Focus On Numbers

Use before Lesson 4.7

Writing Numbers Using Powers of 10

Goal: Write numbers using powers of 10.

Review Vocabulary

Power: _____

Power of 10	Decimal Equivalent
10^4	____
10^3	____
10^2	____
10^1	____
____	1
10^{-1}	____
10^{-2}	____
10^{-3}	____
10^{-4}	____

Example 1 ***Rewriting a Large Number as a Power of 10***

There are 4,000,000,000 bytes of memory in 4 gigabytes of RAM. Write this number using a power of 10.

4,000,000,000 = ____ × _____ Rewrite 4,000,000,000 as ____ × _____.

= ____ × $10^{\square}$ Rewrite _____ as $10^{\square}$.

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Focus On Numbers

Use before Lesson 4.7

Writing Numbers Using Powers of 10

Goal: Write numbers using powers of 10.

Review Vocabulary

Power: A power is the result of a repeated multiplication of the same factor.

Power of 10	Decimal Equivalent
10^4	10,000
10^3	1000
10^2	100
10^1	10
10^0	1
10^{-1}	0.1
10^{-2}	0.01
10^{-3}	0.001
10^{-4}	0.0001

Example 1 ***Rewriting a Large Number as a Power of 10***

There are 4,000,000,000 bytes of memory in 4 gigabytes of RAM. Write this number using a power of 10.

4,000,000,000 = 4 × 1,000,000,000 Rewrite 4,000,000,000 as 4 × 1,000,000,000.

= 4 × 10^{9} Rewrite 1,000,000,000 as 10^{9}.

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✔ ***Checkpoint*** **Write the number using a power of 10.**

1. A stadium has 90,000 seats.

2. A grain of sand weighs 0.000002 gram.

Example 2 ***Solving Problems Using Powers of 10***

A bookstore has 40,000 books on its shelves. An online bookseller has 30,000,000 books available. About how many times greater is the number of books available online than the number of books in the store?

Solution

Write each number using the power of 10 of the ☐ number. Then divide the decimal part of the ☐ number by the decimal part of the ☐ number.

On shelves: 40,000 = ☐ × ☐ = ☐ × $10^{☐}$

Online: 30,000,000 = ☐ × ☐ = ☐ × $10^{☐}$

= ☐ × $10^{☐}$

☐ ÷ ☐ = ☐ Divide.

Answer: The number of books available online is about ☐ times greater than the number of books in the store.

✔ ***Checkpoint*** **Complete the following exercise.**

3. A housefly weighs about 0.00002 pound. A dime weighs about 0.005 pound. How many times greater is the weight of the dime than the weight of the housefly?

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Checkpoint **Write the number using a power of 10.**

1. A stadium has 90,000 seats.

9×10^4

2. A grain of sand weighs 0.000002 gram.

2×10^{-6}

Example 2 ***Solving Problems Using Powers of 10***

A bookstore has 40,000 books on its shelves. An online bookseller has 30,000,000 books available. About how many times greater is the number of books available online than the number of books in the store?

Solution

Write each number using the power of 10 of the [smaller] number. Then divide the decimal part of the [larger] number by the decimal part of the [smaller] number.

On shelves: 40,000 = [4] × [10,000] = [4] × $10^{[4]}$

Online: 30,000,000 = [3] × [10,000,000] = [3] × $10^{[7]}$

= [3000] × $10^{[4]}$

[3000] ÷ [4] = [750] Divide.

Answer: The number of books available online is about [750] times greater than the number of books in the store.

Checkpoint **Complete the following exercise.**

3. A housefly weighs about 0.00002 pound. A dime weighs about 0.005 pound. How many times greater is the weight of the dime than the weight of the housefly?

250

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4.7 Scientific Notation

Goal: Write numbers using scientific notation.

Using Scientific Notation

A number is written in **scientific notation** if it has the form $c \times 10^n$ where $1 \leq c < 10$ and n is an integer.

Standard form	Product form	Scientific notation
725,000	$7.25 \times 100{,}000$	7.25×10^5
0.006	6×0.001	6×10^{-3}

Example 1 ***Writing Numbers in Scientific Notation***

a. The average distance Mars is from the sun is 141,600,000 miles. Write this number in scientific notation.

Standard form	Product form	Scientific notation

b. The diameter of a quarter-ounce gold American Eagle coin is 0.022 meter. Write this number in scientific notation.

Standard form	Product form	Scientific notation

Example 2 ***Writing Numbers in Standard Form***

a. Write 4.1×10^4 in standard form.

Scientific notation	Product form	Standard form

b. Write 7.23×10^{-6} in standard form.

Scientific notation	Product form	Standard form

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4.7 Scientific Notation

Goal: Write numbers using scientific notation.

Using Scientific Notation

A number is written in **scientific notation** if it has the form $c \times 10^n$ where $1 \le c < 10$ and n is an integer.

Standard form	Product form	Scientific notation
725,000	$7.25 \times 100{,}000$	7.25×10^5
0.006	6×0.001	6×10^{-3}

Example 1 *Writing Numbers in Scientific Notation*

a. The average distance Mars is from the sun is 141,600,000 miles. Write this number in scientific notation.

Standard form	Product form	Scientific notation
141,600,000	$1.416 \times 100{,}000{,}000$	1.416×10^8

b. The diameter of a quarter-ounce gold American Eagle coin is 0.022 meter. Write this number in scientific notation.

Standard form	Product form	Scientific notation
0.022	2.2×0.01	2.2×10^{-2}

Example 2 *Writing Numbers in Standard Form*

a. Write 4.1×10^4 in standard form.

Scientific notation	Product form	Standard form
4.1×10^4	$4.1 \times 10{,}000$	41,000

b. Write 7.23×10^{-6} in standard form.

Scientific notation	Product form	Standard form
7.23×10^{-6}	7.23×0.000001	0.00000723

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Checkpoint **Write the number in scientific notation.**

1. 3,050,000,000	**2.** 0.000082

Write the number in standard form.

3. 6.53×10^{7}	**4.** 9.2×10^{-4}

Example 3 ***Ordering Numbers Using Scientific Notation***

Order 5.3×10^{5}, 520,000, and 7.5×10^{4} from least to greatest.

1. Write each number in scientific notation if necessary.

520,000 = ☐

2. Order the numbers with different powers of 10.

Because $10^{\square} < 10^{\square}$, ☐ < ☐ and

☐ < ☐.

3. Order the numbers with the same power of 10.

Because ☐ < ☐, ☐ < ☐.

4. Write the original numbers in order from least to greatest.

☐; ☐; ☐

Checkpoint **Order the numbers from least to greatest.**

5. 23,000; 3.4×10^{3}; 2.2×10^{4}
6. 4.5×10^{-4}; 0.000047; 4.8×10^{-5}

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Checkpoint **Write the number in scientific notation.**

1. 3,050,000,000 3.05×10^9	**2.** 0.000082 8.2×10^{-5}

Write the number in standard form.

3. 6.53×10^7 65,300,000	**4.** 9.2×10^{-4} 0.00092

Example 3 ***Ordering Numbers Using Scientific Notation***

Order 5.3×10^5, 520,000, and 7.5×10^4 from least to greatest.

1. Write each number in scientific notation if necessary.

520,000 = $\boxed{5.2 \times 10^5}$

2. Order the numbers with different powers of 10.

Because $10^{\boxed{4}} < 10^{\boxed{5}}$, $\boxed{7.5 \times 10^4} < \boxed{5.3 \times 10^5}$ and $\boxed{7.5 \times 10^4} < \boxed{5.2 \times 10^5}$.

3. Order the numbers with the same power of 10.

Because $\boxed{5.2} < \boxed{5.3}$, $\boxed{5.2 \times 10^5} < \boxed{5.3 \times 10^5}$.

4. Write the original numbers in order from least to greatest.

$\boxed{7.5 \times 10^4}$; $\boxed{520{,}000}$; $\boxed{5.3 \times 10^5}$

Checkpoint **Order the numbers from least to greatest.**

5. 23,000; 3.4×10^3; 2.2×10^4

3.4×10^3; 2.2×10^4; 23,000

6. 4.5×10^{-4}; 0.000047; 4.8×10^{-5}

0.000047; 4.8×10^{-5}; 4.5×10^{-4}

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Example 4 *Multiplying Numbers in Scientific Notation*

Oxygen Atoms The volume of one mole of oxygen atoms is about 1.736×10^{-5} cubic meters. Find the volume of 1.5×10^{4} moles of oxygen atoms.

Solution

Total volume	=	Volume of one mole of oxygen atoms	×	Number of moles

$= (\square)(\square)$ Substitute values.

$= (\square)(\square)$ Commutative and associative properties of multiplication

$= \square \times (\square)$ Multiply $\square$ and $\square$.

$= \square \times (\square)$ Product of powers property

$= \square \times \square$ Add exponents.

Answer: The volume of 1.5×10^{4} moles of oxygen atoms is about $\square \times \square$ cubic meters.

✔ ***Checkpoint*** **Find the product. Write your answer in scientific notation.**

7. $(2.5 \times 10^{3})(2 \times 10^{5})$	**8.** $(1.5 \times 10^{-2})(4 \times 10^{-4})$

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Example 4 *Multiplying Numbers in Scientific Notation*

Oxygen Atoms The volume of one mole of oxygen atoms is about 1.736×10^{-5} cubic meters. Find the volume of 1.5×10^{4} moles of oxygen atoms.

Solution

Total volume = Volume of one mole of oxygen atoms × Number of moles		
$= (1.736 \times 10^{5})(1.5 \times 10^{4})$		Substitute values.
$= (1.736 \times 1.5)(10^{-5} \times 10^{4})$		Commutative and associative properties of multiplication
$= 2.604 \times (10^{-5} \times 10^{4})$		Multiply 1.736 and 1.5.
$= 2.604 \times (10^{-5+4})$		Product of powers property
$= 2.604 \times 10^{-1}$		Add exponents.

Answer: The volume of 1.5×10^{4} moles of oxygen atoms is about 2.604×10^{-1} cubic meters.

✔ ***Checkpoint*** **Find the product. Write your answer in scientific notation.**

7. $(2.5 \times 10^{3})(2 \times 10^{5})$ 5×10^{8}	**8.** $(1.5 \times 10^{-2})(4 \times 10^{-4})$ 6×10^{-6}

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Focus On Operations

Use after Lesson 4.7

Operations with Scientific Notation

Goal: Perform operations with numbers written in scientific notation.

Review Vocabulary

Scientific notation: ☐

Example 1 ***Multiplying Numbers Written in Scientific Notation***

Evaluate $(5.6 \times 10^6) \times (4.5 \times 10^2)$. Write your answer in scientific notation.

Solution

$(5.6 \times 10^6) \times (4.5 \times 10^2)$

$= (5.6 \times \square) \times (\square \times 10^2)$ Commutative and associative properties of multiplication

$= \square \times 10^{\square}$ ☐ of powers property

$= (\square \times 10^{\square}) \times 10^{\square}$ Rewrite ☐.

$= \square \times (10^{\square} \times 10^{\square})$ ☐ property of multiplication

$= \square \times 10^{\square}$ ☐ of powers property

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Focus On Operations

Use after Lesson 4.7

Operations with Scientific Notation

Goal: Perform operations with numbers written in scientific notation.

Review Vocabulary

Scientific notation: A number is written in scientific notation if it has the form $c \times 10^n$ where $1 \leq c < 10$ and n is an integer.

Example 1 ***Multiplying Numbers Written in Scientific Notation***

Evaluate $(5.6 \times 10^6) \times (4.5 \times 10^2)$. Write your answer in scientific notation.

Solution

$(5.6 \times 10^6) \times (4.5 \times 10^2)$

$= (5.6 \times \boxed{4.5}) \times (\boxed{10^6} \times 10^2)$ Commutative and associative properties of multiplication

$= \boxed{25.2} \times 10^{\boxed{8}}$ $\boxed{\text{Product}}$ of powers property

$= (\boxed{2.52} \times 10^{\boxed{1}}) \times 10^{\boxed{8}}$ Rewrite $\boxed{25.2}$.

$= \boxed{2.52} \times (10^{\boxed{1}} \times 10^{\boxed{8}})$ $\boxed{\text{Associative}}$ property of multiplication

$= \boxed{2.52} \times 10^{\boxed{9}}$ $\boxed{\text{Product}}$ of powers property

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✔ ***Checkpoint*** **Evaluate. Write your answer in scientific notation.**

1. $(5.1 \times 10^8) \times (9 \times 10^{-3})$	**2.** $(8.8 \times 10^5)(2.3 \times 10^4)$
3. $\dfrac{1.28 \times 10^{-5}}{3.2 \times 10^2}$	**4.** $\dfrac{5.68 \times 10^8}{8 \times 10^{-1}}$

Example 2 ***Adding Numbers Written in Scientific Notation***

Evaluate $(1.62 \times 10^2) + (7.78 \times 10^3)$. Write your answer in scientific notation.

Solution

Rewrite 7.78×10^3 so it has the same power of $\square$ as $\square$.

$7.78 \times 10^3 = 7.78 \times 10^{\square} \times 10^{\square} = \square \times 10^{\square}$

$(1.62 \times 10^2) + (\square \times 10^{\square})$

$= (\square + \square) \times \square$ Distributive property

$= \square \times \square$ Add.

$= (\square \times 10^{\square}) \times 10^{\square}$ Rewrite $\square$.

$= \square \times 10^{\square}$ $\square$ of powers property

✔ ***Checkpoint*** **Evaluate. Write your answer in scientific notation.**

5. $(8.63 \times 10^9) + (1 \times 10^7)$	**6.** $(7 \times 10^{-2}) - (2 \times 10^{-3})$

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Checkpoint Evaluate. Write your answer in scientific notation.

1. $(5.1 \times 10^8) \times (9 \times 10^{-3})$ 4.59×10^6	**2.** $(8.8 \times 10^5)(2.3 \times 10^4)$ 2.024×10^{10}
3. $\dfrac{1.28 \times 10^{-5}}{3.2 \times 10^2}$ 4×10^{-8}	**4.** $\dfrac{5.68 \times 10^8}{8 \times 10^{-1}}$ 7.1×10^8

Example 2 ***Adding Numbers Written in Scientific Notation***

Evaluate $(1.62 \times 10^2) + (7.78 \times 10^3)$. Write your answer in scientific notation.

Solution

Rewrite 7.78×10^3 so it has the same power of $\boxed{10}$ as $\boxed{1.62 \times 10^2}$.

$7.78 \times 10^3 = 7.78 \times 10^{\boxed{1}} \times 10^{\boxed{2}} = \boxed{77.8} \times 10^{\boxed{2}}$

$(1.62 \times 10^2) + (\boxed{77.8} \times 10^{\boxed{2}})$

$= (\boxed{1.62} + \boxed{77.8}) \times \boxed{10^2}$ Distributive property

$= \boxed{79.42} \times \boxed{10^2}$ Add.

$= (\boxed{7.942} \times 10^{\boxed{1}}) \times 10^{\boxed{2}}$ Rewrite $\boxed{79.42}$.

$= \boxed{7.942} \times 10^{\boxed{3}}$ $\boxed{\text{Product}}$ of powers property

Checkpoint Evaluate. Write your answer in scientific notation.

5. $(8.63 \times 10^9) + (1 \times 10^7)$ 8.64×10^9	**6.** $(7 \times 10^{-2}) - (2 \times 10^{-3})$ 6.8×10^{-2}

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