Factoring Trinomials

Name: ____________	Date: ____________	Score: ______ / 33

Quick Review

To **factor** a trinomial x^2+bx+c, find two numbers that multiply to c and add to b. If those numbers are p and q, then $x^2+bx+c = (x+p)(x+q)$. Sign rules: if $c > 0$, both numbers share the sign of b; if $c < 0$, they have opposite signs (the larger-magnitude number takes b's sign).

For $ax^2 + bx + c$ with $a \neq 1$, use the **AC method**. Multiply $a \cdot c$, find two numbers that multiply to ac and add to b, split the middle term, then factor by grouping. Quick check: $2x^2+7x+3$ has $ac = 6$, and $6 \cdot 1 = 6$ with $6+1 = 7$ works. Split: $2x^2+6x+x+3 = 2x(x+3)+1(x+3) = (x+3)(2x+1)$.

Special patterns short-cut the work:

- *Difference of squares:* $a^2 - b^2 = (a-b)(a+b)$. So $x^2 - 25 = (x-5)(x+5)$.
- *Perfect-square trinomials:* $a^2 \pm 2ab + b^2 = (a \pm b)^2$. Recognize this by checking that the first and last terms are squares and the middle is ± 2 times the product of their square roots.

Always check by FOILing your factors back out. And *factor out any common factor first* — $4x^3 - 12x^2 + 8x = 4x(x^2 - 3x + 2) = 4x(x-1)(x-2)$.

Some polynomials don't factor over the integers (like x^2+1 or x^2+x+1). When the discriminant $b^2 - 4ac < 0$, no real factor pair exists — the polynomial is irreducible over the reals.

PRACTICE

Factor each polynomial completely over the integers.

1. $x^2 + 7x + 12$ ________
2. $x^2 - 25$ ________
3. The table gives values of $P(x) = x^2 - 5x + 6$. Use the zeros you spot to factor $P(x)$. ________

x	0	1	2	3	4
$P(x)$	6	2	0	0	2

4. $2x^2 + 7x + 3$ ________
5. $4x^3 - 12x^2 + 8x$ ________
6. $x^3 + 2x^2 - 9x - 18$ ________
7. $x^4 - 13x^2 + 36$ ________
8. $x^2 + 8x + 15$ ________
9. $x^2 - 9x + 20$ ________
10. $x^2 + x - 12$ ________
11. The table gives values of $P(x) = x^2 - 2x - 15$. Use its zeros to factor $P(x)$. ________

x	-3	-1	1	3	5
$P(x)$	0	-12	-16	-12	0

12. $3x^2 + 10x + 8$ ________
13. $x^2 - 49$ ________
14. $x^2 + 10x + 25$ ________
15. $2x^2 - 5x - 3$ ________
16. $6x^3 - 15x^2 - 4x + 10$ ________

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17. $y^2 - y - 6$ ________

18. $x^2 + 12x + 36$ ________

19. The table gives values of $P(x) = 5x^2 - 20$. Use its zeros to factor $P(x)$ completely. ________

x	-2	-1	0	1	2
$P(x)$	0	-15	-20	-15	0

20. Factor completely: $x^3 + 2x^2 - 9x - 18$ ________

♦ Word Problems

21. A rectangle has area $x^2 + 9x + 20$ square feet. If its length is $(x + 5)$ feet, what is its width? Express your answer as a binomial. ____

22. A box's volume polynomial is $V(x) = x^3 - x^2 - 12x$. Factor it completely to identify three dimensions. ____

23. A quadratic model has zeros at $x = 4$ and $x = -2$ with leading coefficient 1. Write the model in factored form, then expand to standard form. ____

24. A square swimming pool has area $(x^2 - 8x + 16)$ square meters. Write a polynomial for its side length. ____

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 $(x + 2)$. ________

Answer Keys

1.	$(x+3)(x+4)$	**13.**	$(x-7)(x+7)$
2.	$(x-5)(x+5)$	**14.**	$(x+5)^2$
3.	$(x-2)(x-3)$	**15.**	$(2x+1)(x-3)$
4.	$(2x+1)(x+3)$	**16.**	$(2x-5)(3x^2-2)$
5.	$4x(x-1)(x-2)$	**17.**	$(y-3)(y+2)$
6.	$(x+2)(x-3)(x+3)$	**18.**	$(x+6)^2$
7.	$(x-2)(x+2)(x-3)(x+3)$	**19.**	$5(x-2)(x+2)$
8.	$(x+3)(x+5)$	**20.**	$(x+2)(x-3)(x+3)$
9.	$(x-4)(x-5)$	**21.**	$(x+4)$ feet
10.	$(x+4)(x-3)$	**22.**	$V(x)=x(x-4)(x+3)$
11.	$(x-5)(x+3)$	**23.**	$(x-4)(x+2)=x^2-2x-8$
12.	$(3x+4)(x+2)$	**24.**	$(x-4)$ meters

Additional Practice Answers

25.	x^3+3x-5	**30.**	$(x+4)(x+5)$
26.	4	**31.**	$3x(2x+3)$
27.	$3x^2-2x+3$	**32.**	$6x^2$
28.	$3x^2-4x+7$	**33.**	$x+3$
29.	x^2+x-12		

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

Step-by-Step Explanations

1. Find p,q with $pq=12$ and $p+q=7$. That's 3 and 4. So $x^2+7x+12=(x+3)(x+4)$. Check: $3\cdot 4=12$ ✓.

2. Keep the rule visible: Difference of squares: $x^2-5^2=(x-5)(x+5)$. This is the part to check before moving on, because it keeps the answer tied to the original question.

3. The table reads 0 at $x=2$ and $x=3$, so those are the zeros. A zero at $x=r$ means a factor $(x-r)$, giving $P(x)=(x-2)(x-3)$.

4. AC method: $ac=6$. Need two numbers multiplying to 6 and adding to 7: that's 6 and 1. Split: $2x^2+6x+x+3=2x(x+3)+1(x+3)=(x+3)(2x+1)$.

5. Pull out GCF $4x$: $4x(x^2-3x+2)$. Now factor the trinomial: $pq=2, p+q=-3$ gives $-1,-2$. So $4x(x-1)(x-2)$.

6. Group: $x^2(x+2)-9(x+2)=(x+2)(x^2-9)$. Then $x^2-9=(x-3)(x+3)$. Full factorization: $(x+2)(x-3)(x+3)$.

7. Treat as quadratic in x^2: factor $u^2-13u+36$ where $u=x^2$. Need $pq=36, p+q=-13$: $-4,-9$. So $(x^2-4)(x^2-9)$. Each piece is a difference of squares: $(x-2)(x+2)(x-3)(x+3)$.

8. Find two numbers multiplying to $c=15$ and adding to $b=8$. Since $c>0$ and $b>0$, both are positive: 3 and 5 ($3\cdot5=15, 3+5=8$). So $(x+3)(x+5)$.

9. Need $pq=20$ and $p+q=-9$. With $c>0$ and $b<0$, both numbers are negative: -4 and -5 ($(-4)(-5)=20, -4-5=-9$). So $(x-4)(x-5)$.

10. Keep the rule visible: $pq=-12, p+q=1$: 4 and -3. The larger-magnitude number (4) takes the sign of $b=+1$. That gives a quick check on the answer.

11. The table hits 0 at $x=-3$ and $x=5$. Each zero r gives a factor $(x-r)$: $(x+3)$ and $(x-5)$. So $P(x)=(x-5)(x+3)$.

12. Start with the key idea: $ac=24$. Need numbers with product 24, sum 10: 6 and 4. Split: $3x^2+6x+4x+8=3x(x+2)+4(x+2)=(x+2)(3x+4)$. That gives a quick check on the answer.

13. Both pieces are perfect squares: x^2 and $49=7^2$. Difference of squares $a^2-b^2=(a-b)(a+b)$ gives $(x-7)(x+7)$.

14. Perfect-square trinomial: $x^2+2(5)x+5^2=(x+5)^2$. Both the first and last terms are squares, and the middle is $2\cdot1\cdot5$.

15. One steady path is: $ac=-6$. Need product -6, sum -5: -6 and 1. Split: $2x^2-6x+x-3=2x(x-3)+1(x-3)=(x-3)(2x+1)$. That gives a quick check on the answer.

16. Group: $(6x^3-15x^2)+(-4x+10)=3x^2(2x-5)-2(2x-5)=(2x-5)(3x^2-2)$. The factor $3x^2-2$ doesn't split over integers.

17. Need $pq=-6$ and $p+q=-1$. Since $c<0$, the numbers have opposite signs; -3 and 2 work ($-3\cdot2=-6, -3+2=-1$). So $(y-3)(y+2)$.

18. First term x^2 and last term $36=6^2$ are squares, and the middle $12x=2\cdot6\cdot x$ matches $2ab$. That's the perfect-square pattern, so $(x+6)^2$.

19. The zeros are $x=-2$ and $x=2$. Pull the GCF 5 first: $5(x^2-4)$, then the difference of squares gives $5(x-2)(x+2)$, matching the zeros.

20. Start with the key idea: Group: $x^2(x+2)-9(x+2)=(x+2)(x^2-9)$. Then $(x^2-9)=(x-3)(x+3)$. That gives a quick check on the answer.

21. Width = area / length. Factor the area: $x^2+9x+20=(x+4)(x+5)$. Divide out $(x+5)$: width is $(x+4)$ feet. Quick check: $(x+4)(x+5)=x^2+5x+4x+20=x^2+9x+20$ ✓.

22. GCF first: $x(x^2-x-12)$. Now factor the trinomial: $pq=-12, p+q=-1$ gives $-4,3$. So $V(x)=x(x-4)(x+3)$. The three dimensions are x, $(x-4)$, and $(x+3)$. (For all three to be positive, we need $x>4$.)

23. Zeros at 4 and -2 mean $(x-4)$ and $(x+2)$ are factors. Multiplied: $(x-4)(x+2)=x^2+2x-4x-8=x^2-2x-8$. Quick check: $f(4)=16-8-8=0$ ✓ and $f(-2)=4+4-8=0$ ✓.

24. Recognize the perfect square: $x^2-8x+16=(x-4)^2$. The side length is therefore $(x-4)$ meters. (For the side to be positive, $x>4$.)

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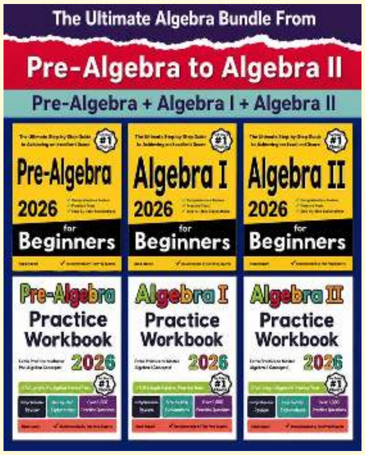

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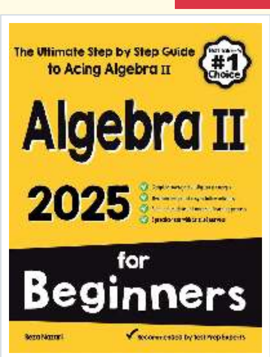

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