Prime Numbers and Prime Factorization

What You'll Learn

To factor numbers and to find the prime factorization of numbers

🔊 **New Vocabulary** factor, composite number, prime number, prime factorization

Why Learn This?

Using factors, you can organize items or people in rows.

Divisibility rules can help you find factors. A **factor** is a whole number that divides a nonzero whole number with remainder 0.

EXAMPLE **Finding Factors**

1 An instructor plans a dance routine for 20 dancers in rows. Each row has the same number of dancers. What are the arrangements the instructor can use?

Look for pairs of factors for 20 to find the possible arrangements.

1×20 ← Write each pair of factors. Start with 1.

$2 \times 10, \ 4 \times 5$ ← 2 and 4 are factors. Skip 3, since 20 is not divisible by 3.

5×4 ← Stop when you repeat factors.

The arrangements are 1×20, 2×10, and 4×5.

Example

❶ Finding Factors List the factors of each number.

a. 24

1×24 ¬ **Write each pair of factors. Start with 1.**

$2 \times \boxed{12}, 3 \times \boxed{8}, 4 \times \boxed{6}$ ¬ $\boxed{2}$, $\boxed{3}$, **and** $\boxed{4}$ **are factors. Skip 5, since 24 is not divisible by 5.**

$6 \times \boxed{4}$ ¬ **Stop when you repeat factors.**

The factors of 24 are $\boxed{1}$, $\boxed{2}$, $\boxed{3}$, $\boxed{4}$, $\boxed{6}$, $\boxed{8}$, $\boxed{12}$, and $\boxed{24}$.

b. 35

1×35 ¬ **Write each pair of factors. Start with 1.**

$\boxed{5} \times 7$ ¬ **Skip 2, 3, and 4, since 35 is not divisible by 2, 3, or 4.** $\boxed{5}$ **is a factor. Skip 6, since 35 is not divisible by 6.**

$7 \times \boxed{5}$ ¬ **Stop when you repeat factors.**

The factors of 35 are $\boxed{1}$, $\boxed{5}$, $\boxed{7}$, and $\boxed{35}$.

1. A gift box must hold the same number of pears in each row. You have 24 pears. What arrangements can you use?

A **composite number** is a whole number greater than 1 with more than two factors. A **prime number** is a whole number with exactly two factors, 1 and the number itself. The numbers 0 and 1 are neither prime nor composite.

EXAMPLE   **Prime or Composite?**

2 Is the number prime or composite? Explain.

a. 51

Composite: 51 is divisible by 3. So 51 has more than two factors.

b. 53

Prime: 53 has only two factors, 1 and 53.

Table talk and see if you can correctly complete these problems:

Examples

❷ **Prime or Composite?** Is the number prime or composite? Explain.

a. 61 [＿＿＿＿] ; 61 has [＿＿] factors, [＿＿] and [＿＿] .

b. 65 [＿＿＿＿＿] ; 65 is divisible by [＿] , so 65 has more than [＿＿] factors.

To write the **prime factorization** of a composite number, you write the number as a product of prime numbers. Each composite number has only one prime factorization.

When a factor repeats, use exponents to write your answer. You can use a division ladder or a factor tree to find the prime factorization of a number.
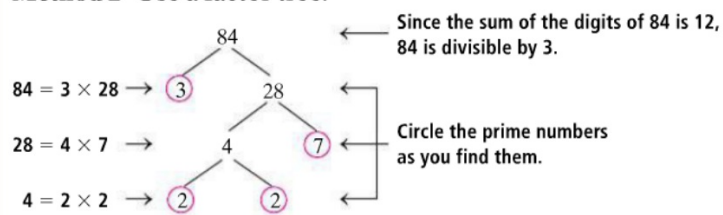
EXAMPLE   **Prime Factorization**

3 Write the prime factorization of 84 using exponents.

Method 1 Use a division ladder.

$2\overline{)84}$ ← Divide 84 by the prime number 2. Work down.
$2\overline{)42}$ ← The result is 42. Since 42 is even, divide by 2 again.
$3\overline{)21}$ ← The result is 21. Divide by the prime number 3.
7 ← The prime factorization is 2 × 2 × 3 × 7.

Method 2 Use a factor tree.

Since the sum of the digits of 84 is 12, 84 is divisible by 3.

84

$84 = 3 \times 28 \rightarrow$ ③   28

$28 = 4 \times 7 \rightarrow$ 4   ⑦

Circle the prime numbers as you find them.

$4 = 2 \times 2 \rightarrow$ ②   ②

The prime factorization of 84 is $2 \times 2 \times 3 \times 7$, or $2^2 \times 3 \times 7$.
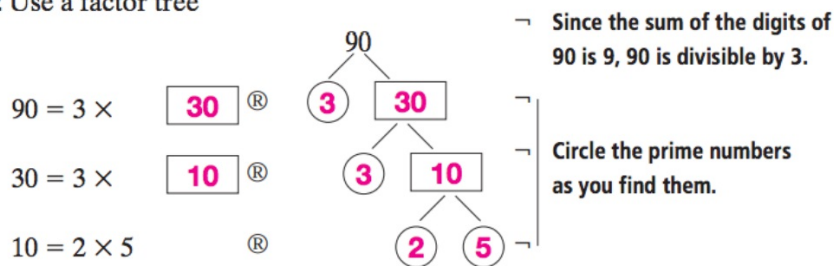
❸ Prime Factorization Write the prime factorization of 90 using exponents.

Method 1 Use a division ladder

$$2\overline{)90}$$ ¬   **Divide 90 by the prime number 2. Work down.**

$$3\overline{)\boxed{45}}$$ ¬   **The result is** $\boxed{45}$ **. Divide by the prime number 3.**

$$3\overline{)\boxed{15}}$$ ¬   **The result is** $\boxed{15}$ **. Divide by 3 again.**

$$\boxed{5}$$ ¬   **The prime factorization is** $\boxed{2} \times \boxed{3} \times \boxed{3} \times \boxed{5}$.

Method 2 Use a factor tree

¬ **Since the sum of the digits of 90 is 9, 90 is divisible by 3.**

$90 = 3 \times \boxed{30}$ ®   ③ $\boxed{30}$ ¬

$30 = 3 \times \boxed{10}$ ®   ③ $\boxed{10}$ ¬ **Circle the prime numbers as you find them.**

$10 = 2 \times 5$ ®   ② ⑤ ¬

The prime factorization of 90 is $\boxed{2} \times \boxed{3} \times \boxed{3} \times \boxed{5}$, or $\boxed{2} \times \boxed{3}^{2} \times \boxed{5}$.

Table talk about all of these problems.

2. Is the number prime or composite? Explain.

a. 39

b. 47

c. 63

3. Find the prime factorization of 27.

You have an assignment worksheet and time to begin working on it now.

Name _____ Class _____ Date _____

Practice 3-3

Prime Numbers and Prime Factorization

1. Make a list of all the prime numbers from 50 through 75. _____

Tell whether each number is prime or composite.

2. 53

3. 86

4. 95

5. 17

_____ _____ _____ _____

6. 24

7. 27

8. 31

9. 51

_____ _____ _____ _____

10. 103

11. 47

12. 93

13. 56

_____ _____ _____ _____

Complete each factor tree.

14.
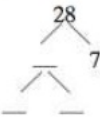
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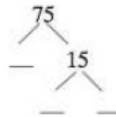
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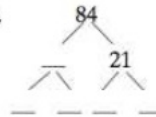
Find the prime factorization of each number.

17. 58

18. 72

_____ _____

19. 40

20. 30

_____ _____

21. 144

22. 310

_____ _____

Find the number with the given prime factorization.

23. $2 \times 2 \times 5 \times 7 \times 11$

24. $2 \times 3 \times 5 \times 7 \times 11$

_____ _____

25. $2 \times 2 \times 13 \times 17$

26. $7 \times 11 \times 13 \times 17$

_____ _____

27. There are 32 students in a class. How many ways can the class be divided into groups with equal numbers of students? What are they?

_____

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