

Elementary Algebra

Skill-Builder # E – 4

Applying the Quotient Rule for Exponents

The following rule applies when dividing exponential expressions with the same base.

For any nonzero real number a , and positive integers m and n ,

$$\frac{a^m}{a^n} = a^{m-n}.$$

The rule says that to divide exponential expressions with the same base, subtract the exponent of the divisor (denominator) from the exponent of the dividend (numerator) and keep the base. We will restrict the examples and exercises to the case when $m > n$.

Examples

1. $\frac{x^8}{x^5} = x^{8-5} = x^3$

2. $\frac{5^5}{5^3} = 5^{5-3} = 5^2 = 25$

We can have either the numerator or denominator as a product of several exponential expressions.

3. Simplify: $\frac{a^6 b^{13}}{a^2 b^7}$

Solution: We can write the expression as the product of two division problems and then we can apply the division rule.

$$\frac{a^6 b^{13}}{a^2 b^7} = \frac{a^6}{a^2} \cdot \frac{b^{13}}{b^7} = a^{6-2} b^{13-7} = a^4 b^6$$

We can also combine this rule with the other exponent rules. Try to justify each step in the next example.

4. Simplify: $\frac{(2xy^2z^3)^3}{(-4xyz^2)^2}$

Solution:

$$\frac{(2xy^2z^3)^3}{(-4xyz^2)^2} = \frac{2^3 x^3 y^6 z^9}{(-4)^2 x^2 y^2 z^4} = \frac{8}{16} x^{3-2} y^{6-2} z^{9-4} = \frac{1}{2} xy^4 z^5$$

Elementary Algebra
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Simplify the following using the quotient rule for exponents.

1. $\frac{2^7}{2^4}$
2. $\frac{a^{21}}{a^{10}}$
3. $\frac{x^8 y^{13}}{x^5 y^8}$
4. $\frac{3^4 a^5 b^8 c^6}{3ab^4 c^2}$

Simplify the following using combined rules for exponents

5. $\frac{(2x^2)^3}{4x^5}$
6. $\frac{a^4 (3ab^4)^3}{(3a^2b)^2 b^3}$
7. $\frac{(x^3y)^2 (xy^4)^3}{(x^2y^2)^2}$
8. $\frac{-8a^3 (ab^2)^2 (3a^4b)^3}{(-2ab)^3 (-3ab)}$

Elementary Algebra
Skill-Builder # E – 4
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Answer Key:

1. 8

2. a^{11}

3. x^3y^5

4. $27a^4b^4c^4$

5. $2x$

6. $3a^3b^7$

7. x^5y^{10}

8. $-9a^{13}b^3$

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