Mathematics9 Date _____

Unit 3: Powers & Exponents

3.2B Negative Exponents

Continue each of the following patterns:

$2^4 = 16$ ÷2
$2^3 = 8$ ÷2
$2^2 = 4$ ÷2
$2^1 = 2$ ÷2
$2^0 = 1$ ÷2
$2^{-1} = \frac{1}{2}$
$2^{-2} = \frac{1}{4}$
$2^{-3} = \frac{1}{8}$
$2^{-4} = \frac{1}{16}$

$3^4 = 81$ ÷3
$3^3 = 27$ ÷3
$3^2 = 9$ ÷3
$3^1 = 3$ ÷3
$3^0 = 1$
$3^{-1} = \frac{1}{3} = \frac{1}{3^1}$
$3^{-2} = \frac{1}{9} = \frac{1}{3^2}$
$3^{-3} = \frac{1}{27} = \frac{1}{3^3}$

$7^{-6} = \frac{1}{7^6}$

How does the result of a negative exponent connect to the result of a positive exponent?

* negative exponents produce reciprocal results

Another approach.....

What exponent law is likely to lead to a negative exponent?

$$\frac{3^2}{3^5} = \frac{1 \cdot \cancel{3} \cdot \cancel{3}^{1}}{1 \cdot 1 \cdot \cancel{3} \cdot \cancel{3} \cdot 3 \cdot 3 \cdot 3} = \frac{1}{3 \cdot 3 \cdot 3}$$

$$= 3^{2-5}$$

$$= 3^{-3} = \frac{1}{3^3}$$

Rule: $b^{-m} = \frac{1}{b^m}$

Ex. Simplify (write with a single positive exponent) & then evaluate:

a) 5^{-3}
$= \frac{1}{5^3}$
$= \frac{1}{125}$

b) 7^{-1}
$= \frac{1}{7^1}$
$= \frac{1}{7}$

c) 10^{-5}
$= \frac{1}{10^5}$
$= \frac{1}{100{,}000}$

d) -2^{-3}
$= \frac{-1}{2^3}$
$= \frac{-1}{8}$

e) $(-2)^{-4}$
$= \frac{1}{(-2)^4}$
$= \frac{1}{16}$

f) $-(-2)^{-6}$
$= \frac{-1}{(-2)^6}$
$= \frac{-1}{64}$

g) $\frac{1}{3^{-3}}$
$= 3^3$
$= 27$

h) $\frac{1}{5^{-2}}$
$= 5^2$
$= 25$

Ex. Simplify using exponent laws:

a) $4^3 \times 4^{-1}$

$= 4^{3+(-1)}$

$= \boxed{4^2}$

b) 2×2^{-4}

$= 2^{1+(-4)}$

$= 2^{-3}$

$= \boxed{\frac{1}{2^3}}$

c) $3^5 \div 3^8$

$= 3^{5-8}$

$= 3^{-3}$

$= \boxed{\frac{1}{3^3}}$

d) $\frac{9}{9^{-4}}$

$= 9^{1-(-4)}$

$= \boxed{9^5}$

e) $\frac{6^{-7}}{6^{-2}}$

$= 6^{-7-(-2)}$

$= 6^{-5}$

$= \boxed{\frac{1}{6^5}}$

f) $(5^{-2})^3$

$= 5^{-6}$

$= \frac{1}{5^6}$

g) $(8^3)^{-1}$

$= 8^{-3}$

$= \frac{1}{8^3}$

h) $(7^{-3})^{-4}$

$= \boxed{7^{12}}$

i) $(5^1 \times 3^1)^{-2}$

$= 5^{-2} \times 3^{-2}$

$= \boxed{\frac{1}{5^2} \times \frac{1}{3^2}}$

j) $\left(\frac{3}{4}\right)^{-3}$

$\frac{3^{-3}}{4^{-3}}$

$\frac{\frac{1}{3^3}}{\frac{1}{4^3}}$

$\frac{1}{3^3} \times \frac{4^3}{1}$

$= \boxed{\frac{4^3}{3^3}}$

$\left(\frac{4}{3}\right)^3$

$\boxed{\frac{4^3}{3^3}}$

Practice: Worksheets/Puzzle(#63) on sheet, 2nd sheet separate paper