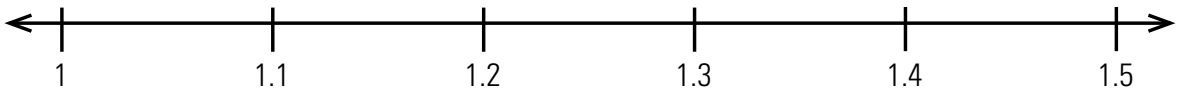
1. The decimal equivalent of $\boxed{1\frac{9}{20}}$ is _____.

2. The decimal equivalent of $\boxed{\sqrt[3]{1}}$ to the nearest tenth is _____.

3. The decimal equivalent of $\boxed{1\frac{5}{11}}$ is _____.

4. The decimal equivalent of $\boxed{\sqrt{2}}$ to the nearest tenth is _____.

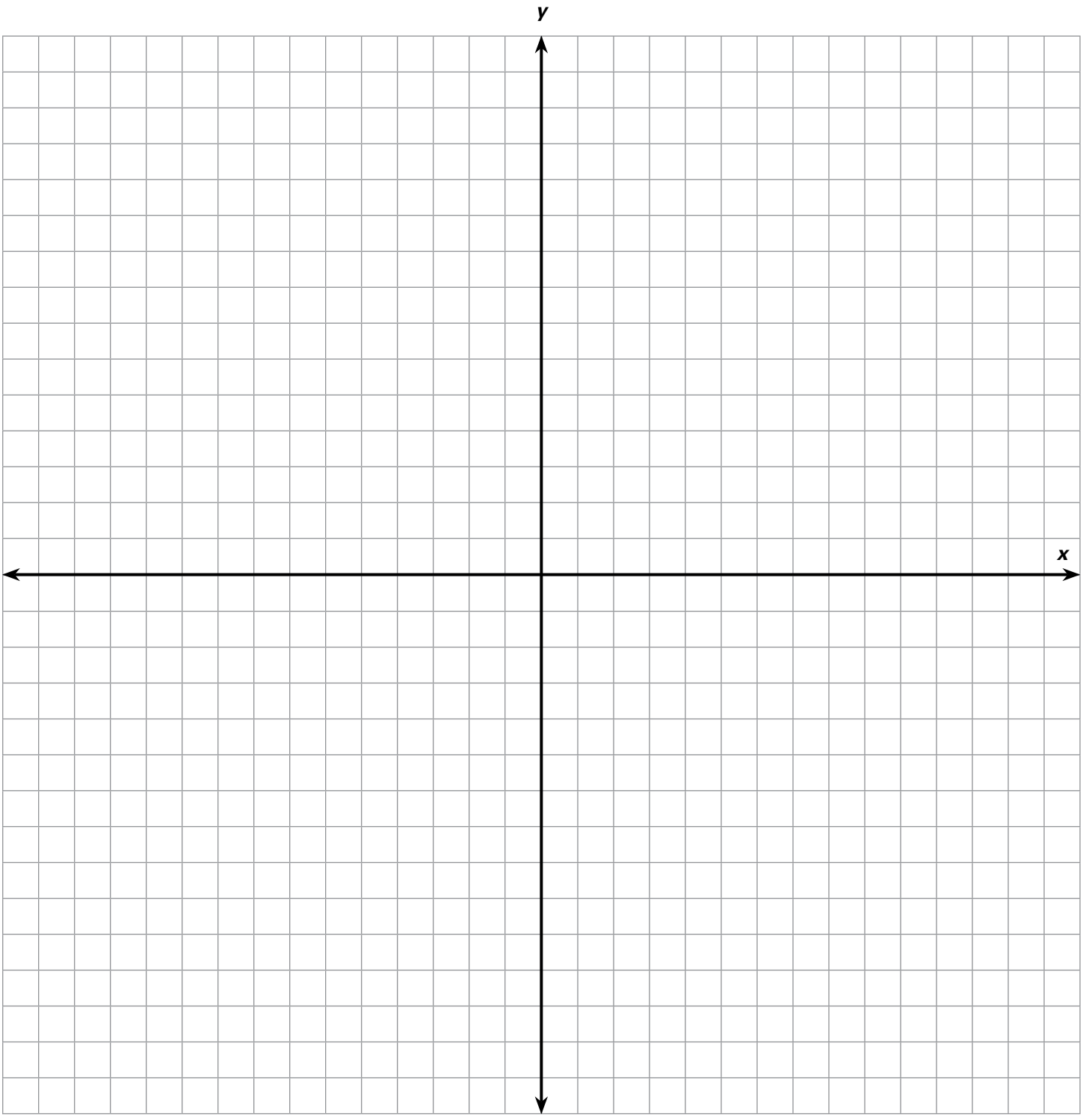
Part 2: Plot the boxed numbers from Part 1 on the number line. Then write two inequalities to show how the numbers compare.



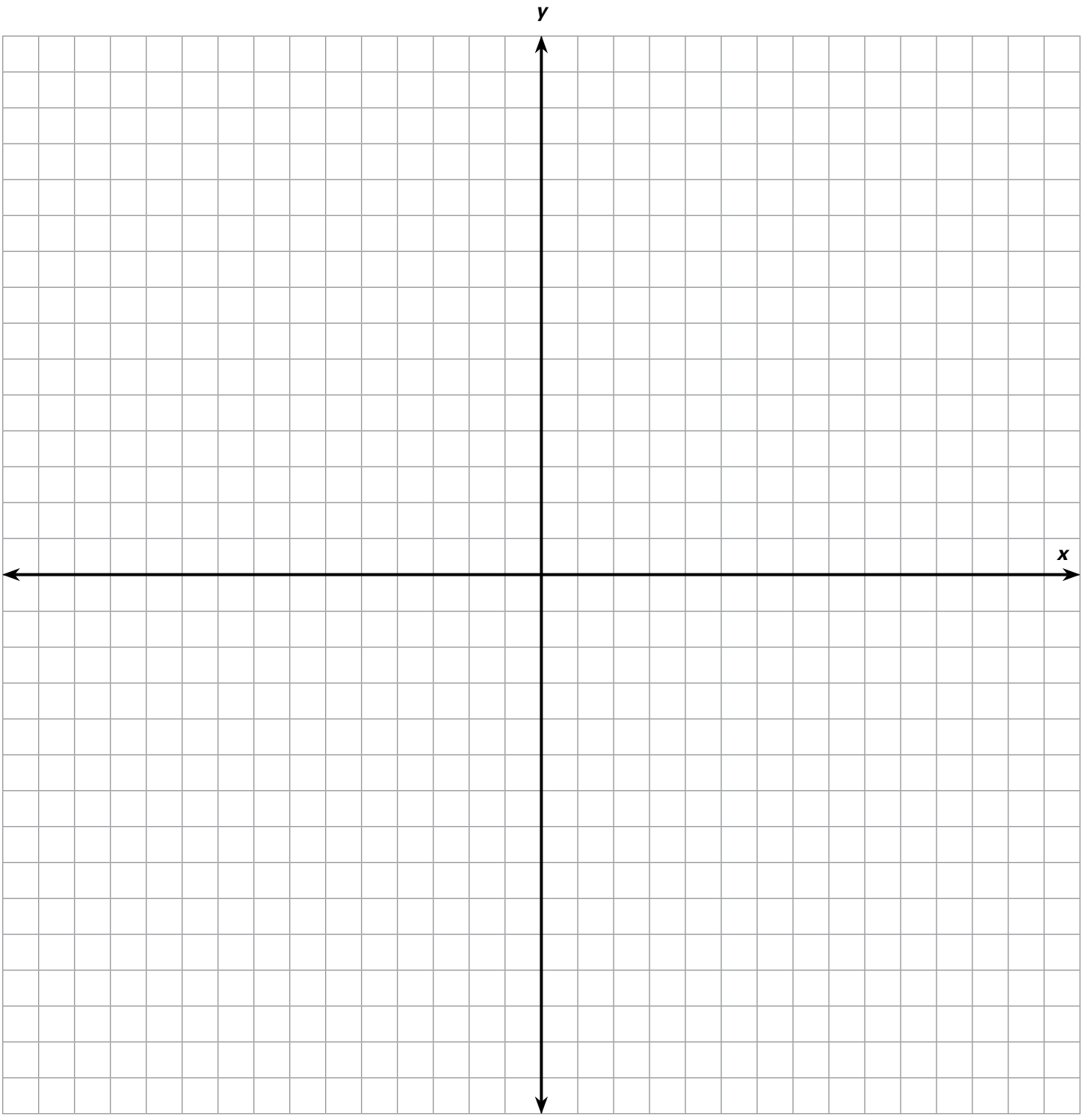
Boxed numbers, greatest to least: _____

Boxed numbers, least to greatest: _____

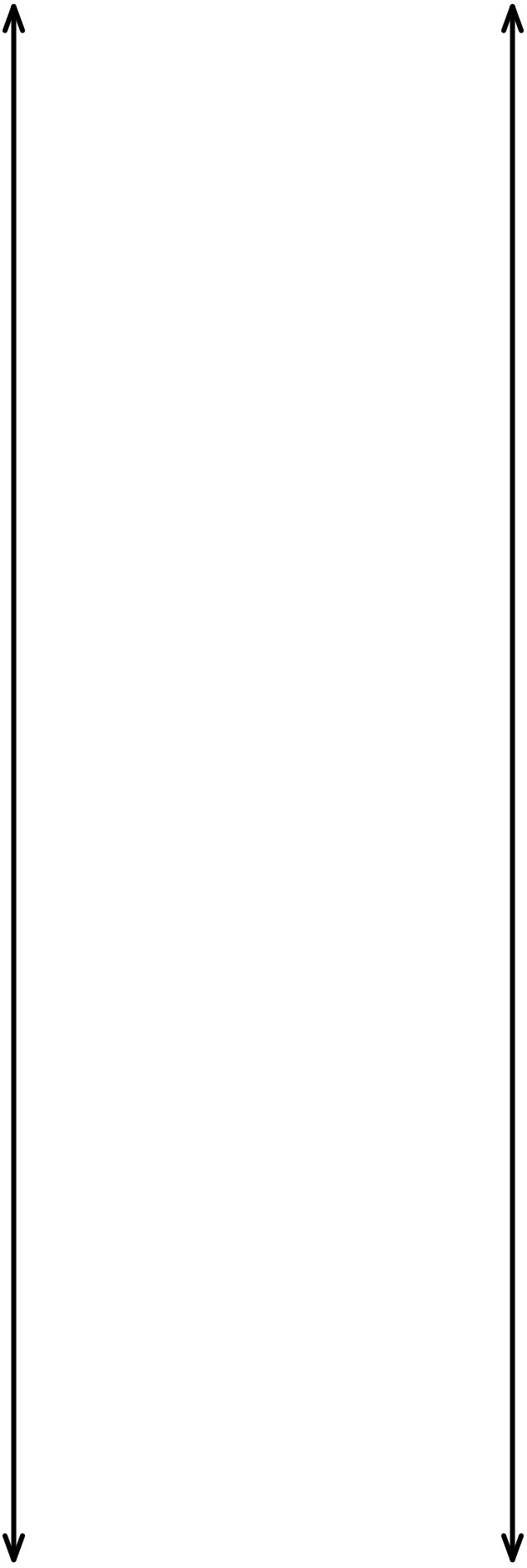
Coordinate Plane



Coordinate Plane

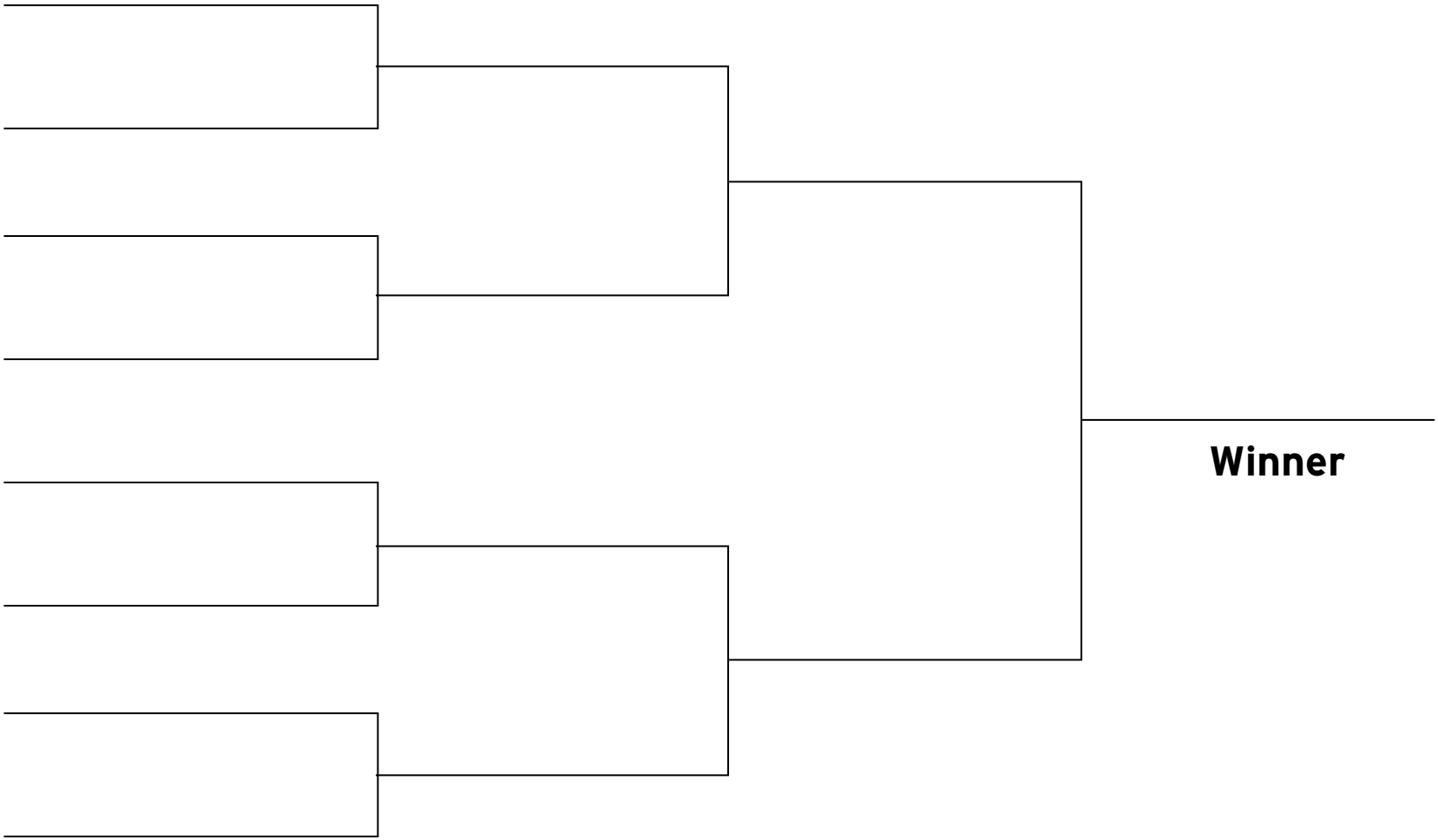


Open Number Lines



Open Number Lines

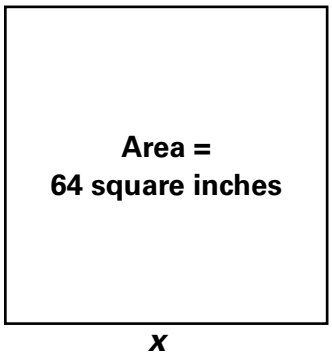
The Great Eight



Assessment

Unit 1 Assessment

1. Complete the equations to model the square. Then record the value of x.



$x^2 =$ _____

$x = \sqrt{\quad}$ _____

$x =$ _____

What is the side length of the square? _____

2. Simplify each expression, if possible. Leave square roots of non-perfect squares in radical form.

$\sqrt{150} =$ _____ $\sqrt{144} =$ _____ $\sqrt{256} =$ _____ $\sqrt{237} =$ _____

3. Angela has a cube-shaped box of beads. One edge of the box is 4 inches. Write an equation with an exponent to model the volume of the box.

Equation: _____

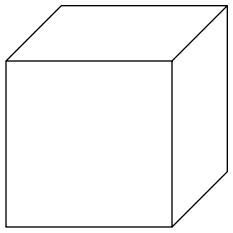
The volume of the box is _____ cubic inches.

4. Simplify each expression, if possible. Leave cube roots of non-perfect cubes in radical form.

$\sqrt[3]{864} =$ _____ $\sqrt[3]{200} =$ _____ $\sqrt[3]{1} =$ _____ $\sqrt[3]{216} =$ _____

5. Label the edge of the cube. Then complete the equation.

V = 729 cubic inches.



Height: _____ in.

$\sqrt[3]{729}$ = _____

Width: _____ in.

Length: _____ in.

6. Find the decimal form of 6 3/8. Show your work.

$6\frac{3}{8}$ = _____

Is this a terminating or repeating decimal? _____

7. Find the decimal form of 7/11. Show your work.

$\frac{7}{11}$ = _____

Is this a terminating or repeating decimal? _____

8. Write each of the following numbers in the appropriate column of the diagram:

$\sqrt[3]{46}$ 46.26 $\sqrt{26}$ –26 $\sqrt[3]{64}$ $4\frac{5}{6}$ $\sqrt{64}$

Rational Numbers	**Irrational Numbers**

9. Use the guess and check strategy to estimate $\sqrt{40}$ to the nearest hundredth. Show your work. Be sure to explain how to use perfect squares to estimate.

$\sqrt{40} \approx$ _____

10. Leo paints miniature figures. The chart shows the heights of figures he has painted.

a. Write the decimal equivalent or estimate in the chart.

Figure	Height (inches)	Decimal Equivalent or Estimate
The Silent Rogue	$1\frac{1}{6}$	
The Frozen Dragon	$\sqrt{3}$	
The Red Knight	$\sqrt[3]{3}$	
The Rugged Ranger	$1\frac{1}{4}$	

b. Plot the heights on the number line.

Unit 1 Cumulative Review

1. Rick drives his car for ¼ of an hour and goes 10½ miles. What is the unit rate of speed?

Rick drives _____ miles per hour.

2. Expand the expression.

$5(2x - 3) =$ _____

3. Layla earns $9 per hour and gets a $28 bonus. How many hours will she need to work to make at least $100? Write an inequality using the variable *h,* then solve the problem.

Inequality: _____

Layla needs to work _____ hours.

4. Solve.

$-12 - 6 =$ _____

5. Verify the proportionality of the ratios using cross multiplication.

$\frac{9}{24} = \frac{21}{56}$ _____

Are the ratios proportional? _____

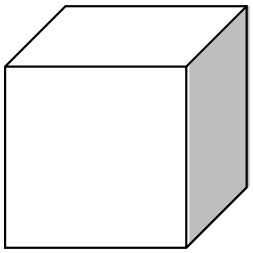
6. Kendrick earns $8.50 per hour for babysitting two children. Write and solve an equation to show how much money Kendrick needs to babysit to earn $51.

Equation: _____

$x =$ _____

Kendrick needs to babysit for _____ hours.

7. The cube-shaped box below has an edge length of 7 centimeters.



7 centimeters

What is the volume of the box? _____

8. Simplify the expression.

$-12 \div 6 =$ _____

9. A grocery store makes a display each week with bags of apples. The table shows the number of bags and the number of apples in the display each week.

Number of Bags ***(x)***	**Number of Apples** ***(y)***
23	184
24	192
25	200
26	208

Write an equation in the form of $y = mx$ to represent the proportional relationship between x and y.

_____

10. Estimate to the nearest tenth.

$\sqrt{8} \approx$ _____

11. Multiply.

$(-3)(-8) =$ _____

12. Amaria likes to download her favorite music. Yesterday she downloaded 112 songs. Today she downloads more songs. Now, Amaria has a total of 121 downloaded songs. Write and solve an equation to find out how many songs Amaria downloaded today.

Amaria downloaded _____ songs today.

13. Solve. Show your work.

$$660 = 60(x + 6)$$

$x =$ _____

14. Emilio's car can travel 34 miles per gallon. Complete the table to show how many miles the car can travel on the given number of gallons.

Gallons of Gasoline	Miles
10	
11	
12	
13	

15. Rowan eats lunch at a restaurant. Her meal costs $12.50. She leaves a 20% tip. What is the total cost of her meal?

Rowan's total meal costs _____ dollars.

Unit 2:

Exponents and Scientific Notation

Catapult Learning™

Going Viral

Part 1: Use the number string pattern to complete the table.

Division	Exponential Expression	Standard Form
$2^3 \div$ _____	2^2	
$2^2 \div$ _____		2
$2^1 \div 2$		
$2^0 \div$ _____	2^{-1}	$\frac{1}{2}$
$2^{-1} \div$ _____	2^{-2}	$\frac{1}{4}$
$2^{-2} \div 2$		
$2^{-3} \div$ _____	2^{-4}	

Part 2: Use division number strings to answer the questions.

1. Trisha was taking microscope photographs of a frog egg that was 3^0 millimeters and a pollen grain that was 3^{-2} millimeters.

a. What number do you divide by in the number string pattern? _____

b. Starting with 3^2, write a number string pattern to find the diameters for each specimen in standard form.

c. What are the two specimens' diameters in standard form?

Pollen grain: _____ mm Frog egg: _____ mm

2. Trisha takes a picture of the flu virus, which is 10^{-4} mm. Explain how she can find the diameter in standard form.

So Many Cells

Review the example problem. Then simplify the expressions and answer the questions.

Example

Xavier is looking at a muscle cell specimen that is $\mathbf{4^{-2}}$ mm under a microscope. Use the rule $a^{-n} = \frac{1}{a^n}$ to simplify the given length to its standard form.

Step 1	Step 2	Step 3
Set $a^{-n} = \mathbf{4}^{-2}$.	Substitute the values of a and n into the rule. $a^{-n} = \frac{1}{a^n}$ $\mathbf{4^{-2}} = \frac{1}{(4^2)}$	Simplify the denominator to find the given weight in its standard form. $\frac{1}{(4^2)} = \frac{1}{16}$ The muscle cell is $\frac{1}{16}$ of a millimeter.

Xavier is looking at specimens of different cells for his biology class. He needs to record the size of each cell.

Write each specimen's length in standard form.

1. Specimen 1: _____

2. Specimen 2: _____

3. Specimen 3: _____

4. Specimen 4: _____

5. Specimen 5: _____

6. Specimen 6: _____

7. Specimen 7: _____

8. Specimen 8: _____

Specimen	Length (mm)
1	3^{-3}
2	7^{-2}
3	9^{-1}
4	10^{-4}
5	6^{-1}
6	2^{-3}
7	8^{-2}
8	6^{-3}

Lesson 10 Exit Ticket

Part 1: Use a number string pattern to complete the table.

1.

Division	Exponential Expression	Standard Form
$5^3 \div 5$	5^2	25
$5^2 \div$ _____		
$5^1 \div$ _____		
$5^0 \div$ _____		
$5^{-1} \div$ _____		
$5^{-2} \div$ _____		
$5^{-3} \div$ _____		

Part 2: Use division number strings to answer the question.

2. A leaf cell from a plant is 4^{-3} mm. Starting with 4^2, write a number string to find the length in standard form.

The leaf cell is _____ mm long.

Part 3: Use the rule $a^{-n} = \frac{1}{a^n}$ to simplify each expression to its standard form.

3. 10^{-4} = _____

4. 7^{-3} = _____

5. 8^{-1} = _____

6. 9^0 = _____

Extra Practice: Secret Message

Write each exponential expression in standard form. Show your work. Then use the code key to write the secret message.

Code Key

A	2^{-3}
D	9^{0}
F	5^{-2}
H	4^{-1}
M	3^{-3}
N	6^{-2}
O	10^{-3}
P	4^{-2}
S	8^{-2}
T	7^{-3}
U	2^{-5}

Secret Coded Message:

_____ _____ _____ _____ _____ _____ _____ _____

$\frac{1}{27}$ $\frac{1}{8}$ $\frac{1}{343}$ $\frac{1}{4}$ $\frac{1}{8}$ 1 1 $\frac{1}{64}$

_____ _____ _____ _____ _____ _____ _____

$\frac{1}{32}$ $\frac{1}{16}$ $\frac{1}{343}$ $\frac{1}{1,000}$ $\frac{1}{25}$ $\frac{1}{32}$ $\frac{1}{36}$

Exponent Memory

1^{-1}	6^{0}	7^{-1}
6^{-3}	3^{-6}	2^{-5}
10^{-4}	7^{-3}	5^{-1}
9^{-2}	2^{-3}	10^{0}

Exponent Memory

1	1	$\frac{1}{7}$
$\frac{1}{216}$	$\frac{1}{729}$	$\frac{1}{32}$
$\frac{1}{10,000}$	$\frac{1}{343}$	$\frac{1}{5}$
$\frac{1}{81}$	$\frac{1}{8}$	1

Powerful Products and Quotients

Part 1: Use **place value disks** to model the multiplication or division and solve.

1. $10^1 \times 10^3 = 10 \times 1{,}000 = 10{,}000 =$ _____

2. $10^2 \times 10^2 =$ _____ × _____ = _____ = _____

3. $10^5 \div 10^2 = 100{,}000 \div 100 = 1{,}000 =$ _____

4. $10^3 \div 10^1 =$ _____ ÷ _____ = _____ = _____

Part 2: Use the rules of exponents to multiply or divide. Then answer the questions.

5. The competition moderator gave Sara and Jonah the problem $2^4 \times 2^3$ to solve. Sara said the answer was 2^7 and Jonah said the answer was 2^{12}.

a. What are the exponents? _____

b. Will you add or subtract the exponents? Why? _____

_____

c. What is the product in exponential form? Who was correct? _____

6. Solve this problem from the competition: $3^2 \div 3^3$.

a. Will you add or subtract the exponents? Why? _____

_____

b. What is the quotient in exponential form? _____

7. Solve this problem from the competition: $5^{-2} \times 5^4$.

a. Will you add or subtract the exponents? Why? _____

_____

b. What is the product in exponential form? _____

More Power

Review the example problem. Then apply the rules for multiplying and dividing numbers with exponents to find the products and quotients and answer the questions.

Example

What is the product of $\mathbf{4^1} \times \mathbf{4^2}$? What is the quotient of $\mathbf{4^1} \div \mathbf{4^2}$?

Step 1	Step 2	Step 3
To multiply, add the exponents of the factors. The sum will be the exponent of the product. The exponents are **1** and **2**. $\mathbf{4^1} \times \mathbf{4^2} = \mathbf{4^{1+2}} = 4^3$.	To divide, subtract the exponents of the dividend and divisor. The difference will be the exponent of the quotient. The exponents are **1** and **2**. $\mathbf{4^1} \div \mathbf{4^2} = \mathbf{4^{1-2}} = 4^{-1}$	Check your work. Simplify the numbers before multiplying or dividing. $\mathbf{4^1} = 4$ and $\mathbf{4^2} = 16$ $\mathbf{4^1} \times \mathbf{4^2} = 4 \times 16 = 64 = 4^3$ $\mathbf{4^1} \div \mathbf{4^2} = 4 \div 16 = \frac{1}{4} = 4^{-1}$

1. Fill in the missing products or quotients.

$2^{-3} \times 2^1 =$	$4^0 \times 4^4 =$
$6^4 \div 6^2 =$	$3^2 \times 3^{-2} =$
$5^3 \div 5^{-2} =$	$7^8 \div 7^5 =$

2. Keith, Johanna, and Tariq are on the same team. They each solved $5^8 \div 5^4$ and got the different answers shown in the table. Determine which student is correct and what mistakes the other two made.

Keith	$5^8 \div 5^4 = 5^{12}$
Johanna	$5^8 \div 5^4 = 5^2$
Tariq	$5^8 \div 5^4 = 5^4$

Lesson 11 Exit Ticket

Part 1: Use **place value disks** to model the multiplication or division and solve.

1. $10^5 \times 10^1 = 100{,}000 \times 10 = 1{,}000{,}000 =$ _____

2. $10^4 \times 10^2 =$ _____ × _____ = _____ = _____

3. $10^6 \div 10^4 =$ _____ ÷ _____ = _____ = _____

Part 2: Use the rules of exponents to multiply or divide.

4. $10^3 \div 10^5 =$ _____

5. $5^{-4} \times 5^6 =$ _____

6. $2^{-1} \div 2^{-4} =$ _____

7. $7^0 \div 7^{-3} =$ _____

8. $3^{-3} \times 3^7 =$ _____

9. $4^5 \times 4^{-8} =$ _____

10. $6^2 \times 6^8 =$ _____

Extra Practice: Shake It Up!

Part 1: Complete the following sentences using so*metimes, always,* or *never.*

When multiplying numbers with exponents, the exponent is _____ positive.

You _____ divide the exponents to find the exponent of a quotient.

The exponent of the product of numbers with exponents is _____ found by adding the factor exponents. The rule for finding the product of numbers with exponents is _____ the same as the rule for finding the quotient of numbers with exponents.

You will _____ have a quotient of numbers with exponents that is less than 1.

Part 2: Match the equations with the correct product/quotient.

1. $2^1 \times 2^3$

2. $2^5 \div 2^2$

3. $2^{-1} \div 2^{-3}$

4. $2^{-4} \times 2^3$

5. $2^3 \div 2^5$

A. 2^2

B. 2^3

C. 2^{-1}

D. 2^{-2}

E. 2^4

Part 3: Use **place value disks** to model the multiplication or division and solve.

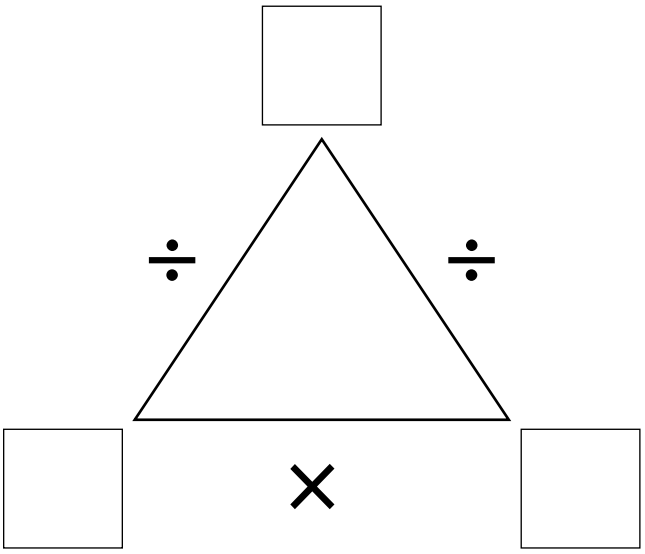
6. $10^5 \div 10^4 = 100{,}000 \div 10{,}000 = 10 =$ _____

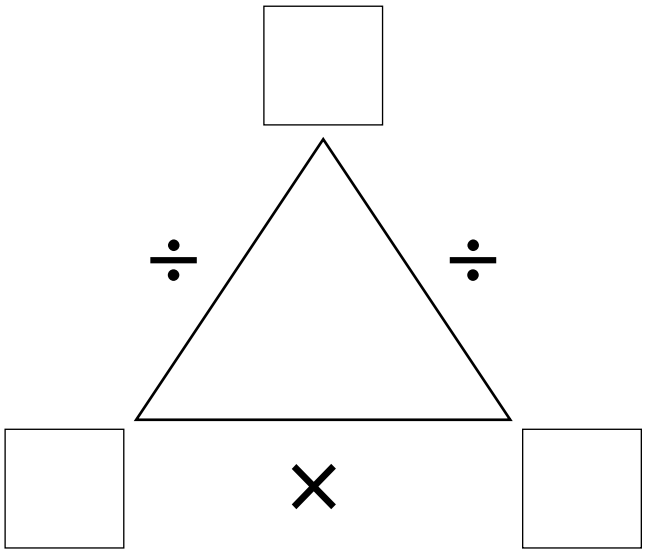
7. $10^5 \div 10^2 =$ _____ ÷ _____ = _____ = _____

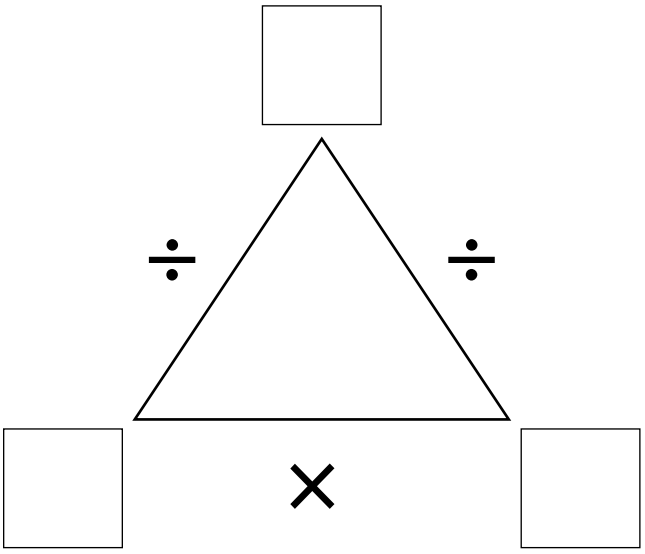
8. $10^2 \times 10^4 =$ _____ × _____ = _____ = _____

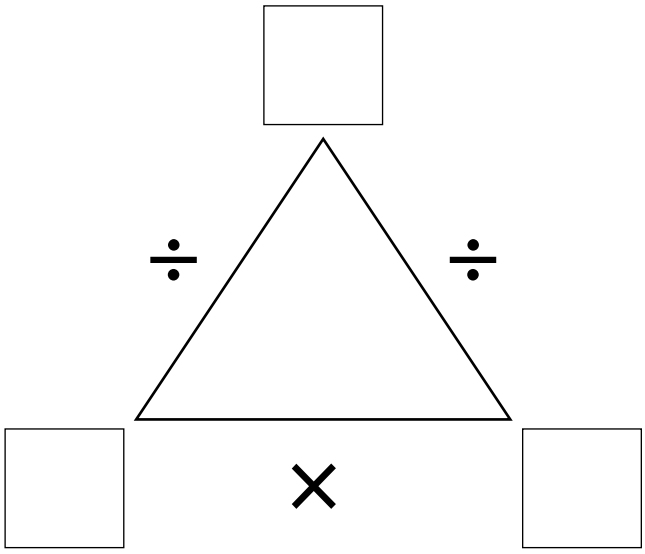
9. $10^3 \times 10^1 =$ _____ × _____ = _____ = _____

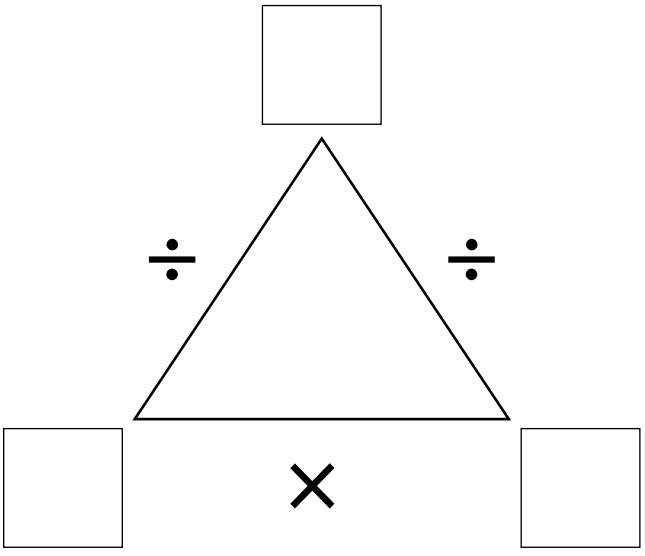
Number Triangles

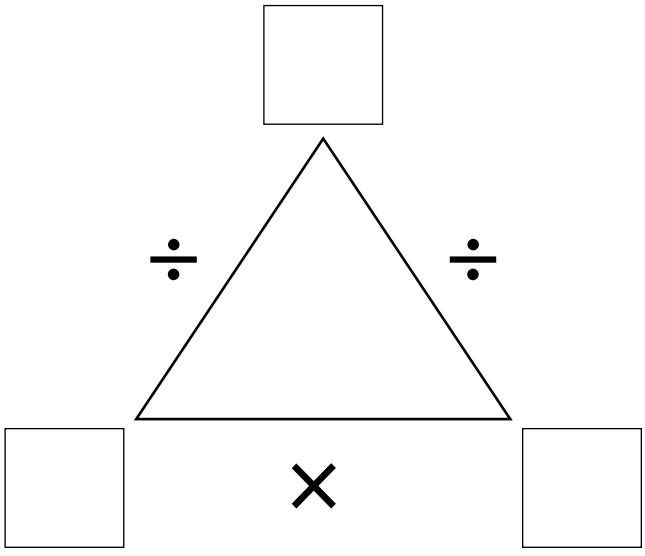












In Deep Water

Part 1: Write an equivalent expression for each product using the rule $(a \times b)^n = a^n \times b^n$.

1. $(9 \times 4)^2 =$ _____

2. $(3 \times 5)^{-2} =$ _____

3. $(64 \times 23)^8 =$ _____

4. $(11 \times 12)^{-6} =$ _____

5. $(125 \times 42)^5 =$ _____

6. $(20 \times 30)^{-40} =$ _____

Part 2: Expand each expression, simplify, then write each solution in standard form.

7. $(3 \times 2)^2 =$ $3^2 \times 2^2$ $=$ 9×4 $=$ _____

8. $(2 \times 5)^{-3} =$ _____ $=$ _____ $=$ _____

9. $(4 \times 2)^2 =$ _____ $=$ _____ $=$ _____

10. $(3 \times 4)^{-2} =$ _____ $=$ _____ $=$ _____

11. $(7 \times 1)^4 =$ _____ $=$ _____ $=$ _____

12. $(1 \times 6)^{-3} =$ _____ $=$ _____ $=$ _____

13. Tanya has a cube-shaped water tank for her sheep. She measures one side length with a 2-foot-long board and finds the tank's side length = 6×2 feet. To find the volume, she needs to raise this length to the third power. What is the volume in cubic feet? Show your work.

_____ cubic feet.

Powers to the Powers

Review the example problem. Then apply the rule $(a^x)^y = a^{xy}$ to find an equivalent expression and solve for the standard form of each exponent raised to a power.

Example

What is the standard form of $\mathbf{(3^2)^{-2}}$?

Step 1

Use the rule $(a^x)^y = a^{xy}$ to find an equivalent expression.

$\mathbf{(3^2)^{-2}} = 3^{(2)(-2)}$

Step 2

Multiply the exponents then simplify.

$$\mathbf{3^{(2)(-2)}} = 3^{-4} = \frac{1}{3^4}$$

$$= \frac{1}{(3 \times 3 \times 3 \times 3)}$$

$$= \frac{1}{81}$$

Step 3

Check your work by simplifying the exponent within the parentheses first, then raise this to the other power.

$$\mathbf{(3^2)^{-2}} = (9)^{-2} = \frac{1}{9^2} = \frac{1}{81}$$

		Equivalent Expression (a^{xy})	Standard Form
1.	$(2^2)^4$		
2.	$(3^{-2})^3$		
3.	$(8^{-1})^{-2}$		
4.	$(5^2)^2$		
5.	$(10^{-4})^2$		
6.	$(4^3)^1$		
7.	$(12^1)^{-2}$		
8.	$(7^2)^2$		

Lesson 12 Exit Ticket

Part 1: Use the exponent rules $(a \times b)^n = a^n \times b^n$ and $(a^x)^y = a^{xy}$ to rewrite each expression in an equivalent form.

		Equivalent Expression
1.	$(11 \times 6)^{-4} =$	
2.	$(2 \times 12)^2 =$	
3.	$3^{-7} \times 2^{-7} =$	
4.	$10^6 \times 4^6 =$	
5.	$(9^4)^5 =$	
6.	$(11^{-6})^4 =$	
7.	$(8^{-13})^{-2} =$	
8.	$(4^3)^{-10} =$	

Part 2: Rewrite each expression in standard form.

9. $(3 \times 6)^{-1} =$ _____

10. $(2 \times 4)^3 =$ _____

11. $(5 \times 2)^{-5} =$ _____

12. $(11 \times 1)^2 =$ _____

13. $(10^{-2})^3 =$ _____

14. $(2^3)^2 =$ _____

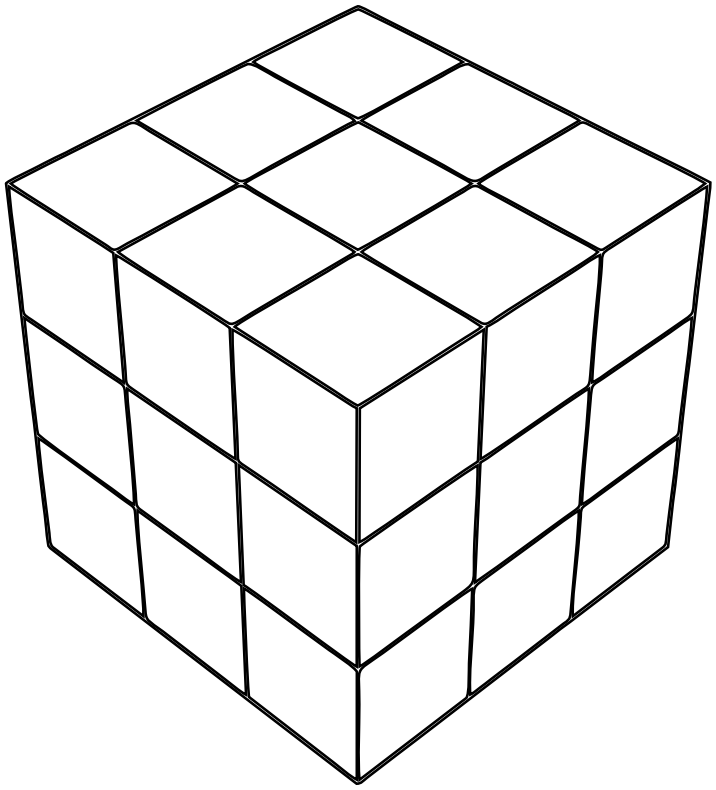
15. $(3^{-1})^{-4} =$ _____

16. $(4^2)^{-2} =$ _____

Extra Practice: Puzzle Power

Complete the table by writing equivalent expressions using exponent rules. Then write the expressions in standard form. Use the color code to color the cubes in the picture.

	Equivalent Expression	Standard Form	Color
$(2^{-2})^{1}$			red
$10^{(-1)(-2)}$			orange
$(3^{1})^{2}$			yellow
$3^{-2} \times 5^{-2}$			green
$8^{(2)(1)}$			blue
$(6 \times 2)^{2}$			purple
$4^{-2} \times 5^{-2}$			black



Power Concentration Cards

$(2 \times 3)^2$	$3^{-2} \times 5^{-2}$	$(5 \times 2)^2$
$(3 \times 2)^3$	$4^2 \times 3^2$	$6^{-2} \times 2^{-2}$
$(7 \times 3)^3$	$(2 \times 4)^{-3}$	$2^{-2} \times 7^{-2}$
36	$\frac{1}{225}$	100
216	144	$\frac{1}{144}$
9,261	$\frac{1}{512}$	$\frac{1}{196}$

Population Growth

Part 1: Answer the questions about the scenario. You can use **place value disks** to model the numbers.

1. Keifer is researching the population of Greenville. He found that in 1960, the population of Greenville was 5×10^4 and in 2010, it was 9×10^6.

a. Model both populations on the place value chart.

b. Write both populations in standard form.

1960: _____

2010: _____

Write and simplify a ratio to compare the populations.

$\frac{(9 \times 10^6)}{(5 \times 10^4)} =$ _____ $\times \frac{10^6}{10^4} =$ _____ $\times \frac{10^6}{10^4} =$ _____ $\times 10^{-} =$ _____

c. How many times greater is the Greenville population in 2010 than in 1960? _____

Part 2: Complete the table by rounding the number to the greatest place value and writing the rounded number in scientific notation.

2.

Number	Rounded to the Greatest Place Value	Scientific Notation
7,304		
469,125		
38,240		
123,776,849		

More Populations

Review the example problem. Then complete the table and answer the questions.

Example

The population for Riverside was **51,390** in 1950 and **223,746** in 2000. Round each number. Then write and simplify a ratio to compare the population in 2000 to the population in 1950.

Step 1

Round each number to its highest place value.

51,390 rounded to nearest ten thousand = 50,000

223,746 rounded to nearest hundred thousand = 200,000

Step 2

Write each rounded population as a single digit times a multiple of 10, and then as a power of 10 (scientific notation).

$50{,}000 = 5 \times 10{,}000 = 5 \times 10^4$

$200{,}000 = 2 \times 100{,}000 = 2 \times 10^5$

Step 3

Create a ratio to compare the 2000 population to the 1950 population. Simplify the ratio.

$$\frac{2 \times 10^5}{5 \times 10^4} = \frac{2}{5} \times \frac{10^5}{10^4} = \frac{2}{5} \times 10^{5-4} = \frac{2}{5} \times 10^1 = \frac{4}{10} \times 10^1 = 0.4 \times 10^1 = 4$$

The population in 2000 was about 4 times what it was in 1950.

1. Complete the table. Round each population to its highest place value and write in scientific notation.

Town	Population in 2020	Rounded Population	Scientific Notation
Blue Harbor	82,400		
Poplar Bluff	8,943		
Seaside	332,499		
Copper Springs	38,762		
Dry Canyon	6,321		

2. Write and simplify a ratio to compare the population in Seaside to the population in Dry Canyon.

The population in Seaside is about _____ times greater than in Dry Canyon.

3. Write and simplify a ratio to compare the population in Blue Harbor to the population in Copper Springs.

About how many times greater is the population in Blue Harbor than in Copper Springs?_____

Lesson 13 Exit Ticket

Part 1: Answer the questions about the scenario. You can use **place value disks** to model the numbers.

1. Lin is researching the population of dogs and cats in his country. He found that the population of dogs is 3×10^6 and of cats, 9×10^7.

a. Write both populations in standard form.

Dogs: _____

Cats: _____

b. Write and solve a ratio to compare the populations.

How many times greater is the cat population than the dog population? _____

Part 2: Complete the table by rounding the number to the greatest place value and writing the rounded number in scientific notation.

2.

Number	Rounded to the Greatest Place Value	Scientific Notation
880,429,736		
51,345		
368,307		
61,907,432		

Part 3: Write the following numbers in standard form.

3. 3×10^7: _____

4. 8×10^2: _____

5. 4×10^6: _____

Extra Practice: Story Time

Part 1: Match the numbers with the corresponding scientific notation.

1. 50	**a.** 5×10^3
2. 50,000	**b.** 5×10^2
3. 5,000	**c.** 5×10^1
4. 500,000	**d.** 5×10^5
5. 500	**e.** 5×10^4

Part 2: Answer the questions about the scenario. You can use **place value disks** to model the numbers.

6. Both Mei and her friend Derek have written short stories. Mei's story has 2×10^3 words and Derek's story has 8×10^3 words.

a. Write each number in standard form. _____

b. Write and solve a ratio to determine how much greater the word count in Derek's story is than in Mei's story.

c. The word count in Derek's story is _____ times greater than in Mei's.

7. Skye has written a novel with 4×10^5 words.

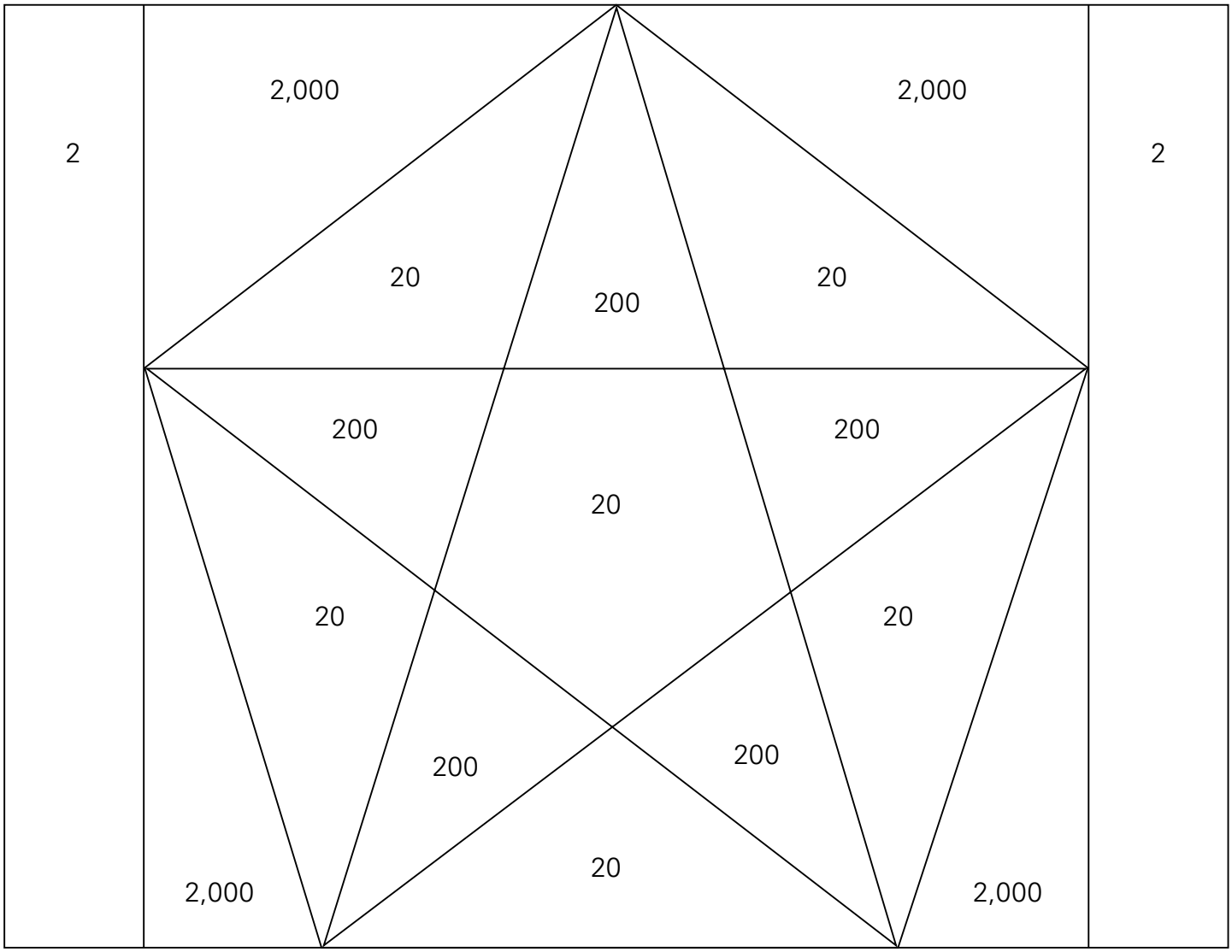
a. Write this number in standard form. _____

b. Skye's novel is _____ times greater than Derek's story.

Skye's novel is _____ times greater than Mei's story.

Kaleidoscope

Solve the problems below to find the color key to fill in the picture.



1. Blue: How many times greater than 4×10^3 is 8×10^6?

2. Red: How many times greater than 4×10^4 is 8×10^5?

3. Yellow: How many times greater than 4×10^2 is 8×10^4?

4. Green: How many times greater than 4×10^8 is 8×10^8?

Ambitious Comics

Part 1: Use **place value disks or drawings** to model dividing large numbers by 10. Then complete the chart and answer the questions.

Ambitious Comics is looking at buying a new machine to print *The Stupendous Six* comic books because they are a special size. The machine can print 41,672 comic books a month. How can Kiara write this number in scientific notation?

Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths

1. How many times did you divide by 10? _____

2. What is 41,672 written in scientific notation? _____

3. Explain what happens to the decimal point in 41,672 every time you divide by a power of 10.

_____

_____

Part 2: Use **place value disks or drawings** to help you write each number in scientific notation.

4. 302,228 = _____

5. 854,892 = _____

6. 1,964 = _____

7. 21,072 = _____

8. 8. 571,814 = _____

9. 19,891 = _____

Power Up

Review the example problem. Rewrite the numbers in scientific notation and answer the questions.

Example

What is **7,806** written in scientific notation?

Step 1

Divide the number by 10 multiple times, until the greatest place value is the ones place. Move the decimal point one place to the left each time you divide by 10. Count the number of times the decimal moves.

7,806 ÷ 10 = **7,806** = **780.6**

780.6 ÷ 10 = **780.6** = **78.06**

78.06 ÷ 10 = **78.06** = **7.806**

The decimal point moves 3 times.

Step 2

Use the number of times you moved the decimal point (the number of times you divided by 10) as the exponent for the power of 10. Use the final quotient as the other factor to write in scientific notation.

The decimal point moved three times to make **7.806**.

7,806 in scientific notation is **7.806** × 10^3.

1. In the comic book *The Protectors,* the leader is Nonbine, who is super strong. Nonbine can lift 502,394 pounds.

In scientific notation, Nonbine can lift _____ pounds.

2. How many times will you move the decimal point to rewrite 3,905,774,821 in scientific notation?

_____

3. Rewrite each number in scientific notation.

Number	Scientific Notation
5,398	
6,098,293,579	
23,046	
64,284,301,657	
204,611,302	
2,074,224	

Lesson 14 Exit Ticket

Part 1: Model the division and answer the questions.

1. Use **place value disks or drawings** to model dividing 3,214 until the quotient is between 1 and 10.

How many times did you divide by 10? _____

2. Complete the chart to show how to divide 10,508 until the quotient is between 1 and 10.

Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths
					.					
					.					
					.					
					.					
					.					
					.					

3. What is 10,508 written in scientific notation? _____

Part 2: Rewrite each number in scientific notation.

	Number	Scientific Notation
4.	6,032	
5.	5,994,867	
6.	472,180	
7.	28,619,835,043	

Extra Practice: Starry Skies

Part 1: Write digits to show how to divide by 10.

1. Based on telescope images, an astronomer says there are 926,583 stars in one part of the sky.

Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths
	2	6				.					
	9		6	5		.	3				
					5	.	8				
				2		.		8			
				9		.					
						.					

2. Use the finished chart. In scientific notation, there are _____ stars.

Part 2: Use place value drawings to show how to divide by 10.

3. An aspiring astronomer has determined he can see 234 stars through his telescope.

Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths
○○	○○○	○○○○	.			
	○○	○○○	.	○○○○		
		○○	.	○○○	○○○○	

4. Use the finished chart. In scientific notation, the astronomer can see _____ stars.

Space Explorers Place Value Mat

Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths
					.				
					.				
					.				
					.				
					.				
					.				

Powers of Pyramids

Part 1: Use **place value drawings and a place value mat** to model multiplying small numbers by 10. Then answer the questions.

1. I read that the Great Pyramid of Giza is made of an estimated 2.3×10^6 blocks. Use your place value mat to model converting the number to standard form.

a. How many times did you multiply by 10? _____

b. What is the number of blocks in standard form? _____ blocks

Part 2: Complete the chart to model multiplying small numbers by 10. Then answer the questions.

2. I read that the Great Pyramid of Giza has a volume of 8.8×10^7 cubic feet. Complete the place value chart to convert the number to standard form.

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths
								.	
								.	
								.	
								.	
								.	
								.	
								.	
								.	

a. How many times did you multiply by 10?_____

b. What is the volume of the pyramid in standard form? _____ cubic feet

Moving the Decimal Point

Review the example problem. Then complete the table. Convert numbers in scientific notation to standard form by moving the decimal point.

Example

What is **6.42** × **10^3** written in standard form?

Step 1

Identify the exponent in the scientific notation. This is the number of times to multiply the rational number by 10.

The exponent in **6.42** × **10^3** is **3**.

I need to multiply **6.42** by 10 **3** times to convert to standard form.

Step 2

To find the standard form, move the decimal point one place to the right for each time you multiply **6.42** by **10**.

6.42 × 10 = 6.42 = 64.2

64.2 × 10 = 64.2 = 642.0

642.0 × 10 = 642.0 = 6,420

6.42 × **10^3** in standard form is 6,420.

Complete the table.

Number in Scientific Notation	Decimal Shift	Standard Form
7.38×10^4	7.3800	
1.9×10^7		
4.564×10^{11}		
3.71×10^3		
6.7×10^8		
4.92×10^7		
8.43×10^2		
4.5×10^6		
8.17×10^3		
6.274×10^5		
3.25×10^9		
9.5×10^7		

Lesson 15 Exit Ticket

Part 1: Use **place value drawings and a place value mat** to model multiplying small numbers by 10. Then answer the questions.

1. Jen saw the number 1.43×10^4 in her science textbook and would like to know the value in standard form.

a. How many times did you multiply by 10? _____

b. What is the number in standard form? _____

Part 2: Use digits to complete a **place value chart** to model multiplying small numbers by 10. Then answer the questions.

2. Bonnie saw the number 4.9823×10^6 in a magazine article about fun animal facts and would like to know the value in standard form.

4.9823×10^6 in standard form is _____.

Part 3: Convert each number to standard form.

Number in Scientific Notation	Standard Form
8.37×10^5	
9.1×10^9	
5.654×10^4	

Extra Practice: Space Distances

1. Convert numbers in scientific notation to standard form and complete the table.

Approximate Distances from Sun (miles)

	Number in Scientific Notation	Standard Form
Mercury	3.6×10^7	
Venus	6.72×10^7	
Earth	9.3×10^7	
Mars	1.416×10^8	
Jupiter	4.838×10^8	
Saturn	8.9×10^8	
Uranus	1.784×10^9	
Neptune	2.7931×10^9	
Pluto	3.6745×10^9	

2. The distance from the Earth to the Moon is rounded to 2.4×10^5 miles. Complete the chart to convert to standard form.

Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths

a. How many times did you multiply by 10? _____

b. What is the rounded distance in standard form? _____ miles

Place Value Chart

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths
								.				
								.				
								.				
								.				
								.				
								.				

Place Value Chart

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths
								.				
								.				
								.				
								.				
								.				
								.				

Place Value Chart

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths
								.				
								.				
								.				
								.				
								.				
								.				

Place Value Chart

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths
								.				
								.				
								.				
								.				
								.				
								.				

Place Value Chart

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths
								.				
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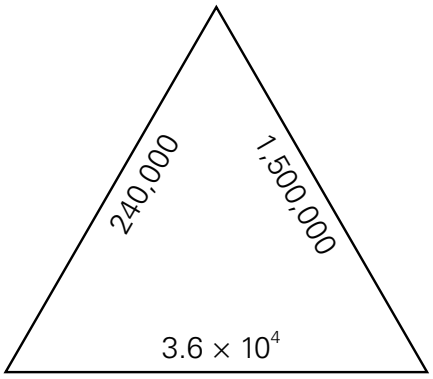
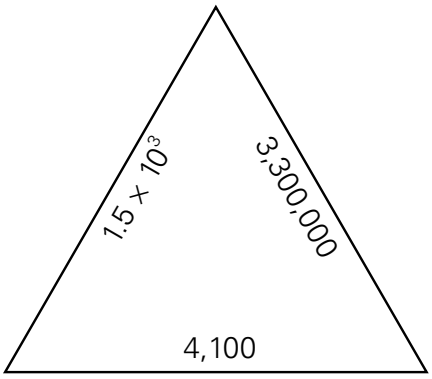
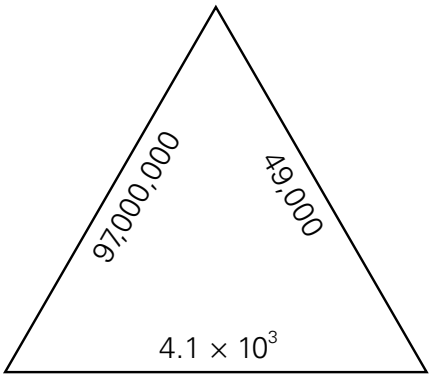
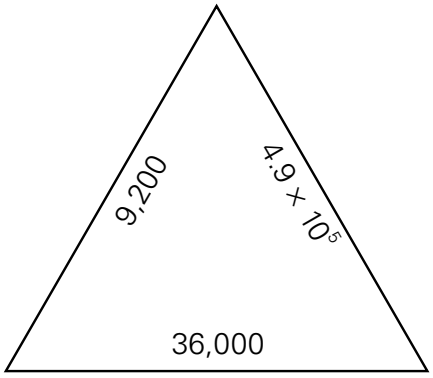
								.				
								.				
								.				

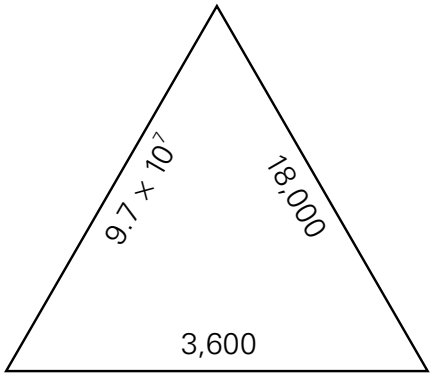
Power Pyramid Puzzle

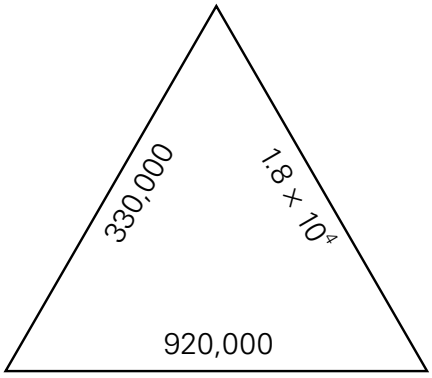


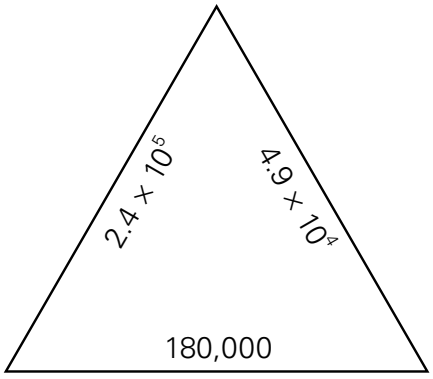


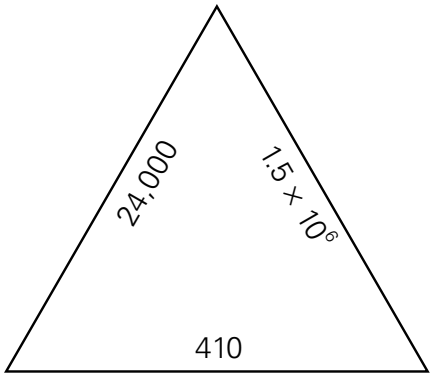


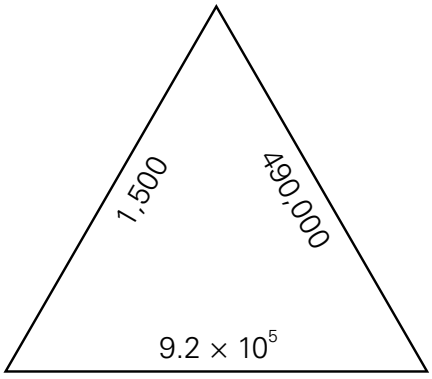












Thin Materials

Part 1: Use **place value disks or drawings** and a place value mat to model the multiplication by 10. Then answer the questions.

1. Ms. Reyes measured the thickness of 1,000 sheets of copy paper as 4 inches. By dividing 4 by 1,000, she found that one sheet of copy paper is 0.004 of an inch thick.

a. Model 0.004 in the first row. Show multiplication by 10 in each of the other rows.

b. How many times did you multiply by 10?_____

c. Will 0.004 in scientific notation have a positive or negative exponent? _____

Why? _____

_____

_____

d. What is 0.004 written in scientific notation?_____

2. A mixed assortment of paper had an average thickness of 0.076 mm per sheet.

a. Model 0.076 in the first row. Show multiplication by 10 in each of the other rows.

b. What is 0.076 written in scientific notation?_____

Part 2: Rewrite each number in scientific notation.

3. 0.000931 = _____

4. 0.001017 = _____

5. 0.00000432 = _____

Small Stuff

Review the example problem. Then write the numbers in scientific notation and use **place value disks or drawings** to check your work.

Example

What is **0.038** written in scientific notation?

Step 1

Multiply by moving the decimal point to the right until you have a number equal to or greater than 1 and less than 10.

0.038

Step 2

Set up the number in scientific notation by writing the final product multiplied by a power of 10.

$0.038 = 3.8 \times 10^{n}$

Step 3

Use the number of times you multiplied the original number as the power of 10 exponent. Use a negative exponent to show you need to do the opposite of multiplying to get back to the original number.

I multiplied by 10 two times, or 10^2, so now I need to multiply by the inverse. The exponent in the scientific notation is –2.

$0.038 = 3.8 \times 10^{-2}$

Step 4

Check your work with a place value mat. Write each digit of the original number in a place value chart. Shift the digits to the left to show multiplying by 10 multiple times. Continue multiplying until the first digit of the number is in the ones place.

Ones	.	Tenths	Hundredths	Thousandths
0	.	0	3	8
0	.	3	8	
3	.	8		

The digits shifted to the left twice, so I multiplied 0.038 by 10 two times.

Rewrite each number in scientific notation.

Number	Scientific Notation
0.00459	
0.0313	
0.00007822	
0.000006268	
0.01818	
0.00095	

Lesson 16 Exit Ticket

Part 1: Use **place value disks or drawings** and a place value mat to model multiplication by 10. Then write the number in scientific notation.

1. Jayne was reading in her art history class that artists in ancient India used gold leaf in their work. The gold leaf was really thin—only 0.00001 of a millimeter!

a. Model 0.00001 in the first row. Show multiplication by 10 in each of the other rows.

b. What is 0.00001 written in scientific notation? _____

Part 2: Use digits in the chart to model the multiplication by 10. Then write the number in scientific notation.

2. Max needs to find the scientific notation for 0.00722.

a. Model 0.00722 in the first row. Show multiplication by 10 in each of the other rows.

Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Millionths	Hundred Millionths	Billionths

b. What is 0.00722 written in scientific notation? _____

Part 3: Use scientific notation to express each number.

Number	Scientific Notation
0.0000378	
0.0051	
0.0000000926	

Extra Practice: Hair Raising

Part 1: Determine whether the following statements are *true* or *false*.

1. When expressing a number less than 1 in scientific notation, you will need to divide by powers of 10. _____

2. To express 0.00574192 in scientific notation, move the decimal point 3 places to the right. _____

3. You can model multiplying by powers of 10 using a place value chart. _____

4. All numbers expressed in scientific notation have a positive exponent. _____

5. 0.83×10^{-4} is correctly expressed in scientific notation. _____

Part 2: Use the place value chart to model multiplying by powers of 10 and express the number in scientific notation.

6. April bought some special microfiber cloths for cleaning her house. The package said that the fibers in the cloths are $\frac{1}{25}$ the width of a human hair—only 0.0016 inches each!

a. Fill in the place value chart to show multiplying 0.0016 by powers of 10.

Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths

b. In scientific notation, the fibers in April's cloths have a width of _____ centimeters.

Secret Code

Complete the Code Key table with the scientific notation for each given number. Use the completed key to fill in the blanks for a secret message.

CODE KEY

	Standard Form	Scientific Notation
A	0.07	
B	0.009	
E	0.007	
G	0.0004	
L	0.0009	
M	0.06	

	Standard Form	Scientific Notation
N	0.003	
R	0.6	
S	0.00003	
T	0.000009	
U	0.02	

SECRET CODED MESSAGE

3.0×10^{-5} 6.0×10^{-2} 7.0×10^{-2} 9.0×10^{-4} 9.0×10^{-4}

3.0×10^{-3} 2.0×10^{-2} 6.0×10^{-2} 9.0×10^{-3} 7.0×10^{-3} 6.0×10^{-1} 3.0×10^{-5}

= 4.0×10^{-4} 6.0×10^{-1} 7.0×10^{-3} 7.0×10^{-2} 9.0×10^{-6} !

Decimal Place Value Charts (Billionths)

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Decimal Place Value Charts (Billionths)

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Decimal Place Value Charts (Billionths)

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Decimal Place Value Charts (Billionths)

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Ones		Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Milionths	Hundred Millionths	Billionths
	.									
	.									
	.									
	.									
	.									
	.									
	.									
	.									

Ah-choo!

Use the place value charts to model the division by 10. Then answer the questions.

1. My friend, Emma, is allergic to cats. Emma's doctor told her that cat dander particles are approximately 7.5×10^{-3} millimeters in size.

a. Rewrite the expression 10^{-3} as a fraction. _____

b. Use this fraction to rewrite the scientific notation as a division expression.

7.5×10^{-3} = _____

Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths

c. What is the size of cat dander particles in standard form? _____ millimeters

2. Emma is also allergic to grass pollen. When she mows the lawn in her backyard, she has to wear a mask. A grass pollen grain has a size of approximately 2.5×10^{-5} meters.

a. Rewrite the expression 10^{-5} as a fraction. _____.

b. Use this fraction to rewrite the scientific notation as a division expression.

2.5×10^{-5} = _____

Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths

c. What is the size of a grass pollen grain in standard form? _____ meters

More Sneezing

Review the example problem. Then convert the numbers in scientific notation to standard form by moving the decimal point. Use a **place value chart** to check your work.

Example

What is $\mathbf{8.3 \times 10^{-2}}$ in standard form?

Step 1

Convert the number with a negative exponent to a fraction, then simplify the expression.

$$\mathbf{8.3 \times 10^{-2} = 8.3 \times \frac{1}{10^2} = \frac{8.3}{10^2}}$$

Step 2

Identify the value of the exponent as the number of times to divide the number **8.3** by 10.

$\mathbf{10^2}$ is the exponent, so the number **8.3** must be divided by 10 two times.

Step 3

To find the standard form, move the decimal point left the same number of places as the exponent, the number of times the number is divided by 10.

0 0 8.3

The decimal moves two places left. The standard form is 0.083.

Step 4

To check, write the original number in a place value chart. Move the digits one place to the right for each time you divide by 10.

Ones	.	Tenths	Hundredths	Thousandths
8	**.**	**3**		
0	**.**	**8**	**3**	
0	**.**	0	**8**	**3**

The standard form is 0.083.

Scientific Notation	Standard Form
6.72×10^{-7}	
1.9×10^{-4}	
5.37×10^{-3}	
9.8×10^{-6}	
5.29×10^{-7}	
3.60504×10^{-4}	
4.0216×10^{-5}	

Lesson 17 Exit Ticket

Answer the questions.

1. 7×10^{-5}

a. What is 10^{-5} as a fraction? _____

b. Rewrite 7×10^{-5} as a division expression.

7×10^{-5} = _____

2. 6.482×10^{-4}

a. Model the division in the place value chart.

Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths	Ten Millionths	Hundred Millionths

b. 6.482×10^{-4} in standard form is _____.

3. Convert each number in scientific notation to standard form.

Scientific Notation	Standard Form
9.35×10^{-2}	
6.2×10^{-12}	
1.947×10^{-6}	
2.81×10^{-4}	

Extra Practice: A Grain of Salt

Part 1: Answer the questions.

1. Sebastian needed to put some salt in his bread dough mixture. He was curious to know if a grain of salt weighed greater than or less than a grain of sugar. Looking it up, Sebastian found that a grain of salt weighs approximately 5.85×10^{-5} grams.

a. Using arrows, show how to move the decimal point to convert the weight of a grain of salt to standard form.

b. What is the weight of a grain of salt in standard form? _____

2. Sebastian also wants to add poppy seeds. He then found that one poppy seed weighs approximately 3.0×10^{-4} grams.

a. Rewrite the expression 10^{-4} as a fraction. _____

b. Use this fraction to rewrite the scientific notation as a division expression.

3.0×10^{-4} = _____

c. Model the division by writing digits in the place value chart.

Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths

d. What is the weight of a poppy seed in standard form? _____ grams

Part 2: Match the numbers in scientific notation to their standard form.

3. 3.1×10^{-2}

4. 3.1×10^{-7}

5. 3.1×10^{-3}

6. 3.1×10^{-10}

7. 3.1×10^{-8}

A. 0.00000000031

B. 0.031

C. 0.0031

D. 0.000000031

E. 0.00000031

Decimal Place Value Charts (Billionths)

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Out There!

Use rules for converting between scientific notation and standard form to add and subtract the numbers and answer the questions.

1. A spaceship that will transport people from Earth to the moon flies at a speed of 5.8×10^4 miles per hour. A spaceship to transport people from Earth to Mars flies at a speed of 3.6×10^6 miles per hour. How much greater is the speed of the spaceship to Mars than the spaceship to the moon?

a. What is the speed of each spaceship in standard form?

Spaceship to the Moon: _____ miles per hour

Spaceship to Mars: _____ miles per hour

b. Write and solve a subtraction equation to find the difference in speeds.

c. In scientific notation, the spaceship to Mars flies at a speed _____ miles per hour greater than the spaceship to the moon.

2. Spaceflight measurements need to be precise. In a spaceflight simulation, the Mars spaceship increases its speed by 6.99×10^{-3} miles per hour. Then it increases its speed again by 3.11×10^{-2} miles per hour.

a. What is each speed increase in standard form?

6.99×10^{-3} miles per hour = _____

3.11×10^{-2} miles per hour = _____

b. Write and solve an addition equation to find the total increase in speed.

c. In scientific notation, what is the total increase in speed? _____ miles per hour

Around the Solar System

Review the example problem. Then convert between scientific notation and standard form to solve.

Example

What is the sum of **$5.45 \times 10^5 + 6.27 \times 10^6$**?

Step 1

Convert the first addend to standard form.

The exponent 5 in **5.45×10^5** tells you to multiply by 10 five times.

5.45000. **5.45×10^5** = 545,000

Step 2

Convert the second addend to standard form.

The exponent 6 in **6.27×10^6** tells you to multiply by 10 six times.

6.270000. **6.27×10^6** = 6,270,000

Step 3

Add using the standard algorithm.

$$\begin{array}{r} {\scriptstyle 1} \\ 6{,}270{,}000 \\ +\ \ 545{,}000 \\ \hline 6{,}815{,}000 \end{array}$$

Step 4

Convert the sum to scientific notation by dividing by 10 until the number is greater than or equal to 1 and less than 10.

6.815000.

I divided by 10 six times. So, the exponent is 6.

$6{,}815{,}000 = 6.815 \times 10^6$

5.45×10^5 + **6.27×10^6** = 6.815×10^6

1. Yazmin is writing the FAQ webpage for Out There! She needs to include round-trip distances. The average distance from Earth to Saturn is 1.45×10^9 kilometers. How far is the trip to Saturn and back? Show your work.

The trip is _____ kilometers.

2. The actual distance between planets changes as they orbit the sun. Yazmin needs to make an adjustment and subtract 9.9×10^3 kilometers from the average distance. What is the adjusted distance from Earth to Saturn? Show your work.

The adjusted difference is _____ kilometers.

Lesson 18 Exit Ticket

Use rules for converting between scientific notation and standard form to add and subtract the numbers and answer questions.

1. Solve $6.83 \times 10^5 - 4.91 \times 10^4$. Show all work converting numbers between scientific notation and standard form and for the subtraction.

In scientific notation, $6.83 \times 10^5 - 4.91 \times 10^4 =$ _____

2. Solve $9.825 \times 10^{-3} + 3.2 \times 10^{-6}$. Show all work converting numbers between scientific notation and standard form and for the addition.

In scientific notation, $9.825 \times 10^{-3} + 3.2 \times 10^{-6} =$ _____

Extra Practice: Around the Globe

Part 1: Complete the following statements with *sometimes, always,* or *never*.

1. Unless otherwise instructed, _____ put your sum or difference in the form of the original numbers.

2. The difference of two numbers in scientific notation will _____ have the same exponent as the two numbers.

3. When adding numbers in scientific notation, you _____ add the exponents.

Part 2: Use rules for converting between scientific notation and standard form to add and subtract numbers written in scientific notation and answer questions.

4. The circumference of the moon is 1.0917×10^4 kilometers. The circumference of Earth is 4.0075×10^4 kilometers. How much greater is Earth's circumference compared to the moon's?

a. What is the circumference of the moon and Earth in standard form?

Moon: _____ kilometers Earth: _____ kilometers

b. Write and solve an equation to determine how much greater the Earth's circumference is when compared to the Moon's.

c. The circumference of Earth is _____ kilometers greater than the circumference of the Moon.

Part 3: Match the equation with the corresponding sum or difference.

5. $7.4 \times 10^2 + 2.9 \times 10^3$

6. $8.8 \times 10^4 - 5.2 \times 10^4$

7. $3.5 \times 10^3 + 6.1 \times 10^5$

8. $5.7 \times 10^5 - 4.3 \times 10^4$

9. $9.6 \times 10^4 - 8.4 \times 10^3$

A. 3.6×10^4

B. 8.76×10^4

C. 5.27×10^5

D. 3.64×10^3

E. 6.135×10^5

Place Value Mat (Thousands)

Thousands			Ones		
Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones

Place Value Mat (Thousands)

Thousands			Ones		
Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones

Airport Construction

Fernando's project for the semester will be to design an airport: runways, parking lots, and terminals. Use the rules of exponents to answer the questions. Use the formulas $A = w \times l$ and $w = A \div l$. Round decimals to the thousandths place if necessary.

1. The new parking lot Fernando is designing will be for people waiting to pick up passengers who have just arrived and picked up their baggage. The parking lot will have a width of 6.75×10^3 feet and a length of 1.5×10^4 feet.

a. Write the expression to find the area: _____

b. Write the rearranged expression: _____

c. Show how you will solve to find the area.

d. In scientific notation, the area of the new parking lot is _____ square feet.

2. In the design for a new terminal building, there is a window with an area of 1.198×10^5 square inches. The length of the window is 6.24×10^2 inches.

a. Write the expression to find the width: _____

b. Show how you will solve to find the width.

c. In scientific notation, the terminal window is _____ inches wide.

More Practice

Review the example problem. Then use exponent rules and the associative property to multiply and divide numbers in scientific notation and answer the questions.

Example

What is the quotient of $(2.666 \times 10^8) \div (8.6 \times 10^4)$?

Step 1

Set the problem up as a fraction.

$$\frac{2.666 \times 10^8}{8.6 \times 10^4}$$

Step 2

Simplify the fraction by dividing the decimal numbers first, then the exponents.

$$\left(\frac{2.666}{8.6}\right) \times \left(\frac{10^8}{10^4}\right)$$

$$0.31 \times \left(\frac{10^8}{10^4}\right)$$

$$0.31 \times (10^{8-4})$$

$$0.31 \times 10^4$$

Step 3

Check that the solution is in scientific notation.

0.31 is less than 1, so the solution is not in scientific notation.

Step 4

Adjust the solution to scientific notation if needed. Shift the decimal point right and balance this by reducing the power of 10 exponent. If you need to shift the decimal point left, balance this by increasing the power of 10 exponent.

0.31×10^4 The quotient is 3.1×10^3.

	Scientific Notation
$(8.2 \times 10^4) \times (1.1 \times 10^7)$	
$(2 \times 10^5) \times (7.1 \times 10^3)$	
$(9.36 \times 10^4) \div (3.12 \times 10^2)$	
$(5.04 \times 10^{10}) \div (6 \times 10^5)$	
$(4.6 \times 10^2) \times (1.6 \times 10^4)$	
$(4.88 \times 10^{-2}) \div (1.22 \times 10^8)$	
$(7 \times 10^{12}) \times (9.8 \times 10^{-6})$	

Lesson 19 Exit Ticket

Use exponent rules and the associative property to multiply and divide numbers written in scientific notation. Show your work.

	Expression	Scientific Notation
1.	$(1.5 \times 10^6) \times (3.4 \times 10^9)$	
2.	$(2 \times 10^5) \times (7.3 \times 10^5)$	
3.	$(6.96 \times 10^8) \div (4.8 \times 10^3)$	
4.	$(3.502 \times 10^{10}) \div (1.7 \times 10^7)$	

Extra Practice: Working with Scientific Notation

Part 1: Determine whether the following statements are *true* or *false*.

1. When dividing two numbers in scientific notation, divide the decimals and subtract the exponents of the powers of 10. _____

2. The product of 2.5×10^3 and 8.6×10^2 in scientific notation is 21.5×10^5. _____

3. You can use the associative property to rearrange factors when multiplying numbers in scientific notation. _____

4. When multiplying two numbers in scientific notation, multiply the numbers and multiply the exponents. _____

Part 2: Find the product or quotient in scientific notation.

5.

$\frac{2.25 \times 10^{12}}{3 \times 10^7}$	
$(3.1 \times 10^3) \times (9 \times 10^6)$	
$(4.7 \times 10^6) \times (1.4 \times 10^8)$	
$\frac{8.844 \times 10^{20}}{6.7 \times 10^2}$	

Part 3: The following numbers are supposed to be in scientific notation. Circle the expressions that are in correct scientific notation. Cross out the expressions that are not in scientific notation and write them in scientific notation.

6.

4.15×10^3

0.57×10^5

7.53×10^2

0.298×10^9

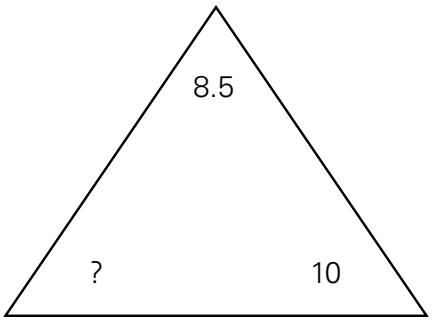
6.8×10^6

1.583×10^7

17.639×10^5

34.642×10^{10}

Number Triangles



_____ × _____ = _____

_____ × _____ = _____

_____ ÷ _____ = _____

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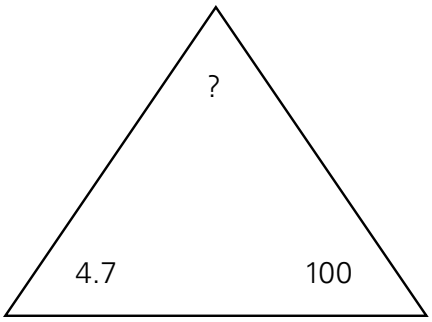

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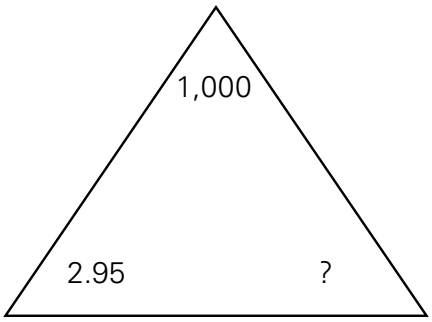

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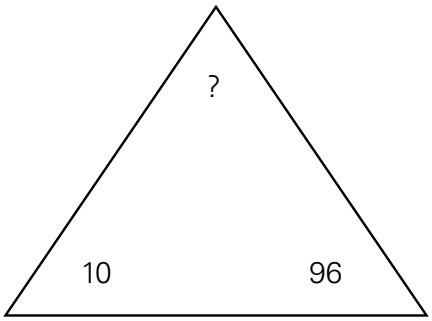

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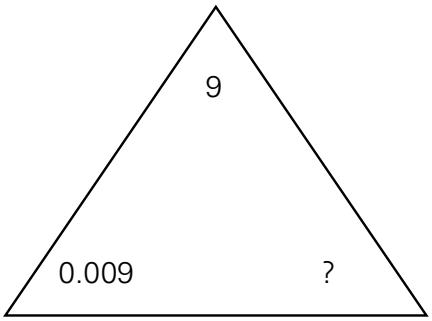

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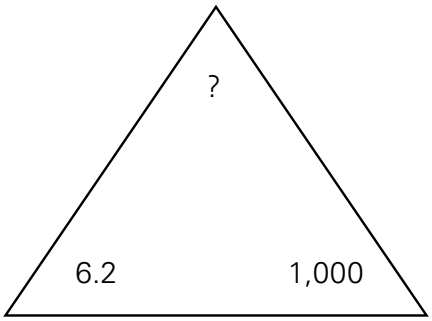

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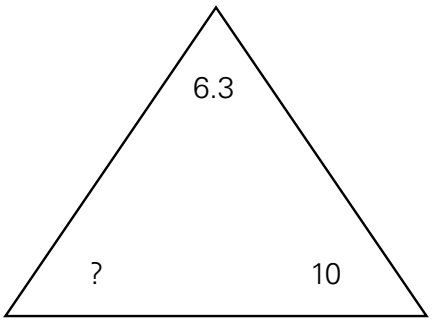

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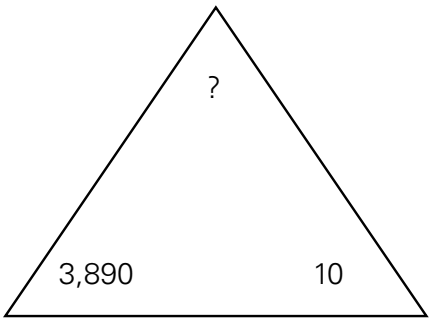

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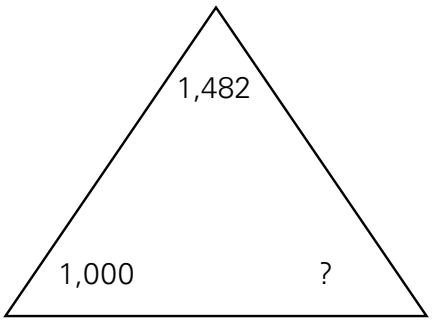


_____ × _____ = _____

_____ × _____ = _____

_____ ÷ _____ = _____

_____ ÷ _____ = _____

Product/Quotient Puzzle

				3×10^3
2.2×10^8		1.32×10^5		7.7×10^6
3.5×10^{-2}		1.1×10^9		1.9×10^3
2.6×10^4		1.2×10^{-4}		4.94×10^7
3.9×10^5	$\div$	$\div$	$=$	$=$
1.3×10^2	$\times$	$\times$	$=$	$=$

Assessment

Unit 2 Assessment

1. Sergei has a rock specimen that weighs 6^{-3} pounds. Starting at 6^0, use a number string pattern to find the weight in standard form.

The rock weighs _____ pounds.

2. Complete the equations. Write the missing products or quotients as exponential expressions.

$4^2 \div 4^5 =$ _____ $10^{-3} \times 10^6 =$ _____

$8^{-1} \div 8^{-7} =$ _____ $a^0 \div a^{-4} =$ _____

3. Write an equivalent form of the expression $(4 \times 6)^2$, then simplify

Equivalent expression: $(4 \times 6)^2 =$ _____

Simplified form: _____

4. The population of Fair Harbor in 1970 was 5×10^5. In 2010, the population was 2×10^6.

a. Write a ratio to show the comparison of the population in 1970 and 2010.

b. How many times greater was the population in Fair Harbor in 2010 than in 1970?

_____

5. Rewrite 80,914,365,227 in scientific notation. _____

6. Rewrite 7.815×10^6 in standard form. Then explain your strategy.

$7.815 \times 10^6 =$ _____

_____

_____

_____

7. Rewrite 0.062 in scientific notation. 0.062 = _____

8. Lisa has the flu. Her doctor told her that the influenza virus has a diameter of approximately 1×10^{-6} millimeters.

a. Write 1×10^{-6} as a fraction. _____

b. In decimal form, the influenza virus has a diameter of _____ millimeters.

9. Add. Show your work. Write the sum in scientific notation.

$1.32 \times 10^4 + 5.8 \times 10^5 =$ _____

10. Use the associative property to multiply. Show your work and write your answer in scientific notation.

$(4.374 \times 10^3) \times (8.75 \times 10^2) =$ _____

Unit 2 Cumulative Review

1. Lindsay wants to buy a new cell phone for $186. She has $51 in her savings account right now and plans on saving $15 each week.

a. Write an equation to determine how many weeks Lindsay will need to save before she can buy her new phone. _____

b. Lindsay can buy her new phone in _____ weeks.

2. At the farmers' market, apples are $5 for 2 pounds.

a. Complete the ratio table.

Apples (pounds)	Price ($)
2	5
4	
	20
	35
16	

b. What is the constant of proportionality? _____

3. Manuel walks his dog every day. He can walk ⅓ of a mile in 1/12 of an hour. What is Manuel's unit rate in miles per hour? _____

4. Isabelle has a cube-shaped packing box with a volume of 512 cubic inches.

a. Write an equation to find the length of each edge of the box. _____

b. What is each side length of Isabelle's box? _____

5. Solve for m. Show your work.

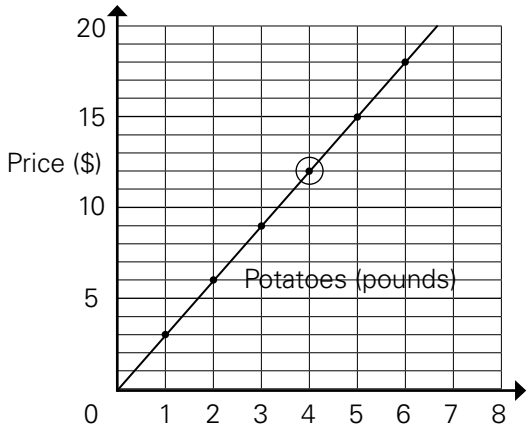
$5 + m = 11$ $m =$ _____

6. Match each fraction with its corresponding decimal.

$\frac{1}{4}$	0.8
$\frac{5}{11}$	$0.\overline{6}$
$\frac{8}{10}$	$0.\overline{45}$
$\frac{2}{3}$	0.25

7. Rewrite 3.9165×10^5 in standard form. _____

8. Ursula made a graph showing the price of potatoes at her grocery store.



a. How much does a pound of potatoes cost? _____

b. What does the point inside the circle represent? _____

9. The new park by the river in Springford has a length of 86 feet and a width of 64 feet.

What is the area of the new park? _____

10. Simplify $(5 \times 7)^3$. Show your work.

11. Are $\frac{8}{12}$ and $\frac{2}{3}$ proportional? Explain how you know.

_____

_____

12. Trinh bought 3 snow cones to share with Blaze and Shakira and spent $15.

a. Write an equation with a variable to determine how much each snow cone cost.

_____

b. Each snow cone cost $_____.

13. Put the following numbers in order from least to greatest.

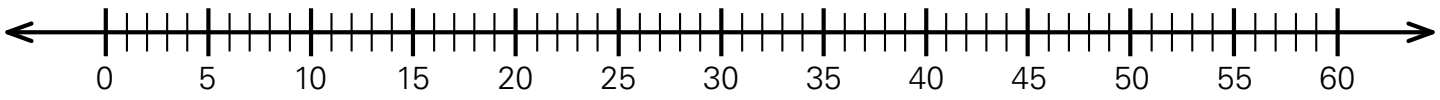
$\sqrt[3]{9}$, $\frac{1}{2}$, 0.02, $\frac{6}{9}$, $\sqrt{3}$, 1.8, $\sqrt{18}$ _____

14. A charter bus can hold 56 people. 18 people have already purchased tickets for the bus.

a. Write an inequality to represent the number of people who may still buy tickets for the bus.

_____

b. Graph the inequality.



c. If the bus is full, how many more people bought tickets? _____

15. Draw a line to match the equivalent expressions.

$4(x - 2) + 3$	$12x + 8$
$x + 6x - 3 + 7$	$4x - 5$
$4(3x + 2)$	$7x + 4$
$8x - 1 + 5 + x$	$9x + 4$