MATHEMATICS · GRADES 10-12

Binomial theorem

Difficulty level: Advanced

Mathematics: Grades 10-12

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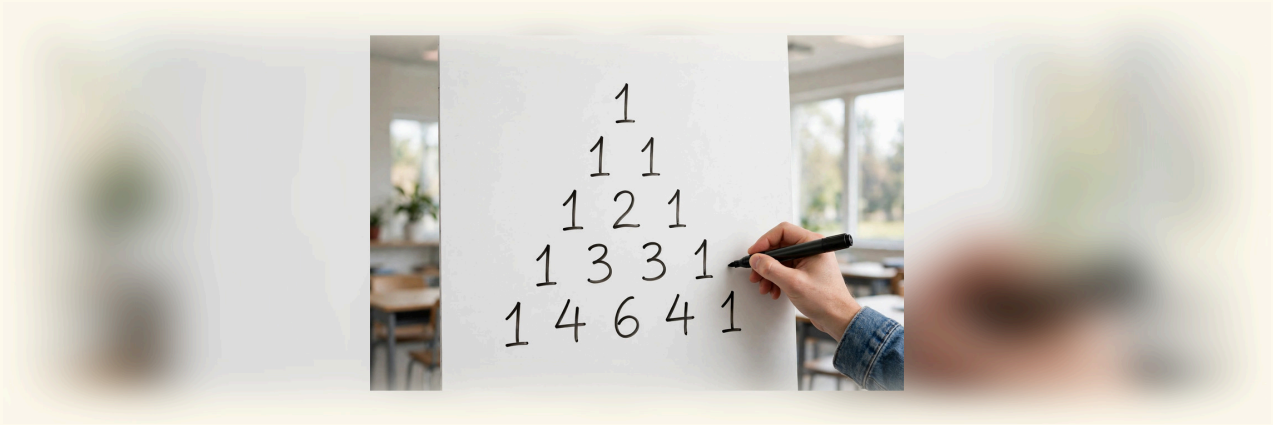
Overview of the concept

This is how you expand a two-part expression raised to a power without multiplying it out over and over. Scientists and engineers use this shortcut when a formula repeats the same two parts, because multiplying it all out by hand would take far too long. The theorem gives you each term directly, so a big expansion becomes a quick calculation.



Rule

Binomial theorem: $(a + b)$ raised^n expands into $n + 1$ terms.

The coefficients come from Pascal's triangle, the powers of a fall from n to 0, and the powers of b rise from 0 to n.

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Worked examples

EXAMPLE 1

Q Expand $(x + 1)^2$ using the binomial theorem.

SOLUTION

Coefficients for power 2 are 1, 2, 1.

Terms: x^2, $2 \times x \times 1$, 1^2

The result is $x^2 + 2x + 1$.

EXAMPLE 2

Q Expand $(x + 2)^2$.

SOLUTION

Coefficients for power 2 are 1, 2, 1.

Terms: x^2, $2 \times x \times 2$, 2^2

The result is $x^2 + 4x + 4$.

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Practice questions

1 Expand $(x + 1)^3$, first term?

- A $3x^2$
- B x^3
- C $3x$
- D 1

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2 Expand $(a + b)^2$

- A $a^2 + b^2$
- B $a^2 + 2ab + b^2$
- C $a^2 - 2ab + b^2$
- D $2a^2 + 2b^2$

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3 How many terms does $(x + y)^4$ have?

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4 Expand $(x + 3)^2$

A $x^2 + 3x + 9$

B $x^2 + 6x + 9$

C $x^2 + 6x + 3$

D $x^2 - 6x + 9$

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5 What are the coefficients for the power of 3?

A 1, 2, 1

B 1, 3, 3, 1

C 1, 4, 6, 4, 1

D 1, 3, 3

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6 Expand $(2x + 1)^2$

A $4x^2 + 2x + 1$

B $2x^2 + 4x + 1$

C $4x^2 + 4x + 1$

D $4x^2 + 4x + 4$

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7 Expand $(x - 1)^2$

A $x^2 + 2x + 1$

B $x^2 - 2x + 1$

C $x^2 - 2x - 1$

D $x^2 + 1$

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8 What are the coefficients for the power of 4?

A 1, 3, 3, 1

B 1, 4, 6, 4, 1

C 1, 5, 10, 10, 5, 1

D 1, 4, 4, 1

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9 **Expand $(x + y)^3$, fully.**

- **A** $x^3 + 3x^2 y + 3x y^2 + y^3$
- **B** $x^3 + 3x y^2 + y^3$
- **C** $x^3 + 2x^2 y + 2x y^2 + y^3$
- **D** $x^3 + y^3$

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10 **Expand $(x + 1)^4$, middle term only.**

- **A** $4x^3$
- **B** $6x^2$
- **C** $4x$
- **D** x^4

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ANSWER KEY

1. x^3

2. $a^2 + 2ab + b^2$

3. 5

4. $x^2 + 6x + 9$

5. 1, 3, 3, 1

6. $4x^2 + 4x + 1$

7. $x^2 - 2x + 1$

8. 1, 4, 6, 4, 1

9. $x^3 + 3x^2 y + 3x y^2 + y^3$

10. $6x^2$

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