MATHEMATICS · GRADES 10-12

Factoring expressions with higher powers

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you simplify a formula with big powers so you can solve it. A formula for the volume of a box might have a power of three or four, and factoring it down makes the size findable. The same patterns you know for squares work here too, just with bigger powers. It is the step that makes a hard formula solvable.



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Worked examples

EXAMPLE 1

Q Factor $x^4 - 16$

SOLUTION

Write it as a difference of squares: $(x^2)^2 - (4)^2$

Factor: $(x^2 - 4)(x^2 + 4)$

Factor the first bracket again: $(x - 2)(x + 2)(x^2 + 4)$

EXAMPLE 2

Q Factor $x^4 - 5x^2 + 4$

SOLUTION

x^2 appears in every part, so for a moment give x^2 the short name u. Then the question becomes $u^2 - 5u + 4$, which factors as $(u - 1)(u - 4)$

Put x^2 back in place of u: $(x^2 - 1)(x^2 - 4)$

Factor both brackets: $(x - 1)(x + 1)(x - 2)(x + 2)$

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Practice questions

1 Factor $x^4 - 81$.

- **A** $(x - 3)(x + 3)(x^2 - 9)$
- **B** $(x - 3)(x + 3)(x^2 + 9)$
- **C** $(x - 9)(x + 9)$
- **D** $(x - 3)^2(x + 3)^2$

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2 Factor $x^4 - 10x^2 + 9$.

- **A** $(x - 1)(x + 1)(x - 3)(x + 3)$
- **B** $(x - 1)^2(x - 3)^2$
- **C** $(x - 3)(x + 3)(x^2 + 1)$
- **D** $(x - 9)(x + 9)(x^2 - 1)$

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3 Factor $x^6 - 1$ completely.

A $(x - 1)(x + 1)(x^4 + x^2 + 1)$

B $(x - 1)(x + 1)(x^4 - x^2 + 1)$

C $(x - 1)(x + 1)(x^2 + 1)$

D $(x - 1)^2(x + 1)^2$

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4 Factor $x^4 - 25$.

A $(x - 5)(x + 5)$

B $(x^2 - 5)^2$

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

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

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5 Factor $x^6 - 5x^3 + 6$ completely.

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

B $(x^3 - 1)(x^3 - 6)$

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

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

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6 Factor $x^8 - 16$ completely.

A $(x^2 - 2)(x^2 + 2)(x^4 + 4)$

B $(x - 2)(x + 2)(x^4 + 4)$

C $(x^4 - 4)(x^4 + 4)$

D $(x^2 - 4)(x^2 + 4)(x^4 + 4)$

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7 Write $x^4 - 8x^2 + 16$ as a product of factors.

A $(x - 4)^2(x + 4)^2$

B $(x - 2)(x + 2)(x^2 + 4)$

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

D $(x - 4)(x + 4)(x^2 + 4)$

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8 Factor $x^4 - 16x^2$ completely.

A $x^2(x - 4)(x + 4)$

B $x^2(x^2 - 16)$

C $x(x - 4)(x + 4)$

D $(x^2 - 4)(x^2 + 4)$

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9 Factor $x^4 + 2x^2 + 1$.

A $(x^2 + 1)^2$

B $(x - 1)^2(x + 1)^2$

C $(x^2 - 1)^2$

D $(x - 1)(x + 1)(x^2 + 1)$

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10 Factor $x^6 + 64$ completely.

A $(x^2 + 4)(x^4 - 4x^2 + 16)$

B $(x^2 - 4)(x^4 + 4x^2 + 16)$

C $(x - 2)(x + 2)(x^4 + 4x^2 + 16)$

D $(x^2 + 4)(x^4 + 4x^2 + 16)$

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ANSWER KEY

1. $(x - 3)(x + 3)(x^2 + 9)$

2. $(x - 1)(x + 1)(x - 3)(x + 3)$

3. $(x - 1)(x + 1)(x^4 + x^2 + 1)$

4. $(x^2 - 5)(x^2 + 5)$

5. $(x^3 - 2)(x^3 - 3)$

6. $(x^2 - 2)(x^2 + 2)(x^4 + 4)$

7. $(x - 2)^2(x + 2)^2$

8. $x^2(x - 4)(x + 4)$

9. $(x^2 + 1)^2$

10. $(x^2 + 4)(x^4 - 4x^2 + 16)$

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