

Factoring Polynomials with Patterns and Grouping

Grade 9 – Algebra 1 math · Worksheet Answer Key · Standards: A-SSE.A.2, A-SSE.B.3a

Each solution lists the numbers that fit, the split or grouping step and the final product in bold. When a factorization does not match yours, multiply it back out. Equal products mean both answers are correct, even if the factors appear in a different order.

Standards: A-SSE.A.2, A-SSE.B.3a · **Level:** Grade 9 Algebra 1

Problem 1 Take Out the GCF

The GCF of 12 and 18 is 6, and the lowest power of x is x^2 . Divide each term: $12x^3 \div 6x^2 = 2x$ and $18x^2 \div 6x^2 = 3$.

$$\mathbf{6x^2(2x + 3)}$$

Problem 2 GCF with Two Variables

GCF: 5, a and b , so $5ab$. Divide: $15a^2b \div 5ab = 3a$ and $20ab^2 \div 5ab = 4b$.

$$\mathbf{5ab(3a - 4b)}$$

Problem 3 Positive Trinomial

Need product 20 and sum 9: 4 and 5.

Check: $x^2 + 5x + 4x + 20 \checkmark$.

$$\mathbf{(x + 4)(x + 5)}$$

Problem 4 Trinomial with Negative Middle

Product +24 and sum -11 means both numbers are negative: -3 and -8 .

$$\mathbf{(x - 3)(x - 8)}$$

Problem 5 Negative Constant, Larger Positive

Product -35 means the signs differ. Sum $+2$: 7 and -5 .

$$(x + 7)(x - 5)$$

Problem 6 Negative Constant, Larger Negative

Product -54 , sum -3 : -9 and 6 .

Check: $x^2 + 6x - 9x - 54 = x^2 - 3x - 54 \checkmark$.

$$(x - 9)(x + 6)$$

Problem 7 Difference of Squares

$49m^2 = (7m)^2$ and $100 = 10^2$.

$$(7m + 10)(7m - 10)$$

Problem 8 Perfect Square Trinomials

a. x^2 and 8^2 ; middle term $2(x)(8) = 16x \checkmark$. So $(x + 8)^2$.

b. $(3y)^2$ and 5^2 ; middle term $-2(3y)(5) = -30y \checkmark$. So $(3y - 5)^2$.

$$(a) (x + 8)^2; (b) (3y - 5)^2$$

Problem 9 GCF Then Trinomial

Take out 3: $3(x^2 - 6x + 8)$. Then -2 and -4 give product 8 and sum -6 .

$$3(x - 2)(x - 4)$$

Problem 10 Leading Coefficient 2

$ac = 24$; the numbers 3 and 8 have sum 11 . Split: $2x^2 + 3x + 8x + 12$.

Group: $x(2x + 3) + 4(2x + 3)$.

	2x	3
x	2x²	3x
4	8x	12

$$2x^2 + 3x + 8x + 12 = (2x + 3)(x + 4)$$

$$(2x + 3)(x + 4)$$

Problem 11 Leading Coefficient 3

$ac = 24$ and the sum is -10 , so use -6 and -4 . Split: $3x^2 - 6x - 4x + 8$.

Group: $3x(x - 2) - 4(x - 2)$.

$$(3x - 4)(x - 2)$$

Problem 12 Mixed Signs with $a = 6$

$ac = -90$ and the sum is 1 , so use 10 and -9 . Split: $6x^2 + 10x - 9x - 15$.

Group: $2x(3x + 5) - 3(3x + 5)$.

$$(2x - 3)(3x + 5)$$

Problem 13 Grouping Four Terms

Group: $(x^3 + 5x^2) + (2x + 10) = x^2(x + 5) + 2(x + 5)$.

$$(x + 5)(x^2 + 2)$$

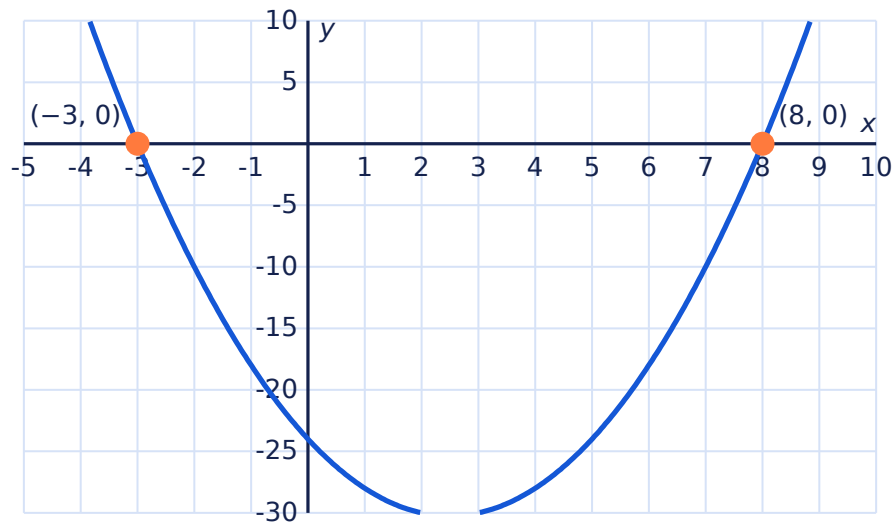
Problem 14 Grouping with Negatives

Group: $3x^2(2x - 3) + 2(2x - 3)$.

$$(2x - 3)(3x^2 + 2)$$

Problem 15 Solve by Factoring

Factor: $(x - 8)(x + 3) = 0$. Set each factor equal to zero: $x - 8 = 0$ or $x + 3 = 0$.



The zeros match the factors $(x - 8)(x + 3)$.

$x = 8$ or $x = -3$

Problem 16 Zeros of a Quadratic Function

$ac = -30$ and the sum is -7 , so use -10 and 3 . Split: $2x^2 - 10x + 3x - 15 = 2x(x - 5) + 3(x - 5) = (2x + 3)(x - 5)$.

$2x + 3 = 0$ gives $x = -\frac{3}{2}$; $x - 5 = 0$ gives $x = 5$.

$x = -\frac{3}{2}$ and $x = 5$

Problem 17 Missing Side of a Rectangle

Factor: $x^2 + 13x + 42 = (x + 6)(x + 7)$, so the length is $x + 7$.

For $x = 5$: width 11 feet and length 12 feet. Area $11 \times 12 = 132$, and $25 + 65 + 42 = 132 \checkmark$.

Length $x + 7$; 12 ft by 11 ft

Problem 18 Ball in the Air

Take out $-16t$: $-16t(t - 4)$.

Set equal to 0: $t = 0$ (thrown) or $t = 4$ (lands). The graph meets the ground at 0 and 4 seconds.

$-16t(t - 4)$; at ground level at 0 s and 4 s

Problem 19 Factor Completely, Two Rounds

Take out 2: $2(x^4 - 16)$. Then $x^4 - 16 = (x^2)^2 - 4^2 = (x^2 + 4)(x^2 - 4)$.

Factor again: $x^2 - 4 = (x + 2)(x - 2)$. The factor $x^2 + 4$ stays.

$$\mathbf{2(x^2 + 4)(x + 2)(x - 2)}$$

Problem 20 See the Structure

Treat $x + 3$ as one quantity: $u^2 - 5^2 = (u + 5)(u - 5)$ with $u = x + 3$.

$$(x + 3 + 5)(x + 3 - 5) = (x + 8)(x - 2).$$

Expand: $(x + 3)^2 - 25 = x^2 + 6x - 16$ and $(x + 8)(x - 2) = x^2 + 6x - 16$ ✓.

$$\mathbf{(x + 8)(x - 2)}$$