Laws of Exponents

Apply the skill to decisions and designs

Name _____ **Date** _____ **Score** _____ / 10

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. Two designs need $2^4 \cdot 2^3$ tiles and $(2^3)^2$ tiles. A shelf can hold at most 100 tiles and the display needs at least 60. Which design fits? Write each count as a power first.

2. A code must satisfy $3^k \div 3^2 = 3^4$. Find the exponent k without trying every value, then check with ordinary numbers.

3. A square tray holds 4^2 items. There are 4 identical trays. Lee says the total is $4^2 + 4$. Write the correct total as one power and explain the difference.

4. In a pattern, level t has 11^t squares. Level 1 has 11, and each step up multiplies by 11. Find level 0 and explain why it is not empty.

5. A storage block holds 10^2 bytes and a folder holds 10^5 bytes. Write a power for the number of whole blocks it can hold. If one block must be reserved, how many blocks remain available?

6. A design uses $(3^2)^4$ slots in its grid. A divider makes 3^3 equal sections. Find slots per section using one power. A sheet has room for 250 slots. How much room is unused if it holds one section?

7. Locker-code rule: a design code satisfies $2^q = 2^5 \cdot 2^3$. Find the whole-number exponent q and verify the matching values.

8. Token-count rule: a design code satisfies $5^q = 5^4 \div 5^2$. Find the whole-number exponent q and verify the matching values.

9. Tile-pack rule: a design code satisfies $3^q = (3^2)^2$. Find the whole-number exponent q and verify the matching values.

10. Meter-offset rule: a design code satisfies $7^q = 7^0$. Find the whole-number exponent q and verify the matching values.

Answer Key

1. Only the second: 64 tiles, versus 128.
2. $k = 6$.
3. $4^3 = 64$ items, not 20.
4. 1 square.
5. $10^3 = 1000$ blocks total; 999 available.
6. $3^5 = 243$ slots per section; room for 7 more.
7. $q = 8$; both sides equal 256.
8. $q = 2$; both sides equal 25.
9. $q = 4$; both sides equal 81.
10. $q = 0$; both sides equal 1.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The first adds same-base exponents: $2^{4+3} = 2^7 = 128$.
2. The second repeats three factors twice: $2^{3 \cdot 2} = 2^6 = 64$.
3. $128 > 100$, but $60 \le 64 \le 100$. Only the second meets both limits.

Problem 2

1. For the same base, subtract exponents: $3^{k-2} = 3^4$.
2. Thus $k - 2 = 4$, so $k = 4 + 2 = 6$.
3. Check $3^6/3^2 = 729/9 = 81 = 3^4$.

Problem 3

1. Four trays repeat 4^2 four times, so use the product $4 \cdot 4^2$.
2. Same base: $4^1 \cdot 4^2 = 4^{1+2} = 4^3 = 64$.
3. $4^2 + 4 = 16 + 4 = 20$ would add four single items, not make four full trays.

Problem 4

1. To go down one level, divide by 11: $11/11 = 1$.
2. This also follows from $11^1/11^1 = 11^{1-1} = 11^0$.
3. A starting value of 0 would still be 0 after multiplying by 11, not the given 11.

Problem 5

1. Divide the capacities: $10^5/10^2 = 10^{5-2} = 10^3$ blocks.
2. $10^3 = 1000$. The capacity is an exact whole number of blocks.
3. Keep one block in reserve: $1000 - 1 = 999$ are available.

Problem 6

1. Raise a power to a power: $(3^2)^4 = 3^{2 \cdot 4} = 3^8$.
2. Divide by 3^3: $3^{8-3} = 3^5 = 243$ slots per section.
3. The unused capacity is $250 - 243 = 7$ slots.

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 $2^3 = 8$.
4. The matching exponent is $q = 8$; $2^8 = 256$ verifies it.

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 $5^2 = 25$.
4. The matching exponent is $q = 2$; $5^2 = 25$ verifies it.

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 $3^2 = 9$.
4. The matching exponent is $q = 4$; $3^4 = 81$ verifies it.

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.
4. The matching exponent is $q = 0$; $7^0 = 1$ verifies it.

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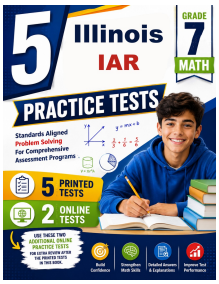

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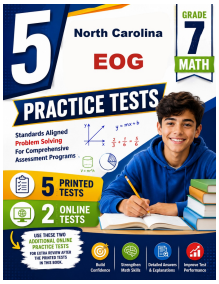

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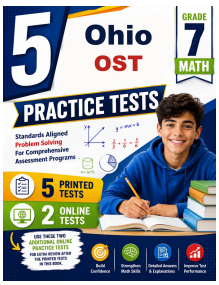

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