

# Permutations and Combinations

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 18

## Quick Review and Helpful Hints

A *permutation* counts arrangements where order matters:  ${}_n P_r = \frac{n!}{(n-r)!}$ . A *combination* counts selections where order does *not* matter:  ${}_n C_r = \frac{n!}{r!(n-r)!}$ . Remember that  $n!$  (factorial) means multiply every whole number from  $n$  down to 1.

▶ **Example:** In how many ways can you arrange 3 of 5 books on a shelf (order matters)? **Work:** Order matters, so use a permutation:  ${}_5 P_3 = \frac{5!}{(5-3)!} = \frac{5!}{2!} = \frac{120}{2}$ . ★ **Answer:** 60

### ◆ Practice Problems

Evaluate each expression.

- |                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. <math>4!</math> _____</p> <p>2. <math>5!</math> _____</p> <p>3. <math>3!</math> _____</p> <p>4. <math>{}_5 P_2</math> _____</p> <p>5. <math>{}_6 P_3</math> _____</p> <p>6. <math>{}_4 P_4</math> _____</p> <p>7. <math>{}_5 C_2</math> _____</p> | <p>8. <math>{}_6 C_2</math> _____</p> <p>9. <math>{}_7 C_3</math> _____</p> <p>10. <math>{}_4 C_1</math> _____</p> <p>11. <math>{}_6 P_2</math> _____</p> <p>12. <math>{}_5 C_5</math> _____</p> <p>13. <math>{}_8 C_2</math> _____</p> <p>14. <math>{}_7 P_2</math> _____</p> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### ◆ Word Problems

15. In how many ways can a president and a vice-president be chosen from a club of 6 members (order matters)? \_\_\_\_\_
16. How many ways can you choose 2 toppings from 5 available toppings (order does not matter)? \_\_\_\_\_
17. How many different 3-letter arrangements can be made from the letters A, B, C, D with no repeats (order matters)? \_\_\_\_\_
18. A team of 3 is chosen from 8 players (order does not matter). How many different teams are possible? \_\_\_\_\_



## Answer Keys

- |                                     |                                     |                                     |
|-------------------------------------|-------------------------------------|-------------------------------------|
| 1. <input type="text" value="24"/>  | 7. <input type="text" value="10"/>  | 13. <input type="text" value="28"/> |
| 2. <input type="text" value="120"/> | 8. <input type="text" value="15"/>  | 14. <input type="text" value="42"/> |
| 3. <input type="text" value="6"/>   | 9. <input type="text" value="35"/>  | 15. <input type="text" value="30"/> |
| 4. <input type="text" value="20"/>  | 10. <input type="text" value="4"/>  | 16. <input type="text" value="10"/> |
| 5. <input type="text" value="120"/> | 11. <input type="text" value="30"/> | 17. <input type="text" value="24"/> |
| 6. <input type="text" value="24"/>  | 12. <input type="text" value="1"/>  | 18. <input type="text" value="56"/> |

### Step-by-Step Explanations

**1.** Start by naming the process: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is A factorial multiplies down to 1:  $4! = 4 \times 3 \times 2 \times 1 = 24$ . So the final answer is 24.

**2.** A good way to think about this is: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$ . So the final answer is 120.

**3.** Step by step: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  $3! = 3 \times 2 \times 1 = 6$ . So the final answer is 6.

**4.** Take it one move at a time: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is Permutations count ordered choices:  ${}_5P_2 = 5 \times 4 = 20$ . So the final answer is 20.

**5.** Start by naming the process: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_6P_3 = 6 \times 5 \times 4 = 120$ . So the final answer is 120.

**6.** A good way to think about this is: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_4P_4 = 4! = 24$  – every arrangement of all four items. So the final answer is 24.

**7.** Step by step: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is Combinations ignore order:  ${}_5C_2 = \frac{5 \times 4}{2 \times 1} = 10$ . So the final answer is 10.

**8.** Take it one move at a time: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_6C_2 = \frac{6 \times 5}{2} = 15$ . So the final answer is 15.

**9.** Start by naming the process: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_7C_3 = \frac{7 \times 6 \times 5}{3 \times 2 \times 1} = 35$ . So the final answer is 35.

**10.** A good way to think about this is: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is Choosing 1 from 4 can be done in 4 ways. So the final answer is 4.

**11.** Step by step: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_6P_2 = 6 \times 5 = 30$ . So the final answer is 30.

**12.** Take it one move at a time: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is There is exactly one way to choose all 5, so  ${}_5C_5 = 1$ . So the final answer is 1.

**13.** Start by naming the process: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_8C_2 = \frac{8 \times 7}{2} = 28$ . So the final answer is 28.

**14.** A good way to think about this is: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is  ${}_7P_2 = 7 \times 6 = 42$ . So the final answer is 42.

**15.** Step by step: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is Order matters (president vs. vice-president), so  ${}_6P_2 = 6 \times 5 = 30$ . So the final answer is 30.

**16.** Take it one move at a time: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is Order doesn't matter for toppings, so  ${}_5C_2 = \frac{5 \times 4}{2} = 10$ . So the final answer is 10.

**17.** Start by naming the process: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is Arrangements care about order:  ${}_4P_3 = 4 \times 3 \times 2 = 24$ . So the final answer is 24.

**18.** A good way to think about this is: Decide whether order matters, then use the counting rule, permutation rule, or combination rule that fits. The setup/work is A team ignores order, so  ${}_8C_3 = \frac{8 \times 7 \times 6}{3 \times 2 \times 1} = 56$ . So the final answer is 56.



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