Date: _____

# 4.5 Negative Exponents and Reciprocals

***Complete the following table:***

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

÷2 ÷2 ÷2 CONT. TO FOLLOW THE PATTERN

The exponent laws still apply to negative exponents:

$a^m \cdot a^n = a^{m+n}$ → IF THE BASES ARE THE SAME, KEEP THE BASE & ADD THE EXPONENTS

ex) $2^4 \cdot 2^5 = 2^9$

$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

$5^{-2} \cdot 5^2 = 5^{-2+2} = 5^0 = 1$

** $5^{-2}$ & $5^2$ ARE RECIPROCALS (THEY RESULT IN A ONE WHEN YOU MULT. THEM)

$\frac{1}{5^2} \cdot 5^2$

$\frac{1}{25} \cdot 25 = \frac{25}{25} = 1$

$$a^{-n} = \frac{1}{a^n} \quad \text{or} \quad \frac{1}{a^{-n}} = a^n$$

"WRITE IN THE RECIPROCAL POSITION"

**Example 1:** ***Evaluate.***

a) $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$

b) $\left(\frac{2}{3}\right)^{-3} = \frac{2^{-3}}{3^{-3}} = \frac{3^3}{2^3} = \frac{27}{8}$

c) $\left(-\frac{3}{4}\right)^{-3}$ $= \left(-\frac{4}{3}\right)^{3} = -\frac{64}{27}$


RECIPROCAL

e) $0.3^{-4}$ $= \left(\frac{3}{10}\right)^{-4} = \left(\frac{10}{3}\right)^{4}$ CHANGE TO FRACTION

$= \frac{10000}{81}$

d) $(-2)^{-5} = \left(-\frac{1}{2}\right)^{5} = -\frac{1}{32}$ $\left(\frac{-2}{1}\right)$

f) $(-1.5)^{-2} = \left(-\frac{3}{2}\right)^{-2} = \left(-\frac{2}{3}\right)^{2}$

$= \frac{4}{9}$

*What if the exponent is a negative **fraction**???*

① WRITE RECIPROCAL
② CHANGE TO A RADICAL

g) $8^{-\frac{2}{3}} = \left(\frac{1}{8}\right)^{\frac{2}{3}} = \left(\sqrt[3]{\frac{1}{8}}\right)^{2}$

$= \left(\frac{\sqrt[3]{1}}{\sqrt[3]{8}}\right)^{2}$

$= \left(\frac{1}{2}\right)^{2} = \frac{1}{4}$

i) $\left(\frac{25}{36}\right)^{-\frac{1}{2}} = \left(\frac{36}{25}\right)^{\frac{1}{2}} = \sqrt{\frac{36}{25}}$

$= \frac{6}{5}$

h) $16^{-\frac{5}{4}} = \left(\frac{1}{16}\right)^{\frac{5}{4}} = \left(\sqrt[4]{\frac{1}{16}}\right)^{5}$

$= \left(\frac{1}{2}\right)^{5}$

$= \frac{1}{32}$

j) $\left(\frac{9}{16}\right)^{-\frac{3}{2}} = \left(\frac{16}{9}\right)^{\frac{3}{2}} = \left(\sqrt{\frac{16}{9}}\right)^{3}$

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

$= \frac{64}{27}$

**Examples 2:** ***Write as a power with negative exponents.***

① FIND A + POWER
② CHANGE INTO − POWER BY WRITING RECIPROCAL

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

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

c) $\frac{9}{25} = \left(\frac{3}{5}\right)^{2} = \left(\frac{5}{3}\right)^{-2}$

**Example 3:**
The speed at which dinosaurs travelled (from fossilized tracks) has been determined to be:

$$v = 0.155 s^{\frac{5}{3}} f^{-\frac{7}{6}}$$

Calculate the speed (*v*) in m/s of a dinosaur with a foot length (*f*) of 0.25 m and 1.00 m between footprints (*s*).

$$v = 0.155(1.00)^{\frac{5}{3}}(0.25)^{-\frac{7}{6}}$$

$$= 0.155(1)(0.25)^{-\frac{7}{6}}$$

$$= 0.155(0.25)^{-\frac{7}{6}} \quad * \text{CALC.}$$

" 0.155 × 0.25 ^ (−7 ÷ 6) = "

$$\doteq 0.78 \text{ m/s}$$

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