MATHEMATICS · GRADES 10-12

Difference of cubes

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is a shortcut for working with a volume that is a cube with a cube taken out. Picture a box with a smaller cube-shaped compartment removed, and you need the volume that is left. The shortcut breaks that volume into simpler pieces you can multiply out. It saves you from expanding a long multiplication every time this shape shows up.



Rule

Difference of cubes: $a^3 - b^3 = (a - b) \times (a^2 + ab + b^2)$.

Write each term as a cube, then use the pattern with those two numbers. The pattern works for any a and b.

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Worked examples

EXAMPLE 1

Q Factor $x^3 - 27$

SOLUTION

Write each term as a cube: x^3 is $(x)^3$ and 27 is $(3)^3$

Put a = x and b = 3 into the pattern $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$: the first bracket is $(x - 3)$, and in the second bracket a^2 is x^2, ab is $3x$, and b^2 is 9.

Write the result: $(x - 3)(x^2 + 3x + 9)$

EXAMPLE 2

Q Factor $8x^3 - 125$

SOLUTION

Write each term as a cube: $8x^3$ is $(2x)^3$ and 125 is $(5)^3$

Put a = 2x and b = 5 into the pattern: the first bracket is $(2x - 5)$, and in the second bracket a^2 is $4x^2$, ab is $10x$, and b^2 is 25.

Write the result: $(2x - 5)(4x^2 + 10x + 25)$

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Practice questions

1 Factor $x^3 - 8$

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

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

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

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

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2 Factor $x^3 - 64$

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

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

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

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

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3 Factor $27x^3 - 1$

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

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

C $(3x + 1)(9x^2 + 3x + 1)$

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

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4 Factor $x^3 - 125$

A $(x + 5)(x^2 + 5x + 25)$

B $(x - 5)(x^2 - 5x + 25)$

C $(x - 5)(x^2 + 5x + 25)$

D $(x - 5)(x^2 + 5x - 25)$

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5 Factor $8x^3 - 27$

A $(2x - 3)(4x^2 + 6x + 9)$

B $(2x - 3)(4x^2 - 6x + 9)$

C $(2x + 3)(4x^2 + 6x + 9)$

D $(2x - 3)(4x^2 + 6x - 9)$

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6 Factor $x^3 - 216$.

A $(x - 6)(x^2 + 6x + 36)$

B $(x - 6)(x^2 - 6x + 36)$

C $(x + 6)(x^2 + 6x + 36)$

D $(x - 6)(x^2 + 6x - 36)$

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7 **The factored form is $(x - 5)(x^2 + 5x + 25)$. What was the original expression?**

- **A** $x^3 - 125$
- **B** $x^3 - 25$
- **C** $x^3 + 125$
- **D** $x^3 - 625$

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8 **Why is the second bracket in $(x - 2)(x^2 + 2x + 4)$ not factorable over the real numbers?**

- **A** It factors as $(x - 2)(x + 2)$.
- **B** Its discriminant is 4 - 16, which is negative, so it has no real factors
- **C** Its discriminant is 4 + 16, which is positive, so it factors.
- **D** It has a repeated factor, so it factors as $(x + 2)^2$.

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9 Which difference of cubes has the factor $(x - 4)$?

- **A** $x^3 - 8$
- **B** $x^3 - 27$
- **C** $x^3 - 64$
- **D** $x^3 - 125$

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10 Which one is not a difference of cubes?

- **A** $x^3 - 8$
- **B** $x^3 - 27$
- **C** $x^3 - 64$
- **D** $x^3 - 100$

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ANSWER KEY

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

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

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

4. $(x - 5)(x^2 + 5x + 25)$

5. $(2x - 3)(4x^2 + 6x + 9)$

6. $(x - 6)(x^2 + 6x + 36)$

7. $x^3 - 125$

8. Its discriminant is 4 - 16, which is negative, so it has no real factors

9. $x^3 - 64$

10. $x^3 - 100$

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