## 4.5 Negative Exponents

**Warm up** - Evaluate each power:

1. a) $7^2 =$ 49 b) $-7^2 =$ $-1 \cdot 7^2$ $-1 \cdot 49 = -49$ c) $(-7)^2 =$ $(-7)(-7)$ $= 49$ d) $-(7)^2 =$ $= -1(49)$ $= -49$ e) $-(-7)^2 =$ $= -1 \cdot (49)$ $= -49$

Brackets influence the solution by including/excluding things

2. Write the reciprocal: → Two numbers are reciprocals if their product equals 1. $\frac{a}{b} \Rightarrow \frac{b}{a}$

a) $\frac{2}{1} \Rightarrow \frac{1}{2}$ b) $\frac{6^2}{1} \Rightarrow \frac{1}{6^2}$ c) $\frac{1}{2} \Rightarrow \frac{2}{1}$ d) $\frac{1}{100^{\$}} \Rightarrow \frac{100}{1}$

$\frac{2}{1} \times \frac{1}{2} = \frac{2}{2} = 1$ $\frac{1}{36}$ 2 100

**Powers with Negative Exponents :**

When $x$ is any non-zero number and $n$ is a rational number, $x^{-n}$ is the reciprocal of $x^n$.

That is, $\frac{x^{-n}}{1} = \frac{1}{x^n}$ and $\frac{1}{x^{-n}} = x^n$ , $x \neq 0$

example : $\frac{6^{-2}}{1} = \frac{1}{6^2} = \frac{1}{36}$ exponent becomes positive

et : $\frac{1}{6^{-2}} = \frac{6^2}{1} = \frac{36}{1} = 36$

It is often more difficult to work with negative exponents; we prefer to work with positive ones.

**Example 1** : Evaluate each power by first writing each one with a positive exponent. (without a calculatc

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

b) $\frac{(-8)^{-\frac{2}{3}}}{1} = \frac{1}{(-8)^{2/3}} = \frac{1}{(\sqrt[3]{(-8)})^2} = \frac{1}{(-2)^2} = \frac{1}{4}$

c) $\frac{16^{-\frac{5}{4}}}{1} = \frac{1}{16^{5/4}} = \frac{1}{(\sqrt[4]{16})^5} = \frac{1}{2^5} = \frac{1}{32}$

**Rational Numbers with Negative Exponents**

$\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^{n}$ where a, b, can b any number but zero.

**Example 2** : Evalute each power. (without a calculator)

a) $\left(\frac{5}{4}\right)^{-2}$

$= \left(\frac{4}{5}\right)^{2}$

$= \frac{4^2}{5^2}$

$= \frac{16}{25}$

b) $\left(0\frac{3}{4}\right)^{-3}$

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

$= \frac{4^3}{(-3)^3}$

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

c) $\left(\frac{10}{3}\right)^{-3}$

$= \left(\frac{3}{10}\right)^{3}$

$= \frac{3^3}{10^3}$

$= \frac{27}{1000}$

d) $\left(\frac{9}{16}\right)^{-\frac{3}{2}}$

Don't flip

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

$= \frac{16^{3/2}}{9^{3/2}}$

$= \frac{(\sqrt{16})^3}{(\sqrt{9})^3}$

$= \frac{4^3}{3^3} = \frac{64}{27}$

e) $\left(\frac{25}{36}\right)^{-\frac{1}{2}}$

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

$= \frac{(36)^{1/2}}{(25)^{1/2}}$

$= \frac{\sqrt{36}}{\sqrt{25}}$

$= \frac{6}{5}$

**Practice**: p. 233 # 3, 5, 6bc, 8bc, 10bc, 11, 12, 15, 16

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