MATH 082

SECTION 3.3

Scientific Notation

"It is not enough to have a good mind.
The main thing is to use it well."

RENE DESCARTES

DIRECTIONS

As you work through this Learning Guide, you should:

- read carefully
- take notes
- do the CheckPoint problems on your own
- check your answers to the CheckPoint problems
- watch the videos by clicking on the 📽 icons

IMPORTANT: Get help if you don't understand a topic.

INTRODUCTION

The last two sections focused on the properties of exponents.

Now we will use exponents in ***scientific notation*** to express very large or very small numbers.

For example, instead of expressing the speed of light as $300{,}000{,}000$ meters per second, we can express it more simply as 3×10^{8} meters per second.

In this section you will learn to convert numbers from standard notation to scientific notation and vice versa. You will also learn to multiply and divide numbers in scientific notation.

Scientific Notation

Scientific notation is used to represent very large or very small numbers.

An example of scientific notation is 2.6×10^{4}.

The notation consists of a number multiplied by a power of 10.

Numbers in scientific notation must be written in a very specific format:

$$\underbrace{2.6}_{\text{A number between 1 and 10. (can equal 1, but not 10)}} \quad \underbrace{\times}_{\text{Multiplied by}} \quad \underbrace{10^{4}}_{\text{10 raised to an exponent.}}$$

There should be one digit, then the decimal point, then the rest of the significant digits.

The exponent must be an integer.

SCIENTIFIC NOTATION
A number written in the form $\boldsymbol{a\times10^{n}}$ where $1\le a<10$ and n is an integer.

Scientific Notation vs. Standard Notation

To help understand scientific notation, perform the operations:

Example: 2.6×10^4 This number is in ***scientific notation***.

$= 2.6\times10000$ Evaluate 10^4. Multiply.

$= 26000$ This is the same number expressed in ***standard*** *(regular)* ***notation***.

Notice that the decimal point moved the number of places indicated by the exponent:

2.6×10^4

$= 2.6000.$

$= 26000$

So, numbers in ***scientific notation*** can be rewritten in ***standard notation*** just by moving the decimal point.

CONVERTING FROM SCIENTIFIC NOTATION TO STANDARD NOTATION

The "regular" way we write numbers is called ***standard notation*** (or *decimal notation*).

To convert from ***scientific notation*** to ***standard notation***, move the decimal point the number of places specified by the exponent.

The sign of the exponent indicates the direction that the decimal point is moved.

CONVERTING FROM SCIENTIFIC NOTATION TO STANDARD NOTATION
Convert from $a \times 10^n$ to Standard Notation: If the exponent n is **positive**, move the decimal point to the **right** n places. If the exponent n is **negative**, move the decimal point to the **left** n places. NOTE: Add zeros as needed to indicate place value.

EXAMPLES: Convert each number from scientific notation to standard notation.

1. 3.156×10^{1} The number is given in scientific notation.

$= 3.156 \times 10^{1}$ Since the exponent is **positive** 1,

$= 3.156$ move the decimal point **1** place to the **right**.

$= 31.56$ This is the result in standard notation.

2. 1.7×10^{2} The number is given in scientific notation.

$= 1.7 \times 10^{2}$ Since the exponent is **positive** 2,

$= 1.70$ move the decimal point **2** places to the **right**. Fill in the space with a 0.

$= 170$ This is the result in standard notation.

3. 4×10^{5} The number is given in scientific notation.

$= 4 \times 10^{5}$ Since the exponent is **positive** 5,

$= 4.00000$ move the decimal point **5** places to the **right**. Fill in the spaces with 0's.

$= 400{,}000$ This is the result in standard notation.

4. 6.25×10^{-1} The number is given in scientific notation.

$= 6.25 \times 10^{-1}$ Since the exponent is **negative** 1,

$= 6.25$ move the decimal point **1** place to the **left**.

$= .625$ This is the result in standard notation.

$= 0.625$ Usually we write a 0 before the decimal point.

5. 8.702×10^{-3} The number is given in scientific notation.

$= 8.702 \times 10^{-3}$ Since the exponent is **negative** 3,

$= 008.702$ move the decimal point **3** places to the **left**. Fill in the spaces with 0's.

$= .008702$ This is the result in standard notation.

$= 0.008702$ Usually we write a 0 before the decimal point.

CHECKPOINT: Convert each number from scientific notation to standard notation (*also called decimal notation*).

1. 7.85×10^{6}

2. 1.6×10^{-4}

3. 2.11×10^{3}

4. 4.376×10^{5}

5. 9.17×10^{-4}

6. 4.9×10^{-5}

Go to the next slide to check your answers.

CheckPoint Answers:

Check your answers with the ones below.

Watch the videos to see step-by-step solutions and hear the explanations.

1. 7,850,000

2. 0.00016

3. 2110

4. 437,600

5. 0.000917

6. 0.000049

CONVERTING FROM STANDARD NOTATION TO SCIENTIFIC NOTATION

CONVERTING FROM STANDARD NOTATION TO SCIENTIFIC NOTATION

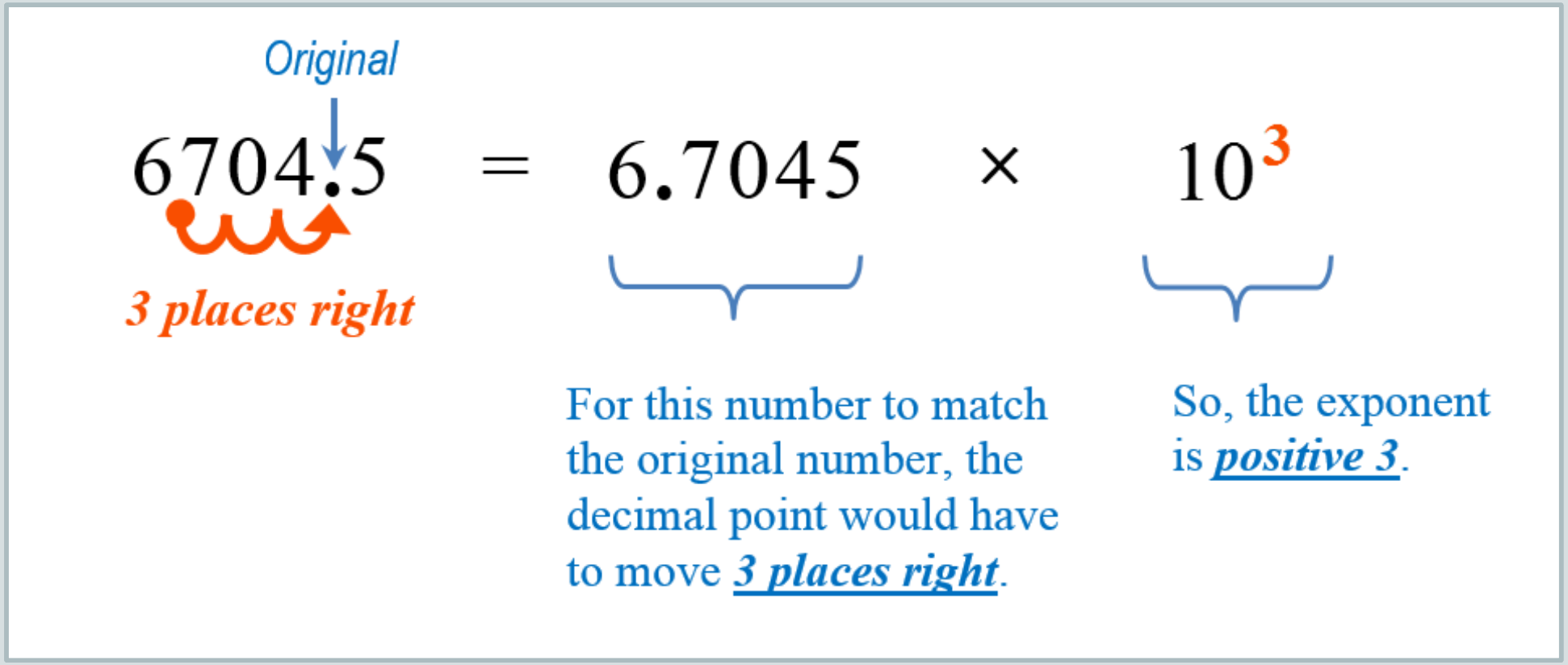
Convert from Standard Notation to $a \times 10^n$

1. Determine ***a***. $(1 \le a < 10)$
   a. Rewrite the number, and place the decimal point after the first non-zero digit.
   b. Drop any insignificant zeros.

2. Determine ***n***. (n is the exponent on 10)
   a. Start at the **NEW** decimal point and count the number of places to the **ORIGINAL** decimal point.
   b. Determine the sign of the exponent:
      - If the direction you count is to the **right**, the exponent is **positive**.
        This occurs when the original number is larger.
      - If the direction you count is to the **left**, the exponent is **negative**.
        This occurs when the original number is smaller.

3. Write the number in scientific notation format: $a \times 10^n$

EXAMPLE 1: Convert 6704.5 from standard notation to scientific notation.

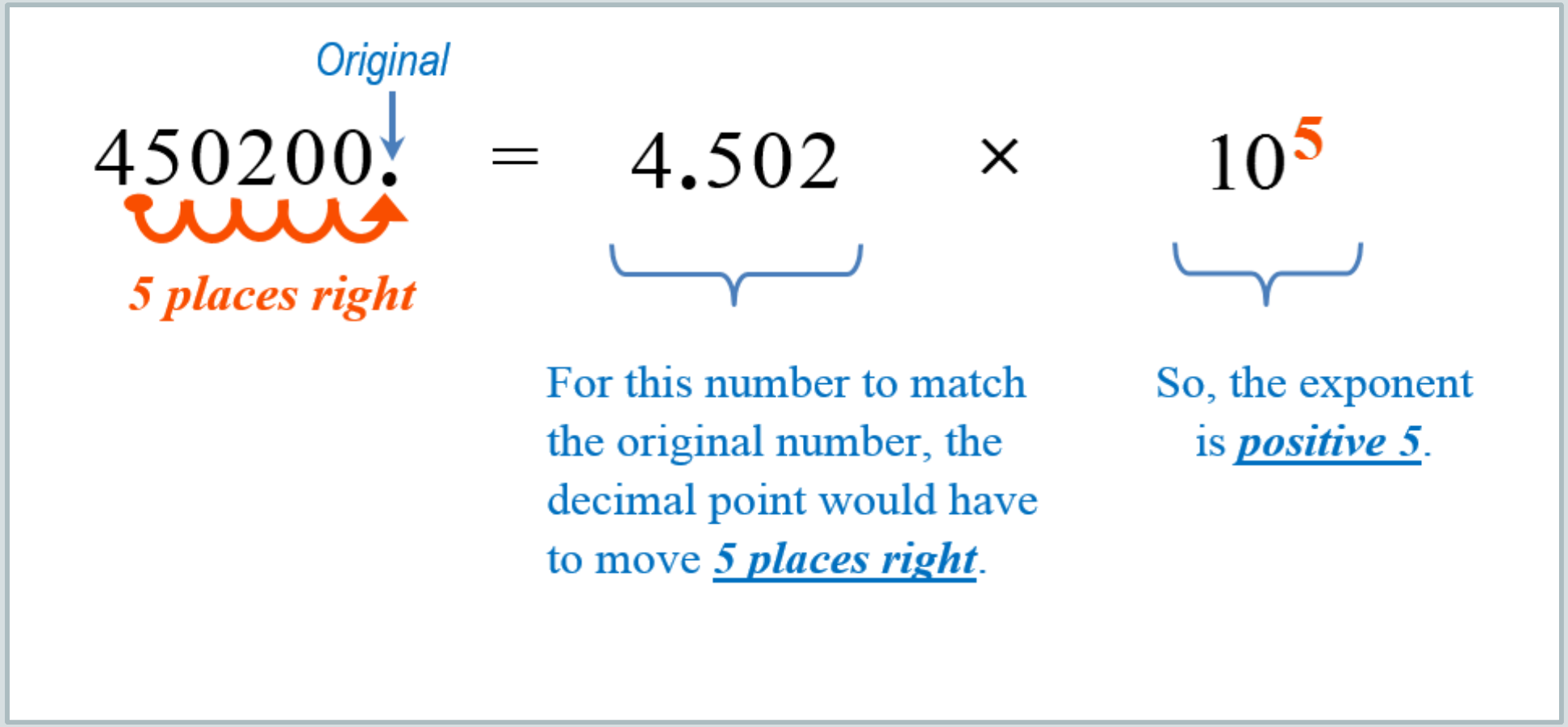


Answer: 6.7045×10^3

EXAMPLE 2: Convert 0.0073 from standard notation to scientific notation.

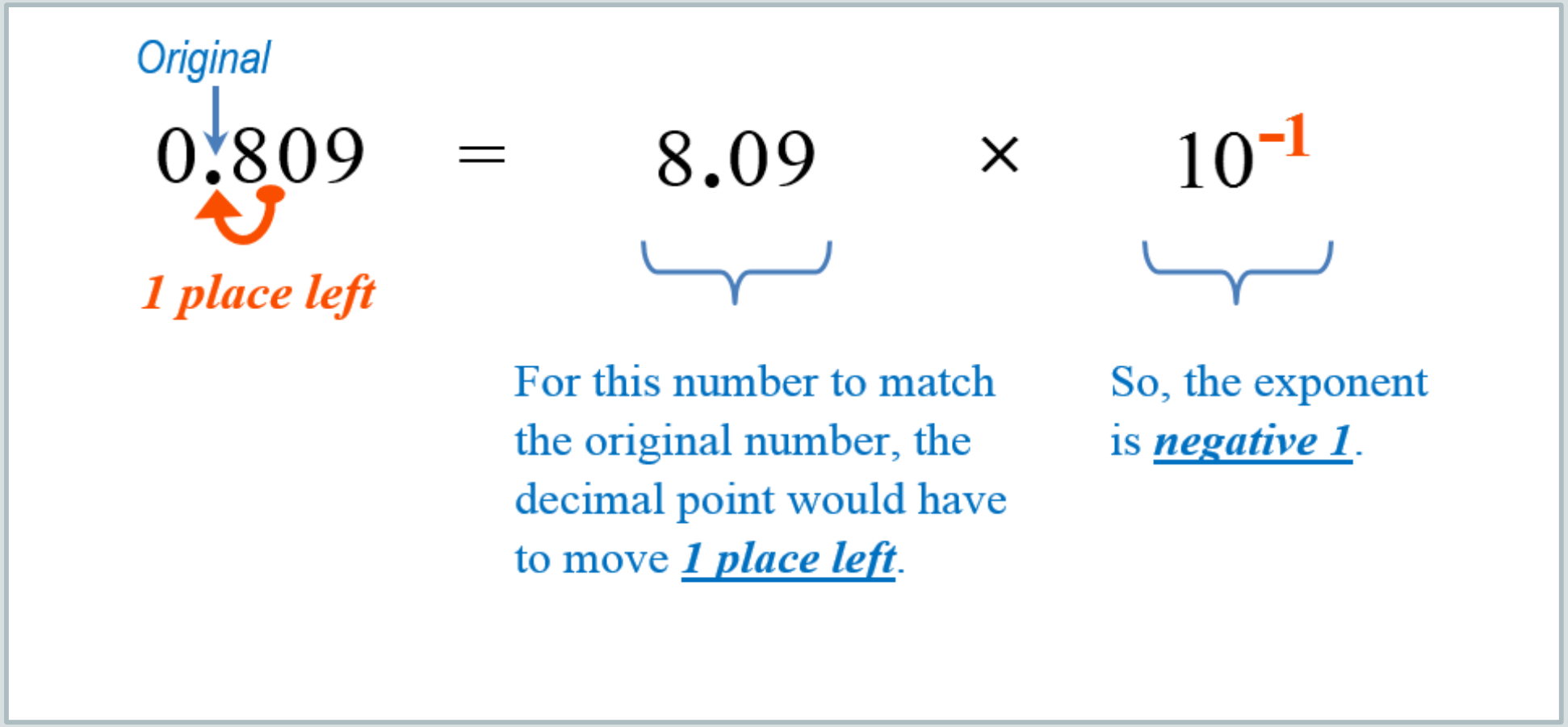
Answer: 7.3×10^{-3}

EXAMPLE 3: Convert 450,200 from standard notation to scientific notation.



Answer: 4.502×10^5

EXAMPLE 4: Convert 0.809 from standard notation to scientific notation.



Answer: 8.09×10^{-1}

CHECKPOINT: Convert each number from standard notation to scientific notation.

1. 642,000

2. 0.0007427

3. 7,427,000

4. 5,400

5. 0.0814

6. 0.00052

Go to the next slide to check your answers.

CheckPoint Answers:

Check your answers with the ones below.

Watch the videos to see step-by-step solutions and hear the explanations.

1. 6.42×10^{5}  *

2. 7.427×10^{-4}  **

3. 7.427×10^{6}  **

4. 5.4×10^{3}  ***

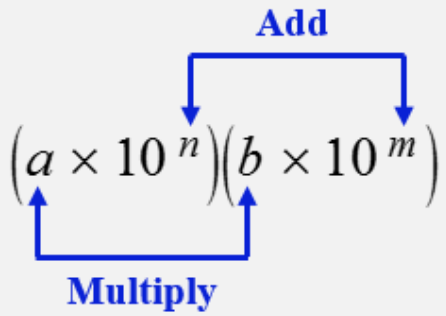
5. 8.14×10^{-2}  ***

6. 5.2×10^{-4}  ***

* *MathHelp.com* ** *TeacherTube.com* *** *YourMathGal.com*

Multiplying Numbers in Scientific Notation

Remember that the Product Rule of Exponents says to add exponents on like bases. This rule will be used to multiply two numbers that are written in scientific notation. We apply the rule by adding the exponents on the powers of ten.

MULTIPLYING NUMBERS IN SCIENTIFIC NOTATION
1. Multiply the numbers in front of each power of 10. 2. Add the exponents on the powers of ten. 3. Write the answer in scientific notation. 

EXAMPLES: Multiply and write the answer in scientific notation.

1. $(3\times10^{7})\times(2\times10^{4}) = (3\times2)\times(10^{7}\times10^{4})$ Multiply the numbers in front of the powers of 10.

$= 6\times10^{7+4}$ Add the exponents on the powers of 10.

$= 6\times10^{11}$ This is the answer in scientific notation.

2. $(4.57\times10^{4})\times(3.6\times10^{-6}) = (4.57\times3.6)\times(10^{4}\times10^{-6})$ Multiply the numbers in front of the powers of 10.

$= 16.452\times10^{4+-6}$ Add the exponents on the powers of 10.

$= 16.452\times10^{-2}$ This is the answer, but it is NOT in scientific notation because there is more than one digit to the left of the decimal point.

$= (1.6452\times10^{1})\times10^{-2}$ Rewrite 16.452 as 1.6452×10^{1} so that it is in scientific notation.

$= 1.6452\times(10^{1}\times10^{-2})$ Regroup.

$= 1.6452\times(10^{1+-2})$ Add the exponents on the powers of 10.

$= 1.6452\times10^{-1}$ This is the answer in scientific notation.

CHECKPOINT: Multiply and write the answer in scientific notation.

1. $\left(1.33\times10^{-1}\right)\times\left(2.4\times10^{5}\right)$

2. $\left(3.4\times10^{5}\right)\left(2.7\times10^{-2}\right)$

3. $\left(9.21\times10^{6}\right)\times\left(3.4\times10^{3}\right)$

4. $\left(6.7\times10^{-6}\right)\left(5.2\times10^{-3}\right)$

Go to the next slide to check your answers.

CheckPoint Answers:

Check your answers with the ones below.

Watch the videos to see step-by-step solutions and hear the explanations.

1. 3.192×10^{4} 

2. 9.18×10^{3} 

3. 3.1314×10^{10} 

4. 3.484×10^{-8} 

Dividing Numbers in Scientific Notation

Remember that the Quotient Rule of Exponents says to subtract exponents on like bases. This rule will be used to divide two numbers that are written in scientific notation. We apply the rule by subtracting the exponents on the powers of ten.

DIVIDING NUMBERS IN SCIENTIFIC NOTATION
1. Divide the numbers in front of each power of 10. 2. Subtract the exponents on the powers of ten. 3. Write the answer in scientific notation.

Divide $\dfrac{a \times 10^{n}}{b \times 10^{m}}$ **Subtract**

EXAMPLES: Divide and write the answer in scientific notation.

1. $\dfrac{6\times10^{5}}{2\times10^{-4}} = \dfrac{6}{2}\times\dfrac{10^{5}}{10^{-4}}$ Divide the numbers in front of the powers of 10.

$= 3 \times 10^{5-(-4)}$ Subtract the exponents on the powers of 10.

$= 3 \times 10^{5+4}$

$= 3 \times 10^{9}$ This is the answer in scientific notation.

2. $\dfrac{4.6\times10^{7}}{8.5\times10^{3}} = \dfrac{4.6}{8.5} \times \dfrac{10^{7}}{10^{3}}$ Divide the numbers in front of the powers of 10.

$= 0.54 \times 10^{7-3}$ Subtract the exponents on the powers of 10.

$= \underbrace{0.54}_{(5.4\times10^{-1})} \times 10^{4}$ This is the answer, but it is NOT in scientific notation. There must be one **non-zero** digit to the left of the decimal point.

$= (5.4\times10^{-1})\times10^{4}$ Rewrite 0.54 as 5.4×10^{-1} so that it is in scientific notation.

$= 5.4\times(10^{-1}\times10^{4})$ Regroup.

$= 5.4\times10^{-1+4}$ Add the exponents on the powers of 10.

$= 5.4\times10^{3}$ This is the answer in scientific notation.

CHECKPOINT: Divide and write the answer in scientific notation.

1. $\dfrac{4.2\times10^{3}}{2.1\times10^{-3}}$

2. $\dfrac{5.32\times10^{4}}{1.9\times10^{-3}}$

3. $\dfrac{1.2\times10^{-7}}{6.0\times10^{-3}}$

4. $\dfrac{2.352\times10^{-6}}{8.4\times10^{-2}}$

Go to the next slide to check your answers.

CheckPoint Answers:

Check your answers with the ones below.

Watch the videos to see step-by-step solutions and hear the explanations.

1. 2×10^{6} 

2. 2.8×10^{7} 

3. 2.0×10^{-5} 

4. 2.8×10^{-5} 

This is the end of the PowerPoint Learning Guide for Section 3.3.

Return to Section 3.3 of the Brightspace course to:

- study the Summary
- complete the Exercise Set