

# Factoring by GCF

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 36

## Q Quick Review

The **greatest common factor** (GCF) of polynomial terms is the biggest expression that divides every term cleanly. Find it by handling each piece separately:

- **Coefficient part:** take the GCF of all the numerical coefficients (gcd).
- **Each variable:** take the *smallest* exponent that appears in every term. The variable must appear in *all* terms or it's not in the GCF.

Quick check: GCF of  $18x^4y^2$  and  $30x^2y^5$  is  $\text{gcd}(18, 30) \cdot x^{\min(4,2)} \cdot y^{\min(2,5)} = 6x^2y^2$ .

Once you have the GCF, factor it out: each term divides by the GCF, and what's left goes inside the parentheses.  $6x^3 + 9x^2$  has GCF  $3x^2$ , giving  $3x^2(2x + 3)$ . Check by distributing back:  $3x^2 \cdot 2x + 3x^2 \cdot 3 = 6x^3 + 9x^2 \checkmark$ .

The common factor doesn't have to be a monomial. A **binomial** can be the common factor too: in  $3x(x + 1) - 5(x + 1)$ , both terms share  $(x + 1)$ , so the factored form is  $(x + 1)(3x - 5)$ . This kind of common-binomial step is the key to *factoring by grouping* on four-term polynomials.

**Trap:** the largest exponent gives the LCM, not the GCF. Use the *smallest*. And not every variable in any one term belongs to the GCF — only variables that appear in *every* term do.

## PRACTICE

Factor out the GCF or the common binomial. Write the answer in fully factored form.

- $6x^3 + 9x^2$  \_\_\_\_\_
- $15x^2y^3 - 25xy^4$  \_\_\_\_\_
- $4x^3 - 8x^2 + 12x$  \_\_\_\_\_
- $3x(x + 1) - 5(x + 1)$  \_\_\_\_\_
- $8x^4y^2 + 12x^3y^3 - 20x^2y$  \_\_\_\_\_
- $7x(2x - 3) + 5(2x - 3)$  \_\_\_\_\_
- The table breaks two monomials into coefficient and exponents. Find the GCF of  $18x^4y^2$  and  $30x^2y^5$ . \_\_\_\_\_

Monomial	Coef.	Power $x$	Power $y$
$18x^4y^2$	18	4	2
$30x^2y^5$	30	2	5

- The table lists the exponent of  $x$  in each monomial. Find the GCF of  $x^4$  and  $x^6$ . \_\_\_\_\_

Monomial	Power of $x$
$x^4$	4
$x^6$	6

- $18x^3 + 24x^2$  \_\_\_\_\_
- $10a^4 - 15a^3 + 25a^2$  \_\_\_\_\_
- $6x^2y + 9xy^2$  \_\_\_\_\_
- $x^3 - x^2 + x$  \_\_\_\_\_
- $12y^2 - 8y + 4$  \_\_\_\_\_
- $a^2(a + 5) - 3(a + 5)$  \_\_\_\_\_
- $24x^5 + 18x^4 - 30x^3$  \_\_\_\_\_



- 16.  $4x^2 - 8x$  \_\_\_\_\_
- 17.  $5x^4 + 10x^2$  \_\_\_\_\_
- 18.  $x^2(2x - 1) + 4(2x - 1)$  \_\_\_\_\_
- 19. The table breaks three monomials into coefficient and power of  $x$ . Find the GCF of  $12x^5$ ,  $18x^3$ ,  $30x^2$ . \_\_\_\_\_

Monomial	Coef.	Power $x$
$12x^5$	12	5
$18x^3$	18	3
$30x^2$	30	2

- 20. Area  $18x^3 + 24x^2$  factored by GCF gives what? \_\_\_\_\_

**◆ Word Problems**

- 21. A rectangular garden has area  $(18x^3 + 24x^2)$  square feet. Use the GCF to write the area as a product of two simpler factors, then identify possible dimensions. \_\_\_\_\_
- 22. Three storage bins hold  $12x^2$ ,  $18x^3$ , and  $30x^4$  cubic feet of grain respectively. Find the largest amount of grain that divides each bin's total evenly. \_\_\_\_\_
- 23. A factory makes parts in two sizes: small parts use  $8x^2y$  ounces of metal, large parts use  $12xy^2$  ounces. Find the GCF of the two amounts. \_\_\_\_\_
- 24. A polynomial expression in a chemistry rate equation is  $7x(2x - 3) + 5(2x - 3)$ . Factor it completely. \_\_\_\_\_

**Additional Practice**

- 25. Write  $3x - 5 + x^3$  in standard form. \_\_\_\_\_
- 26. Find the degree of  $7x^4 - 2x^2 + 9$ . \_\_\_\_\_
- 27. Add  $(2x^2 + 3x - 1) + (x^2 - 5x + 4)$ . \_\_\_\_\_
- 28. Subtract  $(5x^2 - x + 6) - (2x^2 + 3x - 1)$ . \_\_\_\_\_
- 29. Multiply  $(x + 4)(x - 3)$ . \_\_\_\_\_
- 30. Factor  $x^2 + 9x + 20$ . \_\_\_\_\_
- 31. Factor  $6x^2 + 9x$ . \_\_\_\_\_
- 32. Find the GCF of  $12x^3$  and  $18x^2$ . \_\_\_\_\_
- 33. Divide  $(x^2 + 5x + 6)$  by  $(x + 2)$ . \_\_\_\_\_
- 34. Find the remainder when  $x^2 - 1$  is divided by  $x - 3$ . \_\_\_\_\_
- 35. Zeros of  $(x - 5)(x + 1)$ . \_\_\_\_\_
- 36. Is  $x = 2$  a zero of  $x^2 - 4$ ? \_\_\_\_\_



## Answer Keys

- |                               |                                |
|-------------------------------|--------------------------------|
| 1. $3x^2(2x + 3)$             | 13. $4(3y^2 - 2y + 1)$         |
| 2. $5xy^3(3x - 5y)$           | 14. $(a + 5)(a^2 - 3)$         |
| 3. $4x(x^2 - 2x + 3)$         | 15. $6x^3(4x^2 + 3x - 5)$      |
| 4. $(x + 1)(3x - 5)$          | 16. $4x(x - 2)$                |
| 5. $4x^2y(2x^2y + 3xy^2 - 5)$ | 17. $5x^2(x^2 + 2)$            |
| 6. $(2x - 3)(7x + 5)$         | 18. $(2x - 1)(x^2 + 4)$        |
| 7. $6x^2y^2$                  | 19. $6x^2$                     |
| 8. $x^4$                      | 20. $6x^2(3x + 4)$             |
| 9. $6x^2(3x + 4)$             | 21. $6x^2(3x + 4)$ square feet |
| 10. $5a^2(2a^2 - 3a + 5)$     | 22. $6x^2$ cubic feet          |
| 11. $3xy(2x + 3y)$            | 23. $4xy$                      |
| 12. $x(x^2 - x + 1)$          | 24. $(2x - 3)(7x + 5)$         |

## Additional Practice Answers

- |                      |                  |
|----------------------|------------------|
| 25. $x^3 + 3x - 5$   | 31. $3x(2x + 3)$ |
| 26. 4                | 32. $6x^2$       |
| 27. $3x^2 - 2x + 3$  | 33. $x + 3$      |
| 28. $3x^2 - 4x + 7$  | 34. 8            |
| 29. $x^2 + x - 12$   | 35. $x = 5, -1$  |
| 30. $(x + 4)(x + 5)$ | 36. yes          |

**Additional Practice:** Answers for all numbered items, including the added practice, are shown in the grid above.

## Step-by-Step Explanations

- A careful way to see it:  $\gcd(6, 9) = 3$ . Smallest  $x$ -exponent: 2.  $\text{GCF} = 3x^2$ . Divide each term:  $6x^3/(3x^2) = 2x$ ,  $9x^2/(3x^2) = 3$ . So  $3x^2(2x + 3)$ . That gives a quick check on the answer.
- Keep the rule visible:  $\gcd(15, 25) = 5$ . Smallest  $x$ : 1. Smallest  $y$ : 3.  $\text{GCF} = 5xy^3$ . Divide:  $15x^2y^3/(5xy^3) = 3x$  and  $-25xy^4/(5xy^3) = -5y$ . That gives a quick check on the answer.
- One steady path is:  $\gcd(4, 8, 12) = 4$ . Smallest  $x$ : 1.  $\text{GCF} = 4x$ . Quotients:  $x^2, -2x, 3$ . That gives a quick check on the answer.
- Both terms share the binomial  $(x + 1)$ . Factor it out: the leftover from the first term is  $3x$  and from the second is  $-5$ . Result:  $(x + 1)(3x - 5)$ .
- A careful way to see it:  $\gcd(8, 12, 20) = 4$ . Smallest  $x$ : 2. Smallest  $y$ : 1.  $\text{GCF} = 4x^2y$ . Quotients:  $2x^2y, 3xy^2, -5$ . That gives a quick check on the answer.
- Keep the rule visible: Common binomial  $(2x - 3)$ : pull it out, leaving  $7x + 5$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Take  $\gcd$  of the coefficient column:  $\gcd(18, 30) = 6$ . For each variable take the *smaller* exponent:  $\min(4, 2) = 2$  for  $x$ ,  $\min(2, 5) = 2$  for  $y$ . So the  $\text{GCF}$  is  $6x^2y^2$ .
- Use the *smaller* exponent in the column:  $\min(4, 6) = 4$ , so the  $\text{GCF}$  is  $x^4$ . (The larger exponent would give the LCM,  $x^6$ .)
- Coefficient  $\text{GCF}$  is  $\gcd(18, 24) = 6$ ; the smaller power of  $x$  is 2, so the  $\text{GCF}$  is  $6x^2$ . Divide each term:  $18x^3/6x^2 = 3x$  and  $24x^2/6x^2 = 4$ , leaving  $(3x + 4)$ .
- Keep the rule visible:  $\gcd(10, 15, 25) = 5$  and the smallest  $a$ -power is 2, so  $\text{GCF} = 5a^2$ . Divide each term:  $10a^4/5a^2 = 2a^2$ ,  $-15a^3/5a^2 = -3a$ ,  $25a^2/5a^2 = 5$ . That gives a quick check on the answer.
- One steady path is:  $\gcd(6, 9) = 3$ ;  $x$  appears in both with smallest power 1, and so does  $y$ .  $\text{GCF} = 3xy$ . Dividing gives  $6x^2y/3xy = 2x$  and  $9xy^2/3xy = 3y$ . That gives a quick check on the answer.
- Start with the key idea:  $\text{GCF}$  is  $x$  (one factor of  $x$  in every term). Quotients:  $x^2, -x, 1$ . That gives a quick check on the answer.
- A careful way to see it:  $\gcd(12, 8, 4) = 4$ . No common variable factor (the

constant 4 has no  $y$ ).  $\text{GCF} = 4$ . Quotients:  $3y^2, -2y, 1$ . That gives a quick check on the answer.

- Both terms share the binomial  $(a + 5)$ , so treat it like a common factor. Pull it out front; what's left is  $a^2$  from the first term and  $-3$  from the second:  $(a + 5)(a^2 - 3)$ .
- One steady path is:  $\gcd(24, 18, 30) = 6$  and the smallest  $x$ -power is 3, so  $\text{GCF} = 6x^3$ . Divide each term:  $24x^5/6x^3 = 4x^2$ ,  $18x^4/6x^3 = 3x$ ,  $-30x^3/6x^3 = -5$ . That gives a quick check on the answer.
- Start with the key idea:  $\gcd(4, 8) = 4$  and the smaller  $x$ -power is 1, so  $\text{GCF} = 4x$ . Dividing gives  $4x^2/4x = x$  and  $-8x/4x = -2$ , leaving  $(x - 2)$ . That gives a quick check on the answer.
- A careful way to see it:  $\gcd(5, 10) = 5$  and the smaller  $x$ -power is 2, so  $\text{GCF} = 5x^2$ . Divide:  $5x^4/5x^2 = x^2$  and  $10x^2/5x^2 = 2$ . That gives a quick check on the answer.
- Each term carries the binomial  $(2x - 1)$ , so factor it out. The leftovers are  $x^2 + 4$ , giving  $(2x - 1)(x^2 + 4)$ .
- One steady path is:  $\gcd$  of the coefficient column is  $\gcd(12, 18, 30) = 6$ . The smallest power of  $x$  is  $\min(5, 3, 2) = 2$ . So the  $\text{GCF}$  is  $6x^2$ . That gives a quick check on the answer.
- Start with the key idea:  $\gcd(18, 24) = 6$ . Min  $x$ : 2.  $\text{GCF} = 6x^2$ , leaving  $3x + 4$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $\gcd(18, 24) = 6$  and the smaller  $x$ -exponent is 2.  $\text{GCF}$  is  $6x^2$ . Factored area:  $6x^2(3x + 4)$ . Possible dimensions:  $6x^2$  feet by  $(3x + 4)$  feet. That gives a quick check on the answer.
- This is the  $\text{GCF}$  of the three monomials.  $\gcd(12, 18, 30) = 6$ . Smallest  $x$ -exponent:  $\min(2, 3, 4) = 2$ . So  $\text{GCF} = 6x^2$ . (At  $x = 5$ , the  $\text{GCF}$  is 150, and the bins hold 300, 2250, and 18750 — all multiples of 150.)
- One steady path is:  $\gcd(8, 12) = 4$ . Smallest  $x$ :  $\min(2, 1) = 1$ . Smallest  $y$ :  $\min(1, 2) = 1$ .  $\text{GCF} = 4xy$ . That gives a quick check on the answer.
- Both terms contain the common binomial  $(2x - 3)$ . Factor it out:  $(2x - 3)(7x + 5)$ . (Quick check: expand back to  $14x^2 - 21x + 10x - 15 = 14x^2 - 11x - 15$ , which matches the original after distributing.)



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