Laws of Exponents

Explore ideas and representations

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QUICK REVIEW

For a nonzero base, $a^m a^n = a^{m+n}$, $a^m / a^n = a^{m-n}$, $(a^m)^n = a^{mn}$, and $a^0 = 1$. Examples: $6^4/6^2 = 6^2 = 36$ and $(5^2)^3 = 5^6$. These laws combine equal bases, not 2^m with 3^n.

Worked example

Use an exponent law to simplify $8^1 \cdot 8^2$ as one power, then evaluate.

1. The base stays 8; the exponent calculation is $1 + 2 = 3$.
2. The single power is $8^3 = 512$.
3. Numerical base powers: $8^1 = 8$ and $8^2 = 64$.
Answer: $8^3 = 512$.

Practice Problems

Show your thinking.

1. Use an exponent law to simplify $2^3 \cdot 2^2$ as one power, then evaluate. State the number of equal factors in the combined power.

2. Use an exponent law to simplify $3^4 \div 3^2$ as one power, then evaluate. Recover q in 3^q for this quotient.

3. Use an exponent law to simplify $(2^2)^3$ as one power, then evaluate. Explain why multiplying exponents, rather than adding them, counts the factors here.

4. Use an exponent law to simplify 5^0 as one power, then evaluate.

5. Use an exponent law to simplify $10^3 \div 10^1$ as one power, then evaluate. Write the result in ordinary place value.

6. Use an exponent law to simplify $3^2 \cdot 3^2$ as one power, then evaluate. Compare the result with 3^2 by giving the exact multiplicative factor.

7. Use an exponent law to simplify $2^5 \cdot 2^3$ as one power, then evaluate.

8. Use an exponent law to simplify $5^4 \div 5^2$ as one power, then evaluate.

9. Use an exponent law to simplify $(3^2)^2$ as one power, then evaluate.

10. Use an exponent law to simplify 7^0 as one power, then evaluate.

Answer Key

1. $2^5 = 32$. There are 5 factors of 2.
2. $3^2 = 9$. $q = 2$.
3. $2^6 = 64$. Three groups of two factors give six factors.
4. $5^0 = 1$.
5. $10^2 = 100$. 100.
6. $3^4 = 81$. Factor 9.
7. $2^8 = 256$.
8. $5^2 = 25$.
9. $3^4 = 81$.
10. $7^0 = 1$.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The base stays 2; the exponent calculation is $3 + 2 = 5$.
2. The single power is $2^5 = 32$.
3. Numerical base powers: $2^3 = 8$ and $2^2 = 4$.
4. Exponent $3 + 2 = 5$ counts those factors.

Problem 2

1. The base stays 3; the exponent calculation is $4 - 2 = 2$.
2. The single power is $3^2 = 9$.
3. Numerical base powers: $3^4 = 81$ and $3^2 = 9$.
4. $q = 4 - 2 = 2$.

Problem 3

1. The outer 3 repeats the whole 2^2 factor three times: $(2^2)(2^2)(2^2)$. Each group contains two factors of 2.
2. The base stays 2; the exponent calculation is $2 \times 3 = 6$.
3. The single power is $2^6 = 64$.
4. Numerical base powers: $2^2 = 4$ and $2^3 = 8$.

Problem 4

1. The base 5 is not zero, so $5^1/5^1 = 5/5 = 1$.
2. The same-base quotient law also writes it as $5^{1-1} = 5^0$.
3. Therefore $5^0 = 1$, not 0.

Problem 5

1. The base stays 10; the exponent calculation is $3 - 1 = 2$.
2. The single power is $10^2 = 100$.
3. Numerical base powers: $10^3 = 1000$ and $10^1 = 10$.
4. $10^2 = 10(10) = 100$.

Problem 6

1. The base stays 3; the exponent calculation is $2 + 2 = 4$.
2. The single power is $3^4 = 81$.
3. Numerical base powers: $3^2 = 9$ and $3^2 = 9$.
4. $3^4/3^2 = 3^2 = 9$.

Problem 7

1. The base stays 2; the exponent calculation is $5 + 3 = 8$.
2. The single power is $2^8 = 256$.
3. Numerical base powers: $2^5 = 32$ and $2^3 = 8$.

Problem 8

1. The base stays 5; the exponent calculation is $4 - 2 = 2$.
2. The single power is $5^2 = 25$.
3. Numerical base powers: $5^4 = 625$ and $5^2 = 25$.

Problem 9

1. The base stays 3; the exponent calculation is $2 \times 2 = 4$.
2. The single power is $3^4 = 81$.
3. Numerical base powers: $3^2 = 9$ and $3^2 = 9$.

Problem 10

1. The base 7 is not zero, so $7^1/7^1 = 7/7 = 1$.
2. The same-base quotient law also writes it as $7^{1-1} = 7^0$.
3. Therefore $7^0 = 1$, not 0.

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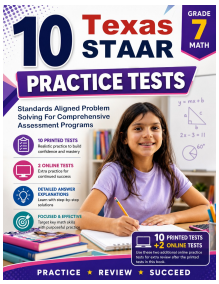

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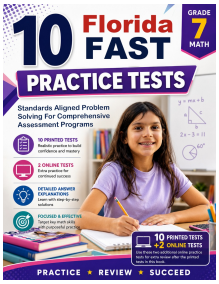

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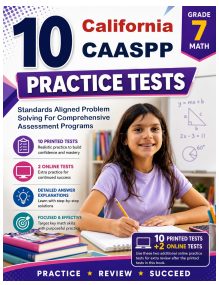

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