Evaluate without calc.

a) $\sqrt[3]{1000}$

$= 10$

b) $25^{\frac{3}{2}}$

$(\sqrt[2]{25})^3 = 5^3$

$= 125$

c) $32^{0.2}$

$32^{\frac{1}{5}}$

$\sqrt[5]{32^1} = 2$

Write as a power:

a) $\sqrt[3]{81^5} = 81^{\frac{5}{3}}$

b) $(\sqrt[4]{16})^5 = 16^{\frac{5}{4}}$

c) $(\sqrt{100})^3 = 100^{\frac{3}{2}}$

# Reciprocals

Two numbers that multiply to give you 1 are **reciprocals**

**Example:**

$(3)\left(\frac{1}{3}\right) = 1$ $\frac{3}{1}$

$(23)\left(\frac{1}{23}\right) = 1$ 5

$(-6)\left(-\frac{1}{6}\right) = 1$

$\left(\frac{4}{7}\right)(\quad) = 1$

# Reciprocals

We define powers with negative exponents so that previously developed properties such as:

Product of powers law: $a^m \cdot a^n = a^{m+n}$

Zero rule: $a^0 = 1$

**Example:**

Apply these properties.

$(5^{-2})(5^2) = 5^{-2+2}$ $\quad 5^{-2+2} = 5^0$

$(\quad)(25) = 5^0$ $\quad = 1$

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

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

Since the product of $5^{-2}$ and $5^2$ is 1, then $5^{-2}$ and $5^2$ are reciprocals.

$(x^3)\ (x^2)$

$x^5$

$\boxed{(5^{-2})\ (5^2)} = 5^0 = 1$

recips

$5^2$ and $\frac{1}{5^2}$ are also reciprocals

$5^2$ and $5^{-2}$ are reciprocals

equal equal

$5^{-2} = \frac{1}{5^2}$

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

$$x^{-n} = \frac{1}{x^n}$$

$$\frac{1}{x^{-n}} = x^n$$

4.5 Negative Exponents and Reciprocals

$$\frac{5^{-2}}{1} = 0.04$$

$$\frac{1}{5^2} = \frac{1}{25} = 0.04$$

**Example 1** Evaluating Powers with Negative Integer Exponents

* Flip the base
change sign of exp.

Evaluate each power.

a) $3^{-2}$ b) $\left(-\frac{3}{4}\right)^{-3}$ c) $0.3^{-4}$

SOLUTION

$\frac{1}{3^2} = \boxed{\frac{1}{9}}$

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

$-\frac{64}{27}$

$\left(\frac{3}{10}\right)^{-4}$

$\left(\frac{10}{3}\right)^4$

$\frac{10000}{81}$

CHECK YOUR UNDERSTANDING



Evaluating Negative Rational Exponents

## Evaluating Negative Rational Exponents

reciprocal

$\boxed{8^{-\frac{2}{3}}}$

square

cube root

Since the exponent $-\frac{2}{3}$ is the product: $(-1)\left(\frac{1}{3}\right)(2)$, and order does not matter when we multiply, we can apply the three operations of reciprocal, cube root, and square in any order.

$$= \left(\frac{1}{8}\right)^{\frac{2}{3}} = \left(\sqrt[3]{\frac{1}{8}}\right)^2 = \frac{(\sqrt[3]{1})^2}{(\sqrt[3]{8})^2} = \frac{1}{4}$$

?

# Homework

## Page 233-234

### Exercises

**A**

3 4 5 6 7 8

**B**

9 10 11 12 13 14 15 16

17 18 19

**C**

20 21