Math Objectives

- Students will use scientific notation to understand numbers, ways of representing numbers, relationships among numbers and number systems.
- Students will develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculated notation.
- Students will try to make a connection with how to understand these topics in IB Mathematics courses and on their final assessments.

Vocabulary

- Scientific Notation
- Integers
- Expanded Form
- Percentage Error

About the Lesson

- This lesson is aligning with the curriculum of IB Mathematics Applications and Interpretations SL/HL and IB Mathematics Approaches and Analysis SL/HL
- This falls under the IB Mathematics Content Topic 1 Numbers and Algebra:
  - **1.1:** Operations with numbers in the form $a \times 10^k$ where $1 \leq a < 10$
  - **1.6:** **(a)** Approximations: decimal places and significant figures
    (c) Percentage errors
    (d) Estimation
  - **3.1:** **(b)** Volume of a sphere

  As a result, students will:
  - Apply this information to real world situations.

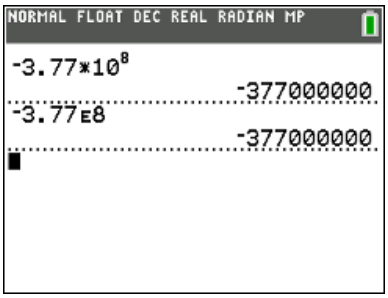
Teacher Preparation and Notes.

- This activity is done with the use of the TI-84 family as an aid to the problems.

Activity Materials

- Compatible TI Technologies: TI-84 Plus*, TI-84 Plus Silver Edition*, TI-84 Plus C Silver Edition, TI-84 Plus CE

** with the latest operating system (2.55MP) featuring MathPrint™ functionality.*



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

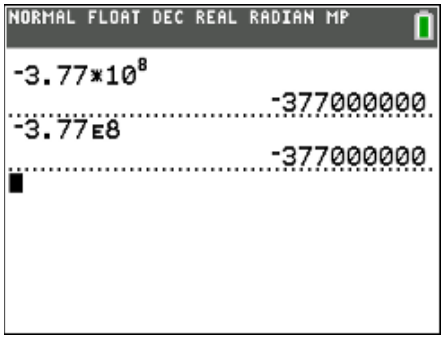
Lesson Files:

Student Activity

84CE-ScientificNotation-Student.pdf

84CE-ScientificNotation-Student.doc

This activity gives students an opportunity to see where large and small numbers are used and how scientific notation offers a convenient method of writing such numbers. This will be done both with and without technology.



Part 1 – Writing Scientific Notation in Expanded Form

Scientific notation is a way of writing very large and very small numbers. Numbers in scientific notation include two parts, a number greater than or equal to 1 and less than 10, and a power of 10. Examples include:

$5.6\times10^{5} = 5{,}600{,}000$ and $2.3\times10^{-8} = 0.000000023$

Write each of the following numbers in expanded notation. Check your answer with a calculator.

1. -3.77×10^{8}

Write the answer. **-377,000,000** _____

2. 1.202×10^{5}.

Write the answer. **120,200** _____

3. 4.224×10^{-6}

Write the answer. **0.000004224**_____

4. -5.24×10^{-12}

Write the answer. **-0.00000000000524** __

Teacher Tip: This is a great time to show your students how to use the notation **5.6 E 5** on the handheld. Take some time to discuss not only using this but also how to interpret it when it sometimes appears in an answer when finding coordinates on a graph.

Part 2 – Writing Numbers in Scientific Notation

To write numbers in scientific notation, place a decimal point so there is one non-zero digit to the left. Count the number of decimal places the decimal point moved. The number of places the decimal point moves to the left is the positive exponent power of 10. The number of places the decimal point moves to the right is the negative exponent power of 10.

For example: $156{,}000{,}000 = 1.56\times10^{8}$ and $0.0000045 = 4.5\times10^{-6}$

5. The following are salaries for the 5 top paid players of the Cincinnati Bengals. Write each salary in scientific notation.

Player	Salary	Scientific Notation
Joe Burrow	$19,515,000	**1.9515×10^7**
DJ Reader	$15,521,000	**1.5521×10^7**
Trey Hendrickson	$15,143,000	**1.5143×10^7**
Jonah Williams	$12,604,000	**1.2604×10^7**
BJ Hill	$10,354,000	**1.0354×10^7**

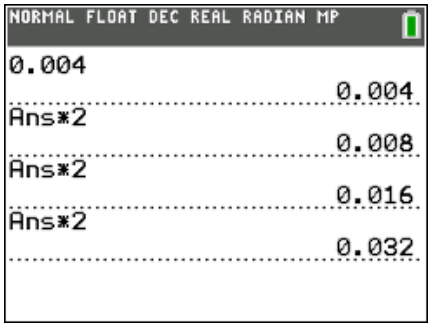
6. The 2022 median American household income was $\$7.4580 \times 10^4$. Compare this to the salaries above. Explain what you notice. _____

Solution: The students should notice that the exponents have a difference of 3. The football salaries are more than 1000 times the median income. _____

7. Imagine you could fold a piece of paper 0.004 inches thick 50 times. Find how many inches thick the resulting paper would be after the 50th fold.

Solution: 4.504×10^{12} inches _____

To solve, type 0.004 on the home screen and press enter. Then, type * 2 enter. Each time enter is pressed, the previous value is doubled.

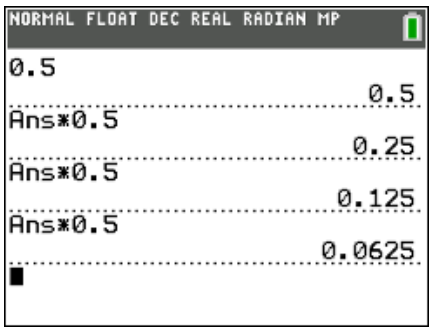


8. Write this answer in expanded form. **Solution: 4,504,000,000,000 inches** _____

9. Find the probability of flipping a coin 40 times and having it come up heads each time.

Solution: 9.095×10^{-13} _____

To solve, type 0.5 on the home screen and press enter. Then, press * 0 . 5 enter. Each time enter is pressed, the previous value is multiplied by 0.5. The screen at the right shows the probability of heads once, two times in a row, three times in a row and four times in a row.



10. Write this answer in expanded form. **Solution: 0.0000000000009095** _____

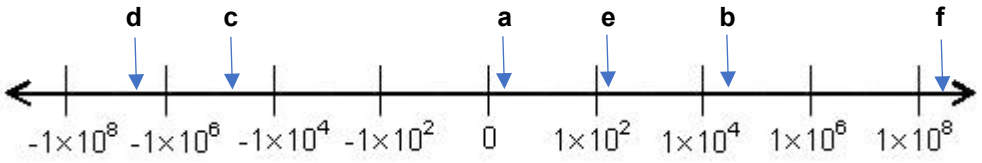
Part 3 – Ordering Numbers in Scientific Notation

11. Place the following numbers on the number line. After placing them on the number line, switch with a partner to check answers.

a. 1.25×10^{-3} **c.** -4.45×10^{4} **e.** 1.8×10^{2}

b. 5.5×10^{4} **d.** -3.11×10^{6} **f.** 7.79×10^{8}

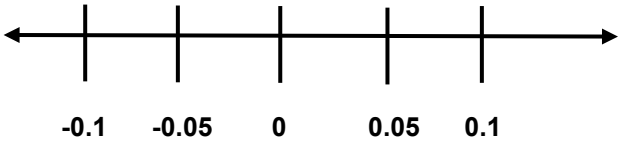
Solution:



12. Draw an appropriate number line for the following numbers. Explain your choice.

2.25×10^{-3} -1.05×10^{-4} 5.603×10^{-2}

Solution: All the numbers are between -1 and 1. The larger the negative exponent, the closer the number is to zero. A possible number line is given.



Teacher Tip: This would be a good point to go a little further with scientific notation. You can have wonderful discussion having students give real world examples where they have seen or may use these values and why it is beneficial.

Part 4 – Operations with Scientific Notation

Numbers that are written in scientific notation can be multiplied and divided rather simply by taking advantage of the properties of numbers and the rules of exponents that you may recall. To multiply numbers in scientific notation, first multiply the numbers that are not powers of 10 (the *a* in $a \times 10^n$). Then multiply the powers of ten by adding the exponents.

In order to divide numbers in scientific notation, you once again apply the properties of numbers and the rules of exponents. You begin by dividing the numbers that are not powers of 10 (the *a* in $a \times 10^n$). Then you divide the powers of ten by subtracting the exponents.

13. Perform the indicated operation for each problem and write in the form $a \times 10^n$, where $1 \leq a < 10$, and $n \in \mathbb{Z}$:

$(a)\ (4 \times 10^7)(5.6 \times 10^{-10})$ **2.24×10^{-2}**

$(b)\ (3.1 \times 10^8)(4.3 \times 10^{-4})(1.2 \times 10^{-5})$ **1.5996×10^0**

$(c)\ \frac{2.75 \times 10^{-6}}{1.25 \times 10^7}$ **2.2×10^{-13}**

$(d)\ \frac{(5.15 \times 10^{-9})(4.21 \times 10^5)}{3.35 \times 10^{10}}$ **6.4721×10^{-14}**

Further IB Application

The asteroid belt orbiting around the sun between Mars and Jupiter is said to be valued at over $715 quintillion dollars (US), where one quintillion = 10^{18}. This equates to each person on the planet earth having approximately 100 billion dollars (US).

(a) Write down the value of the asteroid belt in the form $a \times 10^k$ where $1 \leq a < 10$, $k \in \mathbb{Z}$.

Solution: 7.15×10^{20}

One of the asteroids in the belt is named Diotima and is approximately spherical with a diameter of 176 km.

(b) If you were to use this information to estimate its volume, calculate its volume in km^3.

Solution: $V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{1}{2}\cdot 176\right)$
$= 2{,}850{,}000\ \text{km}^3$ (or 2.85×10^6, or 2854543.238…)

(c) The actual volume is found to be 2.95×10^6 km^3. Find the percentage error in your estimate of the volume.

Solution: $\left|\frac{2854543.23844 - 2.95 \times 10^6}{2.95 \times 10^6}\right| \times 100$
= 3.24% (or 3.235822…%)

Teacher Tip: This is a good place to have students discuss this situation and see if they can add more questions, scenarios and discussions to the problem.

***Note: This activity has been developed independently by Texas Instruments and aligned with the IB Mathematics curriculum, but is not endorsed by IB™. IB is a registered trademark owned by the International Baccalaureate Organization.*