11-1 Permutations and Combinations

Vocabulary

Review

1. Circle each word whose meaning is similar to that of *fundamental*.

basic essential extra necessary secondary unimportant

Vocabulary Builder

permutation (noun) **pur myoo TAY shun**

Related Word: combination (noun)

Definition: A **permutation** is an arrangement of items in a particular order.

Main Idea: When you put a set of objects in a certain order, you make a **permutation**.

set of numbers 5, 7, 11, 8
permutation 11, 7, 8, 5

Use Your Vocabulary

2. Write a *permutation* of each set.

⊃, ∩, ⊂, ∪ A, W, 6, 7, 2, E, V y, o, U, R

3. Write all possible *permutations* of the numbers 5, 9, and 8.

4. There are _____ *permutations* of the numbers 5, 9, and 8.

Problem 1 Using the Fundamental Counting Principle

Got It? **In 1966, one type of Maryland license plate had two letters followed by four digits. How many of this type of plate were possible?**

5. **Multiple Choice** Which set of letters and digits gives a possible 1966 Maryland license plate?

(A) TV 432 (B) RC 2301 (C) KPH 621 (D) OMNQ 23

6. There are ____ possible letters for each letter in the license plate.

There are ____ possible digits for each digit.

7. Use the Fundamental Counting Principle to find the number of possible license plates. Complete the expression.

$26 \cdot \_\_ \cdot \_\_ \cdot \_\_ \cdot \_\_ \cdot \_\_$

8. Circle the number of possible 1966 Maryland license plates.

26,000	45,697,600	6,760,000

Using *factorial* notation, you can write $3 \cdot 2 \cdot 1$ as 3!, read "three factorial." For any positive integer n, ***n factorial*** is $n! = n(n-1) \cdot \ldots \cdot 3 \cdot 2 \cdot 1$. The zero factorial is $0! = 1$.

Problem 2 Finding the Number of Permutations of *n* Items

Got It? **In how many ways can you arrange 8 shirts on hangers in a closet?**

9. Complete the model below.

number of ways to arrange the

	1st shirt	2nd shirt	3rd shirt	4th shirt	5th shirt	6th shirt	7th shirt	8th shirt
Relate								
Write	8	7						

10. The total number of permutations is

$8! = 8 \cdot \_\_ \cdot 6 \cdot \_\_ \cdot 4 \cdot \_\_ \cdot 2 \cdot 1 = \_\_$

take note

Key Concept Number of Permutations

The number of permutations of n items of a set arranged r items at a time is

$$ {}_nP_r = \frac{n!}{(n-r)!} \text{ for } 0 \le r \le n.$$

Example: ${}_{10}P_4 = \frac{10!}{6!} = 5040$

11. Why can't r be greater than n?

_____

_____

_____

Problem 3 Finding ${}_nP_r$

Got It? **In how many ways can 15 runners finish first, second, and third?**

12. Use the permutation formula. Circle the value of n, the number of runners in the set. Underline the value of r, the number of runners arranged at a time.

1	2	3	15

13. Use the justifications at the right to find the number of ways in which 15 runners can finish first, second, and third.

$${}_nP_r = \frac{n!}{(n-r)!}$$ Write the formula.

$$= \frac{\square!}{(\square - \square)!}$$ Substitute n and r.

$$= \frac{\square!}{\square!} = \square$$ Simplify.

take note

Key Concept Number of Combinations

The number of combinations of n items of a set chosen r items at a time is

$${}_nC_r = \frac{n!}{r!(n-r)!} \text{ for } 0 \le r \le n$$

Example: ${}_5C_3 = \frac{5!}{3!(5-3)!} = \frac{5!}{3! \cdot 2!} = \frac{120}{6 \cdot 2} = 10$

14. Which is greater, ${}_5C_3$ or ${}_5P_3$? Explain.

Problem 4 Finding ${}_nC_r$

Got It? **What is the value of ${}_8C_3$?**

15. Cross out the equations that do NOT give the correct formula for ${}_8C_3$.

$${}_8C_3 = \frac{8!}{3!(8-3)!} \qquad {}_8C_3 = 8! \qquad {}_8C_3 = \frac{8!}{(8-3)!}$$

16. Simplify the remaining equation from Exercise 15.

Problem 5 Identifying Whether Order Is Important

Got It? **A chemistry teacher has a class work in groups to draw the molecular structure of water. Each group submits one drawing. There are eight groups. The teacher selects the four drawings that earn the highest grades. In how many ways can he select and arrange the four drawings from left to right on the wall?**

17. Circle the formula you will use to solve this problem.

$${}_nC_r = \frac{n!}{r!(n-r)!} \qquad {}_nP_r = \frac{n!}{(n-r)!}$$

18. Identify each value.

$n =$ $\qquad$ $r =$

19. In how many different ways can the teacher select and arrange the drawings?

Lesson Check • Do you UNDERSTAND?

Reasoning **Use the definition of permutation to show why 0! should equal 1.**

20. Circle the equation that shows the Fundamental Counting Principle and the Permutation Formula for n items arranged n at a time.

$$0! = \frac{n!}{(n-0)!} \qquad n! = \frac{n!}{(n-n)!} \qquad n! = \frac{n!}{(n-0)!}$$

21. Simplify the equation you chose in Exercise 20.

22. Underline the correct expressions to complete the sentence.

For $\frac{n!}{0!}$ to equal 0! / $n!$, 0! must equal 0 / 1.

Math Success

Check off the vocabulary words that you understand.

☐ Fundamental Counting Principle ☐ permutation ☐ n factorial ☐ combination

Rate how well you can *find permutations and combinations.*

Need to review 0 2 4 6 8 10 Now I get it!