Name: ______________________ Date: Jan 22 ______________ Hour: 6th ________

Unit 5 Day 1 and 2: Scientific Notation

Focus Question: What are different ways I can write a number?

A. Forms of Numbers

1. Brainstorm: What are at least 10 ways to write the number 16?

$32 \div 2$ 16.0 $\sqrt{256}$ $4 \cdot 4$ $\frac{16}{1}$

$8 \cdot 2$ $\frac{64}{4}$ $17-1$ $20-4$ $100-84$

When you were first introduced to numbers, you were taught the numbers 1, 2, 3, 4, etc. (the natural numbers). You kept learning about bigger and bigger numbers like 1,725 and 10,600,327. Then you learned about decimals (numbers in between whole numbers) like 4.6 or 0.125. These numbers are written in what is called **standard form**. **Standard form of a number** uses place value to make sense of how big (or small) the number is. Read each of the following numbers out loud.

Thousands	Hundreds	Tens (ty)	Ones	(And)	Tenths	Hundredths	Thousandths
1000s	100s	10s	1s	•	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
	3	7	1	•	2	6	5
9	4	5	0	•	3		

When you started to learn to multiply you learned other ways to write numbers. For instance 10 could be written as $5 \cdot 2$ or 16 could be written as $2 \cdot 2 \cdot 2 \cdot 2$. When we write numbers in a longer way that makes use of its factors (multiplying), this is called **factored or expanded form.** (longer, bigger) (If it is prime factors only, it is called **prime factorization.)**

When a number had several of the same factors, you wrote it in a shortened way called **exponential form.** The table below gives several numbers in their standard, expanded, prime factorization, and exponential form.

Standard Form	Expanded	Prime Factorization	Exponential Form
16	$4 \cdot 4$ or $2 \cdot 8$	$2 \cdot 2 \cdot 2 \cdot 2$	2^4
90	$9 \cdot 10$ or $5 \cdot 3 \cdot 6$	$5 \cdot 2 \cdot 3 \cdot 3$	$5 \cdot 2 \cdot 3^2$ or $10 \cdot 3^2$ (10^1)
250	$25 \cdot 10$ or $2 \cdot 5 \cdot 25$	$2 \cdot 5 \cdot 5 \cdot 5$	$2 \cdot 5^3$ (2^1)

a. Why is "Exponential Form" called Exponential form?

it uses exponents

b. What does the exponent tell you?

how many times to use the base as a factor

(base → 2^4 ← exponent; power)

c. When a number has no exponent, what exponent is implied? 1

d. The number in front of the exponent is called the base

e. Another name for a base with an exponent is a **power.***

2. Write the following expanded form numbers in exponential form and standard form.

a. $5 \cdot 2 \cdot 2 \cdot 2$

Exp Form: $5 \cdot 2^3$

Standard Form: 40

b. $7 \cdot 2 \cdot 6 \cdot 6 \cdot 6 \cdot 6$

Exp Form: $14 \cdot 6^4$

Standard Form: 18,144

c. $2 \cdot 3 \cdot 3 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$

Exp. Form: $2 \cdot 3^2 \cdot 7^6$

Standard Form: 2,117,682

*The button on the calculator that lets you do exponents other than 2 is ^ a.k.a. Carrot *

3. Give the base(s) and then write the following in expanded and standard form.

a. $5 \cdot 7^2$

Base: 7

Expanded: $5 \cdot 7 \cdot 7$

Standard: 245

b. $\frac{1}{2} \cdot 11^4$

Base: 11

Expanded: $\frac{1}{2} \cdot 11 \cdot 11 \cdot 11 \cdot 11$

Standard: 7320.5

c. $7^5 \cdot 10^9$

Base: 7 and 10

Expanded: $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10$

Standard: 1.6807×10^{13} ← not standard form

B. Scientific Notation

At this point, your calculators should be giving you some crazy looking number that still has a small x10 used in it. If we type it in the yellow algebra 1 calculator it says 1.6807E13, which is still weird because of the E. These numbers are called **scientific notation**. Scientific notation is a way of writing really large or really small numbers that **always uses 10 as the base**.

It is written $c \times 10^n$

- $1 \le c < 10$ (which basically means between 1 & 10) its ok to be 1, its not ok to be 10
- The × is meaning multiply. (It is the only time you should use an × to mean multiply!)
- n is an integer (positive or negative whole #)

The E found in calculators is taking the place of x10.

Why can't we just use standard form?

How long is a light year?

- One light year is 5.879×10^{12} miles or one light year is 5,879,000,000,000 miles. ← sci. not.

  Which is easier to say? Which is easier to write?

  (For our video later, keep in mind Hubble has sent us images from 13.2 billion light years away.)

How long is a string? (From Stephen Hawking's String Theory and Quantum Physics)

- A Plank length or 1×10^{-35} meters or 0.00000000000000000000000000000000001 meters. ← sci. not.

  Which is easier to say? Which is easier to write?

1. Fill in the table using a calculator if necessary.

Scientific Notation	2.75×10^0	2.75×10^1	2.75×10^2	2.75×10^3	2.75×10^4
Expanded Form		2.75 · 10	2.75 · 10 · 10	2.75 · 10 · 10 · 10	2.75 · 10 · 10 · 10 · 10
Standard Form	2.75	27.5	275	2,750	27,500

2. What is happening when you multiply by a positive power of 10?

the decimal moves to the right & the # gets bigger

3. Fill in the table using a calculator.

Scientific Notation	2.75×10^0	2.75×10^{-1}	2.75×10^{-2}	2.75×10^{-3}
Standard Form	2.75	0.275	0.0275	0.00275

4. What is happening when you multiply by a negative power of 10?

the decimals move to the left & the # gets small

5. Why do you think scientific notation uses 10 as a base?

our place value is based on 10

The Power of 10!
First, with your arms estimate one meter…keep this length in mind as 10^0.
What would 10^{-1} meters look like? What would 10^1 meters look like?
Watch the video at https://www.youtube.com/watch?v=EMLPJqeW78Q
We can pause the video to help us understand the size at any time.

C. Changing between standard form and scientific notation.

1. Change the following Numbers to Standard form without a calculator!

- If an exponent is positive it means: move decimal right to make # bigger
- If an exponent is negative it means: move decimal left to make # small
- The number in the exponent tells you how many places to move

a. 2.41×10^3 ← right 3 — 2.410 — **2,410**

b. 6.92 E -4 ← left 4 — 0006.92 — **0.000692**

c. 4.1×10^{-1} ← left 1 — **0.41**

d. 1.3 E 7 ← right 7 — 1.3000000 — **13,000,000**

Your Turn on your own: Change the following numbers to standard form.

e. 6.2×10^4 Right 4

62,000

f. 5.13 *E* 1 Right 1

51.3

g. 2.357×10^{-5} left 5

0.00002357

h. 1 *E* − 3 left 3

0.001

i. 3.9×10^0 doesn't move

3.9

2. Change the following numbers to scientific notation.
   - Use a positive exponent if the # is big (more than 1)
   - Use a negative exponent if the # is small (less than 1)
   - The number in the exponent tells you how many times to move it
   - Remember to move the decimal until the # is between 1 & 10

a. 360. big positive exp

3.6 E 2

b. 0.00527 small negative exp

5.27 E −3

c. 32,741,400,000. pos.

3.27414 E 10

d. 0.00000045

4.5 E −7

Your turn:

e. 6,248,000 positive

6.248×10^6

f. 0.0000003 negative

3×10^{-7}

g. 400 positive

4×10^2

h. 0.21 negative

2.1×10^{-1}

3. The population of the US is approximately 327.2 billion people. Write this number in both standard form and scientific notation.

327,200,000,000

3.272×10^{11}

4. The US debt is $22.7 trillion. Write this number in both standard form and scientific notation.

22,700,000,000,000

2.27×10^{13}