MATHEMATICS · GRADES 10-12

Permutations

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you count the ways to pick a first, second, and third place winner, a password order, or a starting lineup where the order matters. A race with ten runners has a different result for every order the top three finish in, and a four digit password changes completely when two digits swap places. A coach choosing a batting order faces the same count, since who bats first changes the lineup. Whenever the order changes the outcome, this is the count you need.



Rule

A permutation counts arrangements where order matters.

To arrange r items chosen from n, multiply n by the next smaller numbers, using one factor for each place to fill. P(n, r) is n × (n - 1)(n - 2), and so on for r factors.

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Worked examples

EXAMPLE 1

Q How many ways can 3 runners finish first, second, third?

SOLUTION

First place: 3 choices

Second place: 2 remaining choices, third place: 1

Multiply: $3 \times 2 \times 1 = 6$ ways

EXAMPLE 2

Q Find P(5, 2), the number of ways to pick and order 2 out of 5.

SOLUTION

Formula: $P(5, 2) = 5 \times 4$

Only two factors, because you pick two places.

$P(5, 2) = 20$

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Practice questions

1. A race has 4 runners and medals for first and second. How many ways can the medals be given out? Give the answer as P(4, 2).

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2. Six friends take turns being captain and vice-captain. How many ways can the two jobs be filled? Give the answer as P(6, 2).

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3. Four books go on a shelf, one in each spot. How many different orders can 4 books be put in?

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4 A club picks a president, secretary, and treasurer from 5 members. How many ways? Give the answer as P(5, 3).

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5 A teacher picks 3 students for 3 different jobs. Why is this a permutation and not a combination?

- **A** When order matters
- **B** When order does not matter
- **C** When repeats are allowed
- **D** When only one student is picked

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6 A lottery draws 2 balls in order from 7. How many ways can the draw come out? Give the answer as P(7, 2).

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7 A spy needs a 2-letter code with no repeats from 26 letters. How many codes can she make? Give the answer as P(26, 2).

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8 A spinner picks 1 winner from 8 players. How many ways can it come out? Give the answer as P(8, 1).

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9 Five friends line up for a photo. How many different lines can they make?

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10 A safe uses a 3-digit code with no repeats from 10 digits. How many codes are possible? Give the answer as P(10, 3).

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ANSWER KEY

1. 12

2. 30

3. 24

4. 60

5. When order matters

6. 42

7. 650

8. 8

9. 120

10. 720

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