Counting Principle and Permutations

Explore ideas and representations

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QUICK REVIEW

The counting principle multiplies the choices at successive stages: 3 shirts and 4 hats give $3 \cdot 4 = 12$ outfits. A permutation assigns distinct positions, so choosing a captain and deputy from 5 people gives $5 \cdot 4 = 20$. An unordered pair is a combination: divide by its 2 orders to get $20/2 = 10$. State whether reuse is allowed.

Worked example

Example for form 1: assign two distinct roles to different people from a group of 5.

1. The positions are distinct, so order matters. Without reuse, the choice counts are $5, 4$ for the successive positions.

2. Multiply: $5 \cdot 4 = 20$. Swapping two selected people or objects changes their positions, so do not divide by the number of reorderings.

Answer: 20 arrangements.

Practice Problems

Show your thinking.

1. Choose one of 3 shirts and one of 4 hats. How many outfits?

2. A menu offers 2 soups, 3 sandwiches, and 2 drinks. Choose one of each. Count meals.

3. From 5 students, assign captain and deputy to different students. Count assignments.

4. From 5 students, choose an unranked two-person team. Count teams.

5. A 3-symbol code uses A, B, C, D with repetition allowed. Count codes.

6. A 3-symbol code uses 6 distinct symbols with no repetition. Count codes.

7. Arrange all 4 distinct books in a row. Count orders.

8. Choose 3 pizza toppings from 5 types, with no repeats and order ignored. Count choices.

9. Choose a route using 2 first-leg paths and then 5 second-leg paths. All pairs work. Count routes.

10. Compare selecting two unranked helpers from 4 people with assigning first and second prizes to two different people from the same four people.

Answer Key

1. 12 outcomes.
2. 12 outcomes.
3. 20 arrangements.
4. 10 selections.
5. 64 outcomes.
6. 120 arrangements.
7. 24 arrangements.
8. 10 selections.
9. 10 outcomes.
10. 6 helper pairs; 12 prize assignments.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. For each of the 3 shirts, any of 4 hats is allowed. An outfit is a shirt-hat pair, so each shirt begins four complete choices.

2. Multiply the number of choices at the successive stages: $3 \cdot 4 = 12$. Each complete outcome uses one choice at every stage, so addition would count only separate choices, not completed outcomes.

Problem 2

1. The first stage has 2 soup choices, the second has 3 sandwich choices, and the third has 2 drink choices. All listed combinations are allowed.

2. Multiply the number of choices at the successive stages: $2 \cdot 3 \cdot 2 = 12$. Each complete outcome uses one choice at every stage, so addition would count only separate choices, not completed outcomes.

Problem 3

1. The positions are distinct, so order matters. Without reuse, the choice counts are $5, 4$ for the successive positions.

2. Multiply: $5 \cdot 4 = 20$. Swapping two selected people or objects changes their positions, so do not divide by the number of reorderings.

Problem 4

1. Counting ordered choices first gives $5 \cdot 4 = 20$. But each selected group appears in $2! = 2$ different orders.

2. Order is irrelevant here, so divide out those repeats: $20/2 = 10$. This is a combination, not an assignment to distinct positions.

Problem 5

1. Each of the three positions has 4 choices. Reusing a letter is permitted, so choosing the first symbol does not reduce later choice counts.

2. Multiply the number of choices at the successive stages: $4 \cdot 4 \cdot 4 = 64$. Each complete outcome uses one choice at every stage, so addition would count only separate choices, not completed outcomes.

Problem 6

1. The positions are distinct, so order matters. Without reuse, the choice counts are $6, 5, 4$ for the successive positions.

2. Multiply: $6 \cdot 5 \cdot 4 = 120$. Swapping two selected people or objects changes their positions, so do not divide by the number of reorderings.

Problem 7

1. The positions are distinct, so order matters. Without reuse, the choice counts are $4, 3, 2, 1$ for the successive positions.

2. Multiply: $4 \cdot 3 \cdot 2 \cdot 1 = 24$. Swapping two selected people or objects changes their positions, so do not divide by the number of reorderings.

Problem 8

1. Counting ordered choices first gives $5 \cdot 4 \cdot 3 = 60$. But each selected group appears in $3! = 6$ different orders.

2. Order is irrelevant here, so divide out those repeats: $60/6 = 10$. This is a combination, not an assignment to distinct positions.

Problem 9

1. A complete route consists of one first-leg path followed by one second-leg path. Each of the 2 first-leg choices permits all 5 second-leg choices.

2. Multiply the number of choices at the successive stages: $2 \cdot 5 = 10$. Each complete outcome uses one choice at every stage, so addition would count only separate choices, not completed outcomes.

Problem 10

1. Ranked prizes use $4(3) = 12$ assignments because first and second are different positions. The same person cannot receive both prizes.

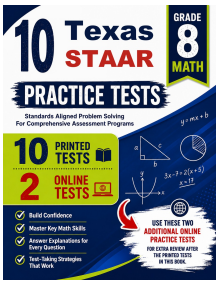
2. Unranked pairs ignore the two orders of each pair, so $12/2 = 6$. Order matters for prizes but not for the helper group.

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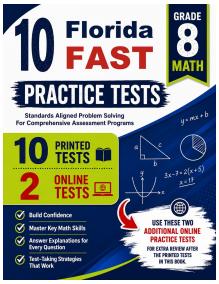
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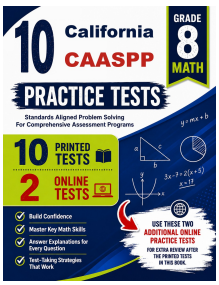
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