Counting Principle and Permutations

Name: _____	Date: _____	Score: _____ / 24

Quick Review

The **Fundamental Counting Principle** says: if one choice can happen in m ways and a second *independent* choice in n ways, then together they can happen in $m \times n$ ways — just multiply the options at each step. A **permutation** is an arrangement where *order matters*. The number of ways to arrange all n different items is $n! = n \times (n-1) \times \cdots \times 2 \times 1$ (read "n factorial"). To arrange r of n items, use $P(n,r) = \dfrac{n!}{(n-r)!}$, which is the product of the first r factors counting down from n. Remember $0! = 1$.

◇ **Example:** A deli offers 3 breads, 4 fillings, and 2 sauces. How many different sandwiches are possible? Also, in how many orders can 5 friends line up?

⇒ For the sandwich, use the counting principle: multiply the choices at each step. 3 breads $\times$ 4 fillings $\times$ 2 sauces $= 24$ sandwiches. For the line-up, order matters and we are arranging all 5 friends, so we use a factorial: $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$ different orders. Notice how fast the factorial grows — arrangements pile up quickly!

Answer: 24 sandwiches, 120 line-ups

PRACTICE

Use the counting principle or permutations. Give a whole-number answer.

1. 3×4 _____

2. $2 \times 3 \times 5$ _____

3. $3 \times 4 \times 2$ _____

4. $4 \times 4 \times 4$ _____

5. 5×6 _____

6. $3!$ _____

7. $4!$ _____

8. $5!$ _____

9. $6!$ _____

10. $7!$ _____

11. $P(4,2)$ _____

12. $P(5,2)$ _____

13. $P(5,3)$ _____

14. $P(6,2)$ _____

15. $P(6,3)$ _____

16. $P(7,2)$ _____

17. $P(7,3)$ _____

18. $P(8,2)$ _____

19. $P(8,3)$ _____

20. $P(10,3)$ _____

♦ Word Problems

21. A school uniform has 3 shirt colors, 2 pant colors, and 4 shoe styles. How many different uniform combinations are possible?

_____

22. Six runners finish a race. In how many different orders can they cross the finish line (no ties)? _____

23. A club of 8 members must choose a president and a vice president (different people). How many ways can this be done?

_____

24. A lock code uses 4 digits, and each digit can be 0 through 9, with repeats allowed. How many codes are possible? _____

Answer Keys

1. $\boxed{12}$	**13.** $\boxed{60}$
2. $\boxed{30}$	**14.** $\boxed{30}$
3. $\boxed{24}$	**15.** $\boxed{120}$
4. $\boxed{64}$	**16.** $\boxed{42}$
5. $\boxed{30}$	**17.** $\boxed{210}$
6. $\boxed{6}$	**18.** $\boxed{56}$
7. $\boxed{24}$	**19.** $\boxed{336}$
8. $\boxed{120}$	**20.** $\boxed{720}$
9. $\boxed{720}$	**21.** $\boxed{3 \times 2 \times 4 = 24 \text{ combinations}}$
10. $\boxed{5040}$	**22.** $\boxed{6! = 720 \text{ orders}}$
11. $\boxed{12}$	**23.** $\boxed{P(8,2) = 8 \times 7 = 56 \text{ ways}}$
12. $\boxed{20}$	**24.** $\boxed{10 \times 10 \times 10 \times 10 = 10{,}000 \text{ codes}}$

Step-by-Step Explanations

1. Counting principle: 3 choices then 4 choices give $3 \times 4 = 12$.
2. Multiply the options at each step: $2 \times 3 \times 5 = 30$.
3. Multiply across all three stages: $3 \times 4 \times 2 = 24$.
4. Four options at each of three stages: $4 \times 4 \times 4 = 64$.
5. Two independent choices: $5 \times 6 = 30$ combinations.
6. $3! = 3 \times 2 \times 1 = 6$.
7. $4! = 4 \times 3 \times 2 \times 1 = 24$.
8. $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$.
9. $6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720$.
10. $7! = 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 5040$.
11. $P(4,2) = 4 \times 3 = 12$ (the first 2 factors counting down from 4).
12. $P(5,2) = 5 \times 4 = 20$.
13. $P(5,3) = 5 \times 4 \times 3 = 60$.
14. $P(6,2) = 6 \times 5 = 30$.
15. $P(6,3) = 6 \times 5 \times 4 = 120$.
16. $P(7,2) = 7 \times 6 = 42$.
17. $P(7,3) = 7 \times 6 \times 5 = 210$.
18. $P(8,2) = 8 \times 7 = 56$.
19. $P(8,3) = 8 \times 7 \times 6 = 336$.
20. $P(10,3) = 10 \times 9 \times 8 = 720$.
21. By the counting principle, multiply the choices at each step: $3 \times 2 \times 4 = 24$ different uniforms.
22. All 6 runners are being arranged and order matters, so it is $6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720$ possible finishing orders.
23. Order matters — president and vice president are different roles — so use $P(8,2) = 8 \times 7 = 56$ ways.
24. Each of the 4 positions has 10 choices and repeats are allowed, so by the counting principle there are $10^4 = 10{,}000$ codes.

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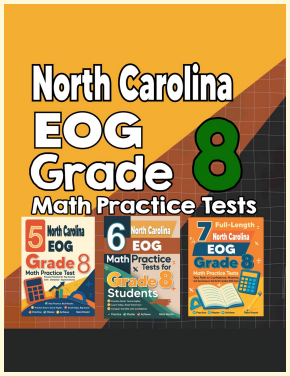

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