1.7 Negative exponents

Key

Activity 1 Negative exponents

When the base a is a non-zero real number and n is a natural number, a^{-n} is a negative power defined by $a^{-n} = \frac{1}{a^n}$.

Calculate.

a) $3^{-2} = \frac{1}{3^2}$ b) $(-5)^{-2} = \frac{1}{(-5)^2}$ or $\frac{1}{25}$ c) $-5^{-2} = -\frac{1}{5^2}$ or $-\frac{1}{25}$

d) $(-2)^{-3} = \frac{1}{(-2)^3}$ e) $10^{-4} = \frac{1}{10^4}$ f) $\left(\frac{2}{3}\right)^{-2} = \frac{2^{-2}}{3^{-2}} = \frac{3^2}{2^2}$

g) $(0.2)^{-1} = \frac{1}{0.2} = 5$ h) $(0.05)^{-3} = \left(\frac{1}{20}\right)^{-3} = 20^3$ i) $(0.01)^{-2} = \frac{1}{0.01} = \frac{1}{10^{-2}}$ or 100

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

NEGATIVE EXPONENTS

For any non-zero real number a, and any natural number n, we have:

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

Ex.: $5^{-2} = \frac{1}{5^2} = \frac{1}{25}$; $(-4)^{-2} = \frac{1}{(-4)^2} = \frac{1}{16}$; $(-2)^{-3} = \frac{1}{(-2)^3} = \frac{-1}{8}$.

1. Explain why it is necessary for the base a to be non-zero in the expression a^{-n}.

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2. The laws of exponents (section 1.6) remain valid when the exponents are negative. Simplify the following calculations using the appropriate law of exponents.

a) $2^3 \times 2^{-5}$

2^{3+-5}

$2^{-2} \rightarrow \frac{1}{2^2}$ or $\frac{1}{4}$

b) $(2^2)^{-3}$

$2^{-6} \rightarrow \frac{1}{2^6}$

c) $(x^2y^{-3})^{-2}$

$x^{-4}y^6 \rightarrow \frac{y^6}{x^4}$

d) $\left(\frac{x^{-3}}{y^2}\right)^{-2}$

$\frac{x^6}{y^{-4}}$

$x^6 y^4$

$\left(\frac{y^2}{x^{-3}}\right)^2$

$(x^3y^2)^2$

x^6y^4

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

$\frac{3^{-2}a^4}{b^{-8}}$

$\frac{a^4b^8}{9}$

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Assignment

Name _____

Date _____ Period ____

Simplify. Your answer should contain only positive exponents.

1) $u^{-2} \cdot 3u^{-4}v^2$

$3u^{-6}v^2 \rightarrow \frac{3v^2}{u^6}$

2) $2y^{-3} \cdot x^2 \cdot 2x^{-2}$

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

3) $2x^3y^3 \cdot y^4 \cdot 3y^4$

$6x^3y^{11}$

4) $4a^2b^2 \cdot 3ab$

$12a^3b^3$

5) $x^2y^{-2} \cdot 4x^4y^3$

$4x^6y^1$

6) $2a^{-4} \cdot 4ab^{-2}$

$8a^{-3}b^{-2} \rightarrow \frac{8}{a^3b^2}$

7) $x^0 \cdot 4x^4y^2$

$4x^4y^2$

8) $a^{-1}b^0 \cdot 4a^{-3}b^{-4}$

$4a^{-4}b^{-4} \rightarrow \frac{4}{a^4b^4}$

9) $y^{-4}x^4$

$\frac{x^4}{y^4}$

10) $2m^2n^{-3} \cdot 2m^3n^{-1} \cdot 4m^4n^{-1}$

$16m^9n^{-5} \rightarrow \frac{16m^9}{n^5}$

11) $x^4y^{-4} \cdot x^{-2}y^4$

x^2

12) $m^3 \cdot m^{-1}n^0$

m^2

13) $uv^3 \cdot u^4v^0$

u^5v^3

14) $x^4y^{-3} \cdot xy^{-1}$

$x^5y^{-4} \rightarrow \frac{x^5}{y^4}$

15) $2xy^{-4} \cdot yx^3$

$2x^4y^{-3} \rightarrow \frac{2x^4}{y^3}$

16) $4u^3v^{-3} \cdot 2uv^{-4} \cdot 2u^2v^{-4}$

$16u^6v^{-11} \rightarrow \frac{16u^6}{v^{11}}$

17) $2x^4y^4 \cdot 2x^{-1}$

$4x^3y^4$

18) $2x^{-4} \cdot 2x^{-3}y^4$

$4x^{-7}y^4 \rightarrow \frac{4y^4}{x^7}$

19) $2b^{-3} \cdot 2a^{-2}b^{-2}$

$4ab^{-5} \rightarrow \frac{4}{a^2b^5}$

20) $a^2b^4 \cdot 2a^0$

$2a^2b^4$