

Prime Factorization with Exponents

Name: _____ Date: _____ Score: _____ / 24

Q 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.

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|--------|-------|---------|-------|
| 1. 12 | _____ | 11. 50 | _____ |
| 2. 18 | _____ | 12. 60 | _____ |
| 3. 20 | _____ | 13. 64 | _____ |
| 4. 24 | _____ | 14. 75 | _____ |
| 5. 27 | _____ | 15. 80 | _____ |
| 6. 30 | _____ | 16. 90 | _____ |
| 7. 36 | _____ | 17. 100 | _____ |
| 8. 40 | _____ | 18. 120 | _____ |
| 9. 45 | _____ | 19. 144 | _____ |
| 10. 48 | _____ | 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

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

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