Grade Level/Course: Grade 8/ Grade 8 Math

Lesson/Unit Plan Name: Using Multiple Methods to Perform Operations with Scientific Notation

Rationale/Lesson Abstract: The focus of this lesson is to show students multiple ways to perform operations with numbers written in scientific notation so that they reinforce their number sense and mathematical understanding while continuing to think flexibly and mathematically. Also to help students understand that numbers written in scientific notation are still just numbers that follow all of the number properties they have learned. It is critical to make the connections between the methods so that the students will truly understand the math rather than simply memorize the procedure.

Timeframe: 2 days, 1 for Multiplying and Dividing with Numbers in Scientific Notation and 1 for Adding and Subtracting with Numbers in Scientific Notation.

Common Core Standard(s):

8.EE.3
Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3×10^8 and the population of the world as 7×10^9, and determine that the world population is more than 20 times larger.

8.EE.4
Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Instructional Resources/Materials:

Activity/Lesson:

These lessons would follow teaching students what is scientific notation, when and how it is used, and how to write numbers in scientific notation.

MULITIPLICATION

Example 1:

Write the product in scientific notation: $(5\times10^3)(4\times10^2)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(5\times10^3)(4\times10^2)$ $=(5{,}000)(400)$ $=2{,}000{,}000$ $=2\times10^6$	$(5\times10^3)(4\times10^2)$ $=(5\bullet10\bullet10\bullet10)(4\bullet10\bullet10)$ $=5\bullet4\bullet10\bullet10\bullet10\bullet10\bullet10$ $=20\bullet10^5$ $=2\bullet10\bullet10^5$ $=2\times10^6$	$(5\times10^3)(4\times10^2)$ $=(5\bullet4\bullet10^3\bullet10^2)$ $=20\bullet10^{3+2}$ $=2\bullet10\bullet10^5$ $=2\times10^6$

You Try 1:

Write the product in scientific notation: $(3\times10^2)(7\times10^3)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(3\times10^2)(7\times10^3)$ $=(300)(7{,}000)$ $=2{,}100{,}000$ $=2.1\times10^6$	$(3\times10^2)(7\times10^3)$ $=(3\bullet10\bullet10)(7\bullet10\bullet10\bullet10)$ $=3\bullet7\bullet10\bullet10\bullet10\bullet10\bullet10$ $=21\bullet10^5$ $=2.1\bullet10\bullet10^5$ $=2.1\times10^6$	$(3\times10^2)(7\times10^3)$ $=(3\bullet7\bullet10^2\bullet10^3)$ $=21\bullet10^{2+3}$ $=2.1\bullet10\bullet10^5$ $=2.1\times10^6$

Example 2:

Write the product in scientific notation: $\left(7.2\times10^{3}\right)\left(1.6\times10^{4}\right)$

Standard Form

$$\begin{aligned}&\left(7.2\times10^{3}\right)\left(1.6\times10^{4}\right)\\&=(7{,}200)(16{,}000)\\&=115{,}200{,}000\\&=1.152\times10^{8}\end{aligned}$$

Decomposition

$$\begin{aligned}&\left(7.2\times10^{3}\right)\left(1.6\times10^{4}\right)\\&=(7.2\bullet10\bullet10\bullet10)(1.6\bullet10\bullet10\bullet10\bullet10)\\&=7.2\bullet1.6\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10\\&=11.52\bullet10^{7}\\&=1.152\bullet10\bullet10^{7}\\&=1.152\times10^{8}\end{aligned}$$

Decomposition Using Properties of Exponents

$$\begin{aligned}&\left(7.2\times10^{3}\right)\left(1.6\times10^{4}\right)\\&=\left(7.2\bullet1.6\bullet10^{3}\bullet10^{4}\right)\\&=11.52\bullet10^{3+4}\\&=1.152\bullet10\bullet10^{7}\\&=1.152\times10^{8}\end{aligned}$$

You Try 2:

Write the product in scientific notation: $\left(3.1\times10^{2}\right)\left(4.3\times10^{3}\right)$

Standard Form

$$\begin{aligned}&\left(3.1\times10^{2}\right)\left(4.3\times10^{3}\right)\\&=(310)(4{,}300)\\&=1{,}333{,}000\\&=1.333\times10^{6}\end{aligned}$$

Decomposition

$$\begin{aligned}&\left(3.1\times10^{2}\right)\left(4.3\times10^{3}\right)\\&=(3.1\bullet10\bullet10)(4.3\bullet10\bullet10\bullet10)\\&=3.1\bullet4.3\bullet10\bullet10\bullet10\bullet10\bullet10\\&=13.33\bullet10^{5}\\&=1.333\bullet10\bullet10^{5}\\&=1.333\times10^{6}\end{aligned}$$

Decomposition Using Properties of Exponents

$$\begin{aligned}&\left(3.1\times10^{2}\right)\left(4.3\times10^{3}\right)\\&=\left(3.1\bullet4.3\bullet10^{2}\bullet10^{3}\right)\\&=13.33\bullet10^{2+3}\\&=1.333\bullet10\bullet10^{5}\\&=1.333\times10^{6}\end{aligned}$$

Example 3:

Write the product in scientific notation: $\left(5\times10^{3}\right)\left(3\times10^{-2}\right)$

Standard Form

$$\left(5\times10^{3}\right)\left(3\times10^{-2}\right)$$
$$=(5{,}000)\left(\frac{3}{100}\right)$$
$$=\frac{15{,}000}{100}$$
$$=150$$
$$=1.5\times10^{2}$$

Decomposition

$$\left(5\times10^{3}\right)\left(3\times10^{-2}\right)$$
$$=(5\bullet10\bullet10\bullet10)\left(\frac{3}{10\bullet10}\right)$$
$$=\frac{5\bullet10\bullet10\bullet10\bullet3}{10\bullet10}$$
$$=150$$
$$=1.5\times10^{2}$$

Decomposition Using Properties of Exponents

$$\left(5\times10^{3}\right)\left(3\times10^{-2}\right)$$
$$=\left(5\bullet3\bullet10^{3}\bullet10^{-2}\right)$$
$$=15\bullet10^{3+(-2)}$$
$$=15\bullet10^{1}$$
$$=1.5\times10^{2}$$

You Try 3:

Write the product in scientific notation: $\left(4\times10^{-2}\right)\left(6\times10^{3}\right)$

Standard Form

$$\left(4\times10^{-2}\right)\left(6\times10^{3}\right)$$
$$=\left(\frac{4}{100}\right)(6{,}000)$$
$$=\frac{24{,}000}{100}$$
$$=240$$
$$=2.4\times10^{2}$$

Decomposition

$$\left(4\times10^{-2}\right)\left(6\times10^{3}\right)$$
$$=\left(\frac{4}{10\bullet10}\right)(6\bullet10\bullet10\bullet10)$$
$$=\frac{4\bullet6\bullet10\bullet10\bullet10}{10\bullet10}$$
$$=240$$
$$=2.4\times10^{2}$$

Decomposition Using Properties of Exponents

$$\left(4\times10^{-2}\right)\left(6\times10^{3}\right)$$
$$=\left(4\bullet6\bullet10^{-2}\bullet10^{3}\right)$$
$$=24\bullet10^{-2+3}$$
$$=24\bullet10$$
$$=2.4\times10^{2}$$

DIVISION

Example 4:

Write the quotient in scientific notation: $(8\times10^5)\div(4\times10^2)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(8\times10^5)\div(4\times10^2)$	$(8\times10^5)\div(4\times10^2)$	$(8\times10^5)\div(4\times10^2)$
$=\dfrac{8\times10^5}{4\times10^2}$	$=\dfrac{8\times10^5}{4\times10^2}$	$=\dfrac{8\times10^5}{4\times10^2}$
$=\dfrac{800{,}000}{400}$	$=\dfrac{2\bullet2\bullet2\bullet10\bullet10\bullet10\bullet10\bullet10}{2\bullet2\bullet10\bullet10}$	$=\dfrac{8}{4}\bullet10^{5-2}$
$=2{,}000$	$=2\bullet10\bullet10\bullet10$	$=2\times10^3$
$=2\times10^3$	$=2\times10^3$	

You Try 4:

Write the quotient in scientific notation: $(9\times10^4)\div(3\times10^2)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(9\times10^4)\div(3\times10^2)$	$(9\times10^4)\div(3\times10^2)$	$(9\times10^4)\div(3\times10^2)$
$=\dfrac{9\times10^4}{3\times10^2}$	$=\dfrac{9\times10^4}{3\times10^2}$	$=\dfrac{9\times10^4}{3\times10^2}$
$=\dfrac{90{,}000}{300}$	$=\dfrac{3\bullet3\bullet10\bullet10\bullet10\bullet10}{3\bullet10\bullet10}$	$=\dfrac{9}{3}\bullet10^{4-2}$
$=300$	$=3\bullet10\bullet10$	$=3\times10^2$
$=3\times10^2$	$=3\times10^2$	

Example 5:

Write the quotient in scientific notation: $\left(8\times10^{-5}\right)\div\left(4\times10^{2}\right)$

Standard Form

$$\left(8\times10^{-5}\right)\div\left(4\times10^{2}\right)$$
$$=\frac{8\times10^{-5}}{4\times10^{2}}$$
$$=\frac{8}{\frac{100,000}{400}}$$
$$=\frac{8}{100,000}\div\frac{400}{1}$$
$$=\frac{8}{100,000}\bullet\frac{1}{400}$$
$$=\frac{8}{40,000,000}$$
$$=0.0000002$$
$$=2\times10^{-7}$$

Decomposition

$$\left(8\times10^{-5}\right)\div\left(4\times10^{2}\right)$$
$$=\frac{8\times10^{-5}}{4\times10^{2}}$$
$$=\frac{8}{10^{5}}\bullet\frac{1}{4\times10^{2}}$$
$$=\frac{8}{4\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10}$$
$$=\frac{2\bullet2\bullet2}{2\bullet2\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10}$$
$$=\frac{2}{10\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10}$$
$$=2\times10^{-7}$$

Decomposition Using Properties of Exponents

$$\left(8\times10^{-5}\right)\div\left(4\times10^{2}\right)$$
$$=\frac{8\times10^{-5}}{4\times10^{2}}$$
$$=\frac{8}{4}\bullet10^{-5-2}$$
$$=2\times10^{-7}$$

You Try 5:

Write the quotient in scientific notation: $\left(6\times10^{-3}\right)\div\left(2\times10^{4}\right)$

Standard Form

$$\left(6\times10^{-3}\right)\div\left(2\times10^{4}\right)$$
$$=\frac{6\times10^{-3}}{2\times10^{4}}$$
$$=\frac{6}{\frac{1,000}{20,000}}$$
$$=\frac{6}{1,000}\div\frac{20,000}{1}$$
$$=\frac{6}{1,000}\bullet\frac{1}{20,000}$$
$$=\frac{6}{20,000,000}$$
$$=0.0000003$$
$$=3\times10^{-7}$$

Decomposition

$$\left(6\times10^{-3}\right)\div\left(2\times10^{4}\right)$$
$$=\frac{6}{10^{3}}\div\left(2\times10^{4}\right)$$
$$=\frac{6}{10^{3}}\bullet\frac{1}{2\times10^{4}}$$
$$=\frac{6}{2\bullet10^{4}\bullet10^{3}}$$
$$=\frac{2\bullet3}{2\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10}$$
$$=\frac{3}{10\bullet10\bullet10\bullet10\bullet10\bullet10\bullet10}$$
$$=3\times10^{-7}$$

Decomposition Using Properties of Exponents

$$\left(6\times10^{-3}\right)\div\left(2\times10^{4}\right)$$
$$=\frac{6\times10^{-3}}{2\times10^{4}}$$
$$=\frac{6}{2}\bullet10^{-3-4}$$
$$=3\times10^{-7}$$

ADDITION

Example 6:

Write the sum in scientific notation: $(5\times10^3)+(4\times10^2)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(5\times10^3)+(4\times10^2)$	$(5\times10^3)+(4\times10^2)$	$(5\times10^3)+(4\times10^2)$
$=(5{,}000)+(400)$	$=(5\bullet10\bullet10\bullet10)+(4\bullet10\bullet10)$	$=(5\bullet10\bullet10^2)+(4\bullet10^2)$
$=5{,}400$	$=(50\bullet10\bullet10)+(4\bullet10\bullet10)$	$=(50\bullet10^2)+(4\bullet10^2)$
$=5.4\times10^3$	$=(50+4)\bullet10\bullet10$	$=(50+4)\bullet10^2$
	$=54\bullet10\bullet10$	$=54\bullet10^2$
	$=54\bullet10^2$	$=5.4\times10^3$
	$=5.4\times10^3$	

You Try 6:

Write the sum in scientific notation: $(6\times10^2)+(3\times10^4)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(6\times10^2)+(3\times10^4)$	$(6\times10^2)+(3\times10^4)$	$(6\times10^2)+(3\times10^4)$
$=(600)+(30{,}000)$	$=(6\bullet10\bullet10)+(3\bullet10\bullet10\bullet10\bullet10)$	$=(6\bullet10^2)+(3\bullet10\bullet10\bullet10^2)$
$=30{,}600$	$=(6\bullet10\bullet10)+(300\bullet10\bullet10)$	$=(6\bullet10^2)+(300\bullet10^2)$
$=3.06\times10^4$	$=(6+300)\bullet10\bullet10$	$=(6+300)\bullet10^2$
	$=306\bullet10\bullet10$	$=306\bullet10^2$
	$=306\bullet10^2$	$=3.06\times10^4$
	$=3.06\times10^4$	

SUBTRACTION

Example 7:

Write the difference in scientific notation: $(2.4\times10^5)-(4.1\times10^3)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(2.4\times10^5)-(4.1\times10^3)$ $=(240{,}000)-(4{,}100)$ $=235{,}900$ $=2.359\times10^5$	$(2.4\times10^5)-(4.1\times10^3)$ $=(2.4\bullet10\bullet10\bullet10\bullet10\bullet10)-(4.1\bullet10\bullet10\bullet10)$ $=(240\bullet10\bullet10\bullet10)-(4.1\bullet10\bullet10\bullet10)$ $=(240-4.1)\bullet10\bullet10\bullet10$ $=235.9\bullet10\bullet10\bullet10$ $=235.9\bullet10^3$ $=2.359\times10^5$	$(2.4\times10^5)-(4.1\times10^3)$ $=(2.4\bullet10\bullet10\bullet10^3)-(4.1\bullet10^3)$ $=(240\bullet10^3)-(4.1\bullet10^3)$ $=(240-4.1)\bullet10^3$ $=235.9\bullet10^3$ $=2.359\times10^5$

You Try 7:

Write the product in scientific notation: $(1.4\times10^3)-(2\times10^2)$

Standard Form	Decomposition	Decomposition Using Properties of Exponents
$(1.4\times10^3)-(2\times10^2)$ $=(1{,}400)-(200)$ $=1{,}200$ $=1.2\times10^3$	$(1.4\times10^3)-(2\times10^2)$ $=(1.4\bullet10\bullet10\bullet10)-(2\bullet10\bullet10)$ $=(14\bullet10\bullet10)-(2\bullet10\bullet10)$ $=(14-2)\bullet10\bullet10$ $=12\bullet10\bullet10$ $=12\bullet10^2$ $=1.2\times10^3$	$(1.4\times10^3)-(2\times10^2)$ $=(1.4\bullet10\bullet10^2)-(2\bullet10^2)$ $=(14\bullet10^2)-(2\bullet10^2)$ $=(14-2)\bullet10^2$ $=12\bullet10^2$ $=1.2\times10^3$

Assessment:

Write the quotient in scientific notation:

$$\left(6\times10^{4}\right)\div\left(2\times10^{2}\right)$$

Write the sum in scientific notation:

$$\left(2.1\times10^{3}\right)+\left(3.2\times10^{4}\right)$$

Assessment: (Worked out solution, methods will vary)

Write the quotient in scientific notation:

$$\left(6\times10^{4}\right)\div\left(2\times10^{2}\right)$$
$$=\frac{6\times10^{4}}{2\times10^{2}}$$
$$=\frac{2\bullet3\bullet10\bullet10\bullet10\bullet10}{2\bullet10\bullet10}$$
$$=3\bullet10\bullet10$$
$$=3\times10^{2}$$

Write the sum in scientific notation:

$$\left(2.1\times10^{3}\right)+\left(3.2\times10^{4}\right)$$
$$=\left(2.1\bullet10^{3}\right)+\left(3.2\bullet10\bullet10^{3}\right)$$
$$=\left(2.1\bullet10^{3}\right)+\left(32\bullet10^{3}\right)$$
$$=10^{3}\left(2.1+32\right)$$
$$=10^{3}\left(34.1\right)$$
$$=\left(3.41\bullet10\right)10^{3}$$
$$=3.41\bullet10^{4}$$