Section 5.7 Negative Exponents

$3^3 = 27$ ÷3
$3^2 = 9$ ÷3
$3^1 = 3$ ÷3
$3^0 = 1$ ÷3
$3^{-1} = \frac{1}{3}$ ÷3
3^{-2} $\frac{1}{9}$ ÷3
3^{-3} $\frac{1}{27}$ $\frac{1}{3^3}$

$1 \div 3$
$\frac{1}{3}$

Negative exponents are fractions

$3^{-3} = \frac{1}{3^3}$ $\quad$ $X^{-2} = \frac{1}{X^2}$

A negative exponent moves a base from the bottom to the top or the top to bottom and the sign of the exponent changes

$\frac{1}{X^{-2}} = X^2$ $\quad$ $\frac{1}{3^{-3}} = 3^3 = 27$

cancel $\frac{X^2}{X^{14}} = \frac{1 \cdot X \cdot X}{1 \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X \cdot X}$

$= \frac{1}{X^{12}}$ $\quad$ $\frac{X^0}{X^{12}} = \frac{1}{X^{12}}$

$$\frac{x^{14}}{x^2} = x^{14-2} = x^{12}$$

$$\frac{x^2}{x^{14}} = \frac{1}{x^{14-2}} = \frac{1}{x^{12}}$$

Simplify so that all exponents are positive

11. $2^{-1} + 3^{-1}$

Negative exponents take the reciprocal

$$= \frac{1\cdot 3}{2\cdot 3} + \frac{1\cdot 2}{3\cdot 2}$$

$$= \frac{3}{6} + \frac{2}{6}$$

$$= \frac{5}{6}$$

18. $\frac{4^{-3}}{2^{-2}} = \frac{2^2}{4^3}$

4.4.4

$$= \frac{4}{64}$$

$$= \frac{1}{16}$$

22. $\left(\frac{3}{4}\right)^{-3} = \left(\frac{4}{3}\right)^3$

reciprocal

flip

$$= \frac{64}{27}$$

52. $\dfrac{(4y^5)^3}{y^{-4}} = \dfrac{4^3 y^{15}}{y^{-4}} = 64y^{15-(-4)}$

$= 64y^{19}$

or $64y^{15}y^4 = 64y^{19}$

62. $\dfrac{3x^3 \cdot 5x^{14}}{20x^{14}} = \dfrac{3}{4}x^3$

or $\dfrac{15x^{17-14}}{20x^{14}} = \dfrac{3}{4}x^3$

or $\dfrac{3x^3}{4}$

10:19

*128. $\dfrac{(xy^{-2})^{-2}}{(x^{-2}y)^{-3}} = \dfrac{x^{-2}y^4}{x^6 y^{-3}} = \dfrac{y^7}{x^8}$

or

$\dfrac{(x^{-2}y)^3}{(xy^{-2})^2} = \dfrac{x^{-6}y^3}{x^2y^{-4}} = \dfrac{y^7}{x^8}$

$\dfrac{x^{-2}y^4}{x^6y^{-3}} = \dfrac{1}{x^{6+2}y^{4+3}}$

$= \dfrac{y^7}{x^8}$

128. with every step shown

$$\frac{(x^1y^{-2})^{-2}}{(x^{-2}y^1)^{-3}} = \frac{x^{1(-2)}\,y^{-2(-2)}}{x^{-2(-3)}\,y^{1(-3)}}$$

Put in the 1 exponents and multiply the exponents

$$= \frac{x^{-2}\,y^{4}}{x^{6}\,y^{-3}}$$

bases with negative exponents move to make positive exponents

$$= \frac{y^4y^3}{x^6x^2}$$

$$= \frac{y^{4+3}}{x^{6+2}}$$

add the exponents

$$= \frac{y^7}{x^8}$$

132. $\left(\frac{x^4 y^5 z^6}{x^{-4} y^{-5} z^{-6}}\right)^{-4} = \frac{1 x^{-16} y^{-20} z^{-24}}{x^{16} y^{20} z^{24}}$

$$= \frac{1}{x^{16} \cdot x^{16} y^{20} y^{20} z^{24} z^{24}}$$

$$= \frac{1}{x^{32} y^{40} z^{48}}$$

$$\frac{1}{x^{32} y^{40} z^{48}}$$

Scientific Notation

$2^1 = 2$

$2^2 = 4$

$2^3 = 8$

$\vdots$

$2^? = 1{,}000{,}000$

2^{15}

2^{20}

2^{60}

$2^{20} > 1{,}000{,}000$

2^{30}

$2^{34} \approx 1.72 \times 10^{10}$ or $1.72E10$

Math 65 **Section 5.7** **Scientific Notation**

1. Complete the table below:

Scientific Notation	Decimal Notation	Calculator Notation (What your calculator shows)
2.42×10^{7} → right	24,200,000	2.42×10^7 or 2.42E7
3.203×10^{-5} ← left	.00003203	3.203×10^-5 or 3.203E-5
-5.11×10^{-9}	−.000000000511 (8 zeros)	−5.11×10^-9 or −5.11E-9
3.902×10^6	3,902,000	3.902×10^6 or 3.902E6
2.34×10^-8	0.0000000234 (small # neg exp)	2.34×10^-8 or 2.34E-8
−1.4001×10^0 (decimal goes after the 1st digit)	-1.4001	−1.4001 or −1.4001E0

2. Perform the indicated operations using your calculator. Write your answers in scientific notation.

a. $(3.21 \times 10^{6})(1.2 \times 10^{4})$ 3.21E6 * 1.2E4

$= 3.852 \times 10^{10}$

$(3.21 \cdot 1.2)10^{6} \cdot 10^{4}$

$= 3.852 \times 10^{10}$

b. $\dfrac{(9.5 \times 10^{-7})}{(4.3 \times 10^{-4})}$ = .0022

$= 2.2 \times 10^{-3}$

3. The United States has a land area of 3.54×10^{6} square miles. In 1990, the population of the United States was 2.5×10^{8}. What was the population density (in people per square mile) of the United States in 1990?

Word problems with scientific notation will not be on the midterm

C. Lee

Math 65 **Section 5.7** **Scientific Notation**

1. Complete the table below:

Scientific Notation	**Decimal Notation**	**Calculator Notation** (What your calculator shows)
2.42×10^{7}	_____	_____
3.203×10^{-5}	_____	_____
-5.11×10^{-9}	_____	_____
_____	3,902,000	_____
_____	0.0000000234	_____
_____	-1.4001	_____

2. Perform the indicated operations using your calculator. Write your answers in scientific notation.

a. $(3.21 \times 10^{6})(1.2 \times 10^{4})$

b. $\dfrac{9.5 \times 10^{-7}}{4.3 \times 10^{-4}}$

3. The United States has a land area of 3.54×10^{6} square miles. In 1990, the population of the United States was 2.5×10^{8}. What was the population density (in people per square mile) of the United States in 1990?

4. Challenge Problem:

Approximately 44,000 thunderstorms and 8 million lightning flashes take place daily around the world. In the United States, lightning annually causes about 150 deaths and $20 million in property damage. It sets 10,000 forest fires a year, which destroy $30 million worth of timber. (Source: Scientific American)

a. Approximate the number of lightning flashes that occur each year on Earth.

b. Approximate the number of thunderstorms that occur each year on Earth.

c. What is the average number of lightning flashes in a thunderstorm?