Program Information	[Title of Lesson]	TEACHER NAME	PROGRAM NAME
	Exponents	**Jolene Seuffert**	**Parma City School District**
	[Unit Title]	**NRS EFL(s)**	**TIME FRAME**
	Exponents	**2 – 3**	**150 minutes**

Instruction

ABE/ASE Standards – Mathematics

Numbers (N)		Algebra (A)		Geometry (G)		Data (D)	
Numbers and Operation		Operations and Algebraic Thinking	**A.2.1** **A.2.2** **A.2.4**	Geometric Shapes and Figures		Measurement and Data	
The Number System	**A.3.6** **A.3.8**	Expressions and Equations	**A.2.10**	Congruence		Statistics and Probability	
Ratios and Proportional Relationships		Functions		Similarity, Right Triangles. And Trigonometry		**Benchmarks identified in *RED* are priority be benchmarks. To view a complete list of priority benchmarks and related Ohio ABLE lesson plans, please see the Curriculum Alignments located on the Teacher Resource Center (TRC).**	
Number and Quantity				Geometric Measurement and Dimensions			
				Modeling with Geometry			

Mathematical Practices (MP)			
X	Make sense of problems and persevere in solving them. (MP.1)	☐	Use appropriate tools strategically. (MP.5)
☐	Reason abstractly and quantitatively. (MP.2)	☐	Attend to precision. (MP.6)
☐	Construct viable arguments and critique the reasoning of others. (MP.3)	☐	Look for and make use of structure. (MP.7)
☐	Model with mathematics. (MP.4)	☐	Look for and express regularity in repeated reasoning. (MP.8)

	LEARNER OUTCOME(S)	ASSESSMENT TOOLS/METHODS

	• Students will be able to recognize that some expressions can be rewritten utilizing exponents to condense and assist in evaluation.
	• Students will be able to simplify independent exponential functions and expressions with exponents.
	• Students will be able to demonstrate (85%) accuracy in simplifying exponential functions and expressions on lesson quiz.
		Formative:
		• Verbal check-in with students as they are working on warm-up – i.e. circulating the groups as students are working out the problem. Gauge if students are discussing during warm-up or if extra directives are needed.
		    ○ Offer individual, group or class assistance if needed. For example, remind students of PEMDAS.
		    ○ Review concepts as a class for accuracy and areas of difficulty, if need-be.
		• Provide more practice problems in form of worksheets if group/individual needs more time. Select and print any worksheet deemed appropriate from www.math-drills.com.
		Summative:
		• Collect quizzes and grade/check for accuracy.
		• If utilized, collect homework next class and grade.
		Next Steps:
		• Incorporate exponents into multistep algebraic equations or begin scientific notation.
		• Introduce scientific notation (under resources) – optional.

	LEARNER PRIOR KNOWLEDGE: • Terms: exponents, order of operations. • Math concepts: PEMDAS; math operations (addition, subtraction, multiplication, division).	

	INSTRUCTIONAL ACTIVITIES	RESOURCES
	1. Warm-up activity: Pair students in groups of 3 or 4. Pose this problem on the board: 3 + 2 x 2 x 2 x 2 x 2 - 4 ÷ 2 2. Have students solve the problem individually then share their solutions with the other members of their group. Groups should discuss and compare their answers and approaches for solving the problem. 3. Student groups should select one answer from the members that they feel is correct (or most likely to be correct). When all groups make a selection, have a student from each group write their selected answer on the board. 4. Teacher identifies correct answers or shares with class correct answer to problem. (The answer is 33 when utilizing order of operations). Provide students the opportunity to voice their misconceptions or issues in the solving process. 5. Using your own knowledge, introduce the term exponent to the students. (Optional definitions: a quantity that is raised by a power; or, a symbol that is written above to the right of a number to indicate how many times the number should be multiplied by itself). 6. Utilize a class volunteer, or do yourself – write an example of an exponent. Then have the class verbally indicate how to write it out. (Example: 4^3 is 4x4x4). 7. Refocus class' attention to original warm-up problem. Inquire to the class if there is any part of the problem that can be re-written utilizing the exponent function. Write out 3 + 2ˆ5 – 4 ÷ 2 on the board. Have students individually try to solve the problem. Discuss the difference solving the original problem versus the rewritten problem. 8. Video Lesson – play *MuchoMath Exponents video*. Teacher can play video to class via projector or students can watch the video individually on the computer using headphones. Alternatively, students can be paired to watch video together if space allows due to sound. 9. Teacher choice: distribute *Optional In-Class Practice Worksheet - Exponents* (attached) to students and allow them to complete it either individually or, in the interest of differentiating for the varied levels in the	White/chalkboard/chart paper (choose one) Student paper for in-class exercises Classroom projector with speakers that can hookup to a laptop/computer with internet for MuchoMath video lesson. Or, computer lab with sufficient internet accessible computers and headphones for students to watch MuchoMath video lesson independently or in pairs MuchoMath Exponents Video Lesson, accessible here: https://www.youtube.com/watch?v=i_1LVdI8MVs Student copies of *Optional In-Class Practice Worksheet* (attached) Student copies of *Exponent Quiz* (attached) • *Quiz 1 Exponents - Beginner* • *Quiz 2 Exponents - Advanced* *Answer Key Quiz 1 Exponents - Beginner* (attached) *Answer Key Quiz 2 Exponents - Advanced* (attached) Student copies of *Teacher-Generated Supplemental Practice* worksheets. Retrieved from: http://www.k5learning.com/free-math-worksheets/sixth-grade-6/exponents (Teacher can utilize link to create a class appropriate worksheet. Site allows for teacher to

	classroom, in structured pairs which allow advanced students to work with struggling students. 10. Practice quiz: pass out *Exponents Quiz* (attached) based upon student comfort with concepts (either *Beginner* or *Advanced*). Allow students to complete quiz individually to gauge acquisition of knowledge. 11. Optional: pass out *Teacher-Generated Supplemental Practice* homework worksheets, which can be tailored to the class's unique needs on the website http://www.k5learning.com/free-math-worksheets/sixth-grade-6/exponents as extra take-home practice or homework. 12. Collect homework and grade/check for accuracy and understanding of new concepts. 13. Next step: Introduce the concept of Scientific Notation by having class view *Khan Academy Scientific Notation video*.	level worksheets based upon student/class abilities) Student copies of *Vocabulary Sheet – Exponents* (attached) Khan Academy Video: Scientific Notation Introduction. Retrieved from: https://www.khanacademy.org/math/pre-algebra/exponents-radicals/scientific-notation/v/scientific-notation-old Student copies of *Scientific Notation Practice Worksheet* (attached)
	DIFFERENTIATION (options) • Distribute *Vocabulary Sheet - Exponents* with terms and definitions to students who appear to be struggling. • Video lesson: teacher can play video on large screen for entire class; students can watch video individually on a computer. • Pairing: students can be paired to watch the lesson together; (teacher preference to pair same level or low with high-level). • Higher level option: advanced quiz, homework options via website in resources. • Circulate room to provide additional assistance throughout activities/exercises.	

In-Class Practice Worksheet

Exponents

The rule of exponents

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

2. $2^5 \div 2^3 = \dfrac{2 \times 2 \times \cancel{2} \times \cancel{2} \times \cancel{2}}{\cancel{2} \times \cancel{2} \times \cancel{2}} = 2 \times 2 =$

3. $(2^2)^3 = 2^2 \times 2^2 \times 2^2 =$

Rule:
Rule:
Rule:

The number being raised to a power (2 in this case) is called the **base**.
Note: **You can only apply these rules to numbers involving the same base.**
So, for example, you cannot apply the rules of exponents to $3^2 + 2^3$

Try these:

Ex1 $2^4 \times 2^7 =$

Ex2 $3^9 \div 3^4 =$

Ex3 $(5^3)^6 =$

Ex4

Ex5

Ex6

Negative Exponents

$2^{-1} =$

$3^{-2} =$

$2^{-4} =$

$4^{-3} =$

Now consider $2^3 \times 2^{-3} =$

But $2^3 \times 2^{-3} = 8 \times \dfrac{1}{8} =$

So,

And generally,

QUIZ 1: EXPONENTS

Name: ____

1.

Powers and Exponents

Express the following as an exponent:

$9 \cdot 9 \cdot 9 \cdot 9 \cdot 9$

- a) 9^9
- b) 9^5
- c) 5^9
- d) 5^5

2.

Powers and Exponents

Express the following as an exponent:

$-12 \cdot 12 \cdot a \cdot a \cdot a$

- a) $-12^2 \cdot a^3$
- b) $(-12)^2 \cdot a^3$
- c) $-(12a)^5$
- d) $-12^3 \cdot a^5$

QUIZ 1 EXPONENTS

Powers and Exponents

Express the following as a product of terms:

$(-z)^3 \cdot 19^3$

- a) $-z \cdot -z \cdot -z \cdot 19 \cdot 19 \cdot 19$
- b) $-z \cdot z \cdot z \cdot 19 \cdot 19 \cdot 19$
- c) $-3z \cdot 19 \cdot 19 \cdot 19$
- d) $-z \cdot z \cdot 19 \cdot 19$

3. ______

Powers and Exponents

Express the following as a product of terms:

$8^2 \cdot x^2 \cdot 11^4$

- a) $8 \cdot 8 \cdot x \cdot x \cdot 11 \cdot 11 \cdot 11 \cdot 11 \cdot 11$
- b) $8 \cdot x \cdot 11 \cdot 11 \cdot 11 \cdot 11$
- c) $8 \cdot 8 \cdot 8 \cdot x \cdot x \cdot 11 \cdot 11 \cdot 11 \cdot 11$
- d) $8 \cdot 8 \cdot x \cdot x \cdot 11 \cdot 11 \cdot 11 \cdot 11$

4. ______

QUIZ 1 EXPONENTS

Powers and Exponents

Simplify the following:

$6^4 \bullet 6^6$

a) 6^{24}

b) 6^{10}

c) 6^3

d) 10^6

5.

Powers and Exponents

Simplify the following:

$z^2 \bullet z^3 \bullet y^2$

a) $z^5 \bullet y^2$

b) $z^6 \bullet y^2$

c) $5z \bullet 2y$

d) $(zy)^7$

6.

7.

Powers and Exponents

Simplify the following:

$$\frac{31^5}{31^4}$$

a) 31^2

b) 31^{20}

c) 31^9

d) 31

ANSWER KEY – QUIZ 1 BEGINNER

1. **B**
2. **A**
3. **A**
4. **D**
5. **B**
6. **D**
7. **B**

Name________________________

QUIZ 2: EXPONENTS

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Simplify the expression. Use positive exponents. Assume variables represent nonzero real numbers.

1) $6^4 \cdot 6^5$ — 1) ______

A) 6^{20} B) 6^9 C) 36^9 D) 36^{20}

2) $(-5p^4)(-8p^3)$ — 2) ______

A) $40p^7$ B) $40p^{12}$ C) $-40p^{12}$ D) $-40p^7$

Use the power rules for exponents to simplify. Write the answer in exponential form.

3) $9(rt)^5$ — 3) ______

A) $9rt^5$ B) $9r^5t$ C) $9^5r^5t^5$ D) $9r^5t^5$

4) $\left(-3^3\right)^3$ — 4) ______

A) 3^6 B) -3^9 C) 3^9 D) -3^6

Evaluate.

5) $(-11)^0 + (-3)^0$ — 5) ______

A) -2 B) -14 C) 0 D) 2

Evaluate the expression.

6) $(-5)^{-4}$ — 6) ______

A) $-\frac{1}{625}$ B) 625 C) $\frac{1}{625}$ D) -625

Perform the division.

7) $(6m^2 + 13m - 15) \div (m + 3)$ — 7) ______

A) $m - 5$ B) $6m + 5$ C) $6m - 5$ D) $6m - 5 + \frac{4}{m - 5}$

Perform the indicated operation.

8) $(7 + 6x^3 + 8x^5 - 4x^4) + (-5x^4 + 2x^3 - 2 + 7x^5)$ — 8) ______

A) $2x^5 + 2x^4 + 6x^3 + 3$ B) $15x^5 - 9x^4 + 8x^3 + 5$

C) $14x^{24} + 5$ D) $15x^{10} - 9x^8 + 8x^6 + 5$

9) $(4x^7 + 7x^9 + 6 - 2x^8) - (-5 - 5x^8 + 9x^9 + 8x^7)$ — 9) ______

A) $16x^9 - 7x^8 + 12x^7 + 1$ B) $-2x^9 + 3x^8 - 4x^7 + 11$

C) $16x^9 - 7x^8 + 12x^7 + 11$ D) $-2x^9 - 7x^8 + 12x^7 + 1$

ANSWER KEY – QUIZ 2 ADVANCED

1. B
2. A
3. A
4. D
5. B
6. D
7. B

Vocabulary Sheet – Exponents

Variables – a factor or quantity that can vary, or change; represented in math by a letter such as x or y

Numbers – an arithmetical value expressed by a symbol or word, represents a quantity

Operators – addition, subtraction, multiplication, and division symbols

Exponents – a quantity representing the power a given number or expression is to be raised

Parenthesis – ( ), a pair of rounded brackets used to mark off a mathematical number or expression

Expression – numbers and symbols with operators (+, -, x, /) grouped together to show the value of something

Algebraic Expression – a mathematical phrase that contains numbers, variables and operators

PEMDAS – Acronym for "Please Excuse My Dear Aunt Sally" to help learners remember the order to work through/solve operations. The order of operations should be parenthesis first ( ); exponents second; multiplication and division third from left to right; and addition and subtraction last from left to right

MATH HANDBOOK TRANSPARENCY MASTER 1

Scientific Notation

Use with Appendix B, Scientific Notation

Scientists need to express small measurements, such as the mass of the proton at the center of a hydrogen atom (0.000 000 000 000 000 000 000 000 001 673 kg), and large measurements, such as the temperature at the center of the Sun (15 000 000 K). To do this conveniently, they express the numerical values of small and large measurements in scientific notation, which has two parts.

A number in which only one digit is placed to the left of the decimal → $N \times 10^n$ ← An exponent of 10 by which the number is multiplied

Thus, the temperature of the Sun, 15 million kelvins, is written as 1.5×10^7 K in scientific notation.

Positive Exponents Express 1234.56 in scientific notation.

Each time the decimal place is moved one place to the left, the exponent is increased by one.

$$1234.56$$

$$1234.56 \times 10^0 = 123.456 \times 10^1$$

$$123.456 \times 10^1 = 12.3456 \times 10^2$$

$$12.3456 \times 10^2 = 1.234\,56 \times 10^3$$

$$1.234\,56 \times 10^3$$

Negative Exponents Express 0.006 57 in scientific notation.

Each time the decimal place is moved one place to the right, the exponent is decreased by one.

$$0.006\,57$$

$$0.006\,57 \times 10^0 = 0.0657 \times 10^{-1}$$

$$0.0657 \times 10^{-1} = 0.657 \times 10^{-2}$$

$$0.657 \times 10^{-2} = 6.57 \times 10^{-3}$$

$$6.57 \times 10^{-3}$$

MATH HANDBOOK TRANSPARENCY WORKSHEET 1

Scientific Notation

Use with Appendix B, Scientific Notation

1. Express each of the following numbers in scientific notation.

a. 230

b. 5601

c. 14 100 000

d. 56 million

e. 2/10

f. 0.450 13

g. 0.089

h. 0.000 26

i. 0.000 000 698

j. 12 thousandth

2. Express each of the following measurements in scientific notation.

a. speed of light in a vacuum, 299 792 458 m/s

b. number of seconds in a day, 86 400 s

c. mean radius of Earth, 6378 km

d. density of oxygen gas at 0°C and pressure of 101 kPa, 0.001 42 g/mL

e. radius of an argon atom, 0.000 000 000 098 m

SCIENTIFIC NOTATION

Name ____________________

Scientists very often deal with very small and very large numbers, which can lead to a lot of confusion when counting zeros! We have learned to express these numbers as powers of 10.

Scientific notation takes the form of $M \times 10^n$ where $1 \leq M < 10$ and "n" represents the number of decimal places to be moved. Positive n indicates the standard form is a large number. Negative n indicates a number between zero and one.

Example 1: Convert 1,500,000 to scientific notation.
We move the decimal point so that there is only one digit to its left, a total of 6 places.

$1{,}500{,}000 = 1.5 \times 10^6$

Example 2: Convert 0.000025 to scientific notation.
For this, we move the decimal point 5 places to the right.

$0.000025 = 2.5 \times 10^{-5}$

(Note that when a number starts out less than one, the exponent is always negative.)

Convert the following to scientific notation.

1. 0.005 = ____________________
2. 5,050 = ____________________
3. 0.0008 = ____________________
4. 1,000 = ____________________
5. 1,000,000 = ____________________
6. 0.25 = ____________________
7. 0.025 = ____________________
8. 0.0025 = ____________________
9. 500 = ____________________
10. 5,000 = ____________________

Convert the following to standard notation.

1. 1.5×10^3 = ____________________
2. 1.5×10^{-3} = ____________________
3. 3.75×10^{-2} = ____________________
4. 3.75×10^2 = ____________________
5. 2.2×10^5 = ____________________
6. 3.35×10^{-1} = ____________________
7. 1.2×10^{-4} = ____________________
8. 1×10^4 = ____________________
9. 1×10^{-1} = ____________________
10. 4×10^0 = ____________________

MATH HANDBOOK TRANSPARENCY MASTER 2

Operations with Scientific Notation

Use with Appendix B, Operations with Scientific Notation

Addition and Subtraction

Before numbers in scientific notation can be added or subtracted, the exponents must be equal.

Not equal — Equal

$$(3.4 \times 10^2) + (4.57 \times 10^3) = (0.34 \times 10^3) + (4.57 \times 10^3)$$

The decimal is moved to the left to increase the exponent.

$$= (0.34 + 4.57) \times 10^3$$

$$= 4.91 \times 10^3$$

Multiplication

When numbers in scientific notation are multiplied, only the number is multiplied. The exponents are added.

$$(2.00 \times 10^3)(4.00 \times 10^4) = (2.00)(4.00) \times 10^{3+4}$$

$$= 8.00 \times 10^7$$

Division

When numbers in scientific notation are divided, only the number is divided. The exponents are subtracted.

$$\frac{9.60 \times 10^7}{1.60 \times 10^4} = \frac{9.60}{1.60} \times 10^{7-4}$$

$$= 6.00 \times 10^3$$

MATH HANDBOOK TRANSPARENCY WORKSHEET 2

Operations with Scientific Notation

Use with Appendix B, Operations with Scientific Notation

1. Perform the following operations and express the answers in scientific notation.

a. $(1.2 \times 10^5) + (5.35 \times 10^6)$

b. $(6.91 \times 10^{-2}) + (2.4 \times 10^{-3})$

c. $(9.70 \times 10^6) + (8.3 \times 10^5)$

d. $(3.67 \times 10^2) - (1.6 \times 10^1)$

e. $(8.41 \times 10^{-5}) - (7.9 \times 10^{-6})$

f. $(1.33 \times 10^5) - (4.9 \times 10^4)$

2. Perform the following operations and express the answers in scientific notation.

a. $(4.3 \times 10^8) \times (2.0 \times 10^6)$

b. $(6.0 \times 10^3) \times (1.5 \times 10^{-2})$

c. $(1.5 \times 10^{-2}) \times (8.0 \times 10^{-1})$

d. $\dfrac{7.8 \times 10^3}{1.2 \times 10^4}$

e. $\dfrac{8.1 \times 10^{-2}}{9.0 \times 10^2}$

f. $\dfrac{6.48 \times 10^5}{(2.4 \times 10^4)(1.8 \times 10^{-2})}$

Name______________________ Date__________ Class__________

MATH HANDBOOK TRANSPARENCY WORKSHEET **1**

Scientific Notation

Use with Appendix B, Scientific Notation

1. Express each of the following numbers in scientific notation.
   - a. 230
     $230 = 2.3 \times 10^2$
   - b. 5601
     $5601 = 5.601 \times 10^3$
   - c. 14 100 000
     $14\,100\,000 = 1.41 \times 10^7$
   - d. 56 million
     $56 \text{ million} = 56\,000\,000 = 5.6 \times 10^7$
   - e. 2/10
     $2/10 = 2 \times 0.1 = 2 \times 10^{-1}$
   - f. 0.450 13
     $0.450\,13 = 4.5013 \times 10^{-1}$
   - g. 0.089
     $0.089 = 8.9 \times 10^{-2}$
   - h. 0.000 26
     $0.000\,26 = 2.6 \times 10^{-4}$
   - i. 0.000 000 698
     $0.000\,000\,698 = 6.98 \times 10^{-7}$
   - j. 12 thousandth
     $12 \text{ thousandth} = 12/1000 = 12 \times 0.001 = 12 \times 10^{-3} = 1.2 \times 10^{-2}$
2. Express each of the following measurements in scientific notation.
   - a. speed of light in a vacuum, 299 792 458 m/s
     $299\,792\,458 \text{ m/s} = 2.997\,924\,58 \times 10^8 \text{ m/s}$
   - b. number of seconds in a day, 86 400 s
     $86\,400 \text{ s} = 8.64 \times 10^4 \text{ s}$
   - c. mean radius of Earth, 6378 km
     $6378 \text{ km} = 6.378 \times 10^3 \text{ km}$
   - d. density of oxygen gas at 0°C and pressure of 101 kPa, 0.001 42 g/mL
     $0.001\,42 \text{ g/mL} = 1.42 \times 10^{-3} \text{ g/mL}$
   - e. radius of an argon atom, 0.000 000 000 098 m
     $0.000\,000\,000\,098 \text{ m} = 9.8 \times 10^{-11} \text{ m}$

Name______________________ Date__________ Class__________

MATH HANDBOOK TRANSPARENCY WORKSHEET **2**

Operations with Scientific Notation

Use with Appendix B, Operations with Scientific Notation

1. Perform the following operations and express the answers in scientific notation.
   - a. $(1.2 \times 10^5) + (5.35 \times 10^6)$
     $(1.2 \times 10^5) + (5.35 \times 10^6) = (0.12 \times 10^6) + (5.35 \times 10^6) = (0.12 + 5.35) \times 10^6$
     $= 5.47 \times 10^6$
   - b. $(6.91 \times 10^{-2}) + (2.4 \times 10^{-3})$
     $(6.91 \times 10^{-2}) + (2.4 \times 10^{-3}) = (6.91 \times 10^{-2}) + (0.24 \times 10^{-2})$
     $= (6.91 + 0.24) \times 10^{-2} = 7.15 \times 10^{-2}$
   - c. $(9.70 \times 10^5) + (8.3 \times 10^5)$
     $(9.70 \times 10^5) + (8.3 \times 10^5) = (9.70 \times 10^5) + (0.83 \times 10^5) = (9.70 + 0.83) \times 10^5$
     $= 10.53 \times 10^5 = 1.053 \times 10^7$
   - d. $(3.67 \times 10^2) - (1.6 \times 10^1)$
     $(3.67 \times 10^2) - (1.6 \times 10^1) = (3.67 \times 10^2) - (0.16 \times 10^2) = (3.67 - 0.16) \times 10^2$
     $= 3.51 \times 10^2$
   - e. $(8.41 \times 10^{-5}) - (7.9 \times 10^{-6})$
     $(8.41 \times 10^{-5}) - (7.9 \times 10^{-6}) = (8.41 \times 10^{-5}) - (0.79 \times 10^{-5})$
     $= (8.41 - 0.79) \times 10^{-5} = 7.62 \times 10^{-5}$
   - f. $(1.33 \times 10^5) - (4.9 \times 10^4)$
     $(1.33 \times 10^5) - (4.9 \times 10^4) = (1.33 \times 10^5) - (0.49 \times 10^5) = (1.33 - 0.49) \times 10^5$
     $= 0.84 \times 10^5 = 8.4 \times 10^4$
2. Perform the following operations and express the answers in scientific notation.
   - a. $(4.3 \times 10^8) \times (2.0 \times 10^6)$
     $(4.3 \times 10^8) \times (2.0 \times 10^6) = (4.3)(2.0) \times 10^{8+6} = 8.6 \times 10^{14}$
   - b. $(6.0 \times 10^3) \times (1.5 \times 10^{-2})$
     $(6.0 \times 10^3) \times (1.5 \times 10^{-2}) = (6.0)(1.5) \times 10^{3+(-2)} = 9.0 \times 10^1$
   - c. $(1.5 \times 10^{-2}) \times (8.0 \times 10^{-1})$
     $(1.5 \times 10^{-2}) \times (8.0 \times 10^{-1}) = (1.5)(8.0) \times 10^{-2+(-1)} = 12.00 \times 10^{-3}$
     $= 1.2 \times 10^{-2}$
   - d. $\dfrac{7.8 \times 10^3}{1.2 \times 10^4}$
     $7.8 \times 10^3/1.2 \times 10^4 = 7.8/1.2 \times 10^{3-4} = 6.5 \times 10^{-1}$
   - e. $\dfrac{8.1 \times 10^{-2}}{9.0 \times 10^2}$
     $8.1 \times 10^{-2}/9.0 \times 10^2 = 8.1/9.0 \times 10^{-2-2} = 0.90 \times 10^{-4} = 9.0 \times 10^{-5}$
   - f. $\dfrac{6.48 \times 10^5}{(2.4 \times 10^4)(1.8 \times 10^{-2})}$
     $6.48 \times 10^5/(2.4 \times 10^4)(1.8 \times 10^{-2}) = 6.48/(2.4)(1.8) \times 10^{5-4-(-2)} = 1.5 \times 10^3$

SCIENTIFIC NOTATION

Name ____________________

Scientists very often deal with very small and very large numbers, which can lead to a lot of confusion when counting zeros! We have learned to express these numbers as powers of 10.

Scientific notation takes the form of $M \times 10^n$ where $1 \leq M < 10$ and "n" represents the number of decimal places to be moved. Positive n indicates the standard form is larger than zero whereas negative n would indicate a number smaller than zero.

> **Example 1:** Convert 1,500,000 to scientific notation.
>
> We move the decimal point so that there is only one digit to its left, a total of 6 places.
>
> $1{,}500{,}000 = 1.5 \times 10^6$
>
> **Example 2:** Convert 0.000025 to scientific notation.
>
> For this, we move the decimal point 5 places to the right.
>
> $0.000025 = 2.5 \times 10^{-5}$
>
> (Note that when a number starts out less than one, the exponent is always negative.)

Convert the following to scientific notation.

1. 0.005 = 5×10^{-3}
2. 5,050 = 5.05×10^{3}
3. 0.0008 = 8×10^{-4}
4. 1,000 = 1×10^{3}
5. 1,000,000 = 1×10^{6}
6. 0.25 = 2.5×10^{-1}
7. 0.025 = 2.5×10^{-2}
8. 0.0025 = 2.5×10^{-3}
9. 500 = 5×10^{2}
10. 5,000 = 5×10^{3}

Convert the following to standard notation.

1. 1.5×10[illegible] = 1,500
2. 1.5×10[illegible] = 0.0015
3. 3.75×10[illegible] = 0.0375
4. 3.75×10[illegible] = 375
5. 2.2×10[illegible] = 220,000
6. 3.35×10[illegible] = 0.335
7. 1.2×10[illegible] = 0.00012
8. 1×10[illegible] = 10,000
9. 1×10[illegible] = 0.1
10. 4×10[illegible] = 4