Prime Factorization with Exponents

Name: _____	Date: _____	Score: _____ / 24

Quick Review

The **prime factorization** of a whole number writes it as a product of *prime numbers* only — numbers like $2, 3, 5, 7, 11$ that have no factors besides 1 and themselves. A **factor tree** helps: keep breaking a number into two factors until every branch ends in a prime. When the same prime shows up more than once, gather the copies into an **exponent**, so $2 \times 2 \times 2 = 2^3$. Every whole number greater than 1 has exactly *one* prime factorization, so this is like a number's fingerprint. It also makes finding the GCF and LCM much easier.

◇ **Example:** Write the prime factorization of 72 using exponents.

⇒ Build a factor tree. Start by splitting $72 = 8 \times 9$. Now break each branch: $8 = 2 \times 2 \times 2$ and $9 = 3 \times 3$. Every branch now ends in a prime, so $72 = 2 \times 2 \times 2 \times 3 \times 3$. Finally, collect the repeats into exponents — there are three 2s and two 3s — which gives $2^3 \times 3^2$. (Quick check: $8 \times 9 = 72$.)

Answer: $72 = 2^3 \times 3^2$

PRACTICE

Write the prime factorization of each number using exponents.

1. 12 _____

2. 18 _____

3. 20 _____

4. 24 _____

5. 27 _____

6. 30 _____

7. 36 _____

8. 40 _____

9. 45 _____

10. 48 _____

11. 50 _____

12. 60 _____

13. 64 _____

14. 75 _____

15. 80 _____

16. 90 _____

17. 100 _____

18. 120 _____

19. 144 _____

20. 200 _____

Word Problems

21. A music teacher has 84 stickers to share. Write the prime factorization of 84 using exponents. _____

22. A number's prime factorization is $2^3 \times 3$. What is the number? _____

23. Two gears have $2^2 \times 3$ and 2×3^2 teeth. Using prime factorizations, find the least common multiple of their tooth counts. _____

24. Nina says the prime factorization of 30 is $1 \times 2 \times 3 \times 5$. What mistake did she make? _____

Answer Keys

1. $2^2 \times 3$
2. 2×3^2
3. $2^2 \times 5$
4. $2^3 \times 3$
5. 3^3
6. $2 \times 3 \times 5$
7. $2^2 \times 3^2$
8. $2^3 \times 5$
9. $3^2 \times 5$
10. $2^4 \times 3$
11. 2×5^2
12. $2^2 \times 3 \times 5$
13. 2^6
14. 3×5^2
15. $2^4 \times 5$
16. $2 \times 3^2 \times 5$
17. $2^2 \times 5^2$
18. $2^3 \times 3 \times 5$
19. $2^4 \times 3^2$
20. $2^3 \times 5^2$
21. $84 = 2^2 \times 3 \times 7$
22. 24
23. 36
24. 1 is not prime; $30 = 2 \times 3 \times 5$

Step-by-Step Explanations

1. $12 = 4 \times 3 = 2 \times 2 \times 3$, which is $2^2 \times 3$.
2. $18 = 2 \times 9 = 2 \times 3 \times 3 = 2 \times 3^2$.
3. $20 = 4 \times 5 = 2 \times 2 \times 5 = 2^2 \times 5$.
4. $24 = 8 \times 3 = 2 \times 2 \times 2 \times 3 = 2^3 \times 3$.
5. $27 = 3 \times 9 = 3 \times 3 \times 3 = 3^3$.
6. $30 = 2 \times 15 = 2 \times 3 \times 5$; each prime appears once.
7. $36 = 4 \times 9 = 2 \times 2 \times 3 \times 3 = 2^2 \times 3^2$.
8. $40 = 8 \times 5 = 2 \times 2 \times 2 \times 5 = 2^3 \times 5$.
9. $45 = 9 \times 5 = 3 \times 3 \times 5 = 3^2 \times 5$.
10. $48 = 16 \times 3 = 2 \times 2 \times 2 \times 2 \times 3 = 2^4 \times 3$.
11. $50 = 2 \times 25 = 2 \times 5 \times 5 = 2 \times 5^2$.
12. $60 = 4 \times 15 = 2 \times 2 \times 3 \times 5 = 2^2 \times 3 \times 5$.
13. $64 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^6$.
14. $75 = 3 \times 25 = 3 \times 5 \times 5 = 3 \times 5^2$.
15. $80 = 16 \times 5 = 2^4 \times 5$.
16. $90 = 2 \times 45 = 2 \times 3 \times 3 \times 5 = 2 \times 3^2 \times 5$.
17. $100 = 4 \times 25 = 2 \times 2 \times 5 \times 5 = 2^2 \times 5^2$.
18. $120 = 8 \times 15 = 2^3 \times 3 \times 5$.
19. $144 = 16 \times 9 = 2^4 \times 3^2$.
20. $200 = 8 \times 25 = 2^3 \times 5^2$.
21. $84 = 4 \times 21 = 2 \times 2 \times 3 \times 7$. Collecting the two 2s gives $2^2 \times 3 \times 7$.
22. $2^3 = 8$ and then $8 \times 3 = 24$, so the number is 24.
23. Take the highest power of each prime that appears: 2^2 and 3^2. The LCM is $2^2 \times 3^2 = 4 \times 9 = 36$.
24. The number 1 is not a prime number, so it should never appear in a prime factorization. The correct answer is just $2 \times 3 \times 5$.

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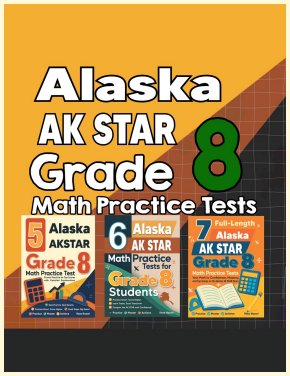

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