

# 11.1 - Permutations and Combinations

**LICENSE PLATES** The standard configuration for a Texas license plate is 1 letter followed by 2 digits followed by 3 letters.



- a. How many different license plates are possible if letters and digits can be repeated?
- b. How many different license plates are possible if letters and digits cannot be repeated?

a)  $26 \cdot 10 \cdot 10 \cdot 26 \cdot 26 \cdot 26$

b)  $26 \cdot 10 \cdot 9 \cdot 25 \cdot 24 \cdot 23$

32,292,000

45,697,600

# Using the *Fundamental Counting Principle*

sometimes we can use counting  
and multiplication to answer questions. . .

**1.** How many 2-letter pairs of 1 vowel and 1 consonant can you make from the English alphabet? Consider “y” to be a consonant.

$$5 \cdot 21 = 105$$

**2.** An ice cream shop offers 33 flavors of ice cream and 7 toppings. How many different sundaes can the shop make using 1 flavor and 1 topping?

$$33 \cdot 7 = 231$$

**3.** A contest winner gets to choose 1 of 8 possible vacations and bring 1 of 10 friends with her. How many different ways could the contest winner select her prize?

$$8 \cdot 10 = 80$$

## PERMUTATIONS

An ordering of  $n$  objects is a **permutation** of the objects.

If we have 3 volunteers standing in the front of the classroom, in how many ways can we order them?

$$3 \cdot 2 \cdot 1 = 6$$

What if we have 4 volunteers?

$$4 \cdot 3 \cdot 2 \cdot 1 = 24$$

How many permutations can you make of the letters in the word "house?"

$$5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$$

*This symbol means 5 times all the whole numbers less than it:*

5!

"5 factorial"

$$5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$$

In how many ways can any 5 letters from the alphabet be arranged?

$$26 \cdot 25 \cdot 24 \cdot 23 \cdot 22 \\ = 7,893,600$$

How can you show  $10 \cdot 9 \cdot 8 \cdot 7$  using factorials?

$$\frac{10!}{6!} = \frac{10 \cdot 9 \cdot 8 \cdot 7 \cdot \cancel{6} \cdot \cancel{5} \cdot \cancel{4} \cdot \cancel{3} \cdot \cancel{2} \cdot 1}{\cancel{6} \cdot \cancel{5} \cdot \cancel{4} \cdot \cancel{3} \cdot \cancel{2} \cdot 1}$$

$$\frac{26!}{21!} = 26 \cdot 25 \cdot 24 \cdot 23 \cdot 22$$

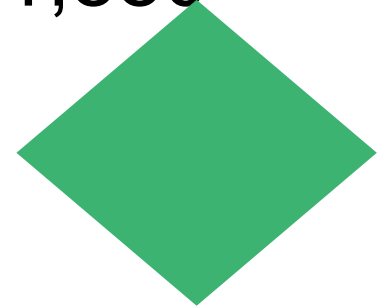
**MUSIC** You are burning a demo CD for your band. Your band has 12 songs stored on your computer. However, you want to put only 4 songs on the demo CD. In how many orders can you burn 4 of the 12 songs onto the CD?

$$12 \cdot 11 \cdot 10 \cdot 9$$

$$\frac{12!}{8!}$$

	NORMAL	FLOAT	AUTO	REAL	DEGREE	MP
12!	479001600					
Ans/8!	11880					

11,880



## Permutations of $n$ Objects Taken $r$ at a Time

The number of permutations of  $r$  objects taken from a group of  $n$  distinct objects is denoted by  ${}_n P_r$  and is given by this formula:

$${}_n P_r = \frac{n!}{(n-r)!}$$

$${}_{12} P_4 = \frac{12!}{(12-4)!} = \frac{12!}{8!}$$

$$13. {}_{12}P_{11} = \frac{12!}{1!} = 479,001,600$$

$$14. {}_{12}P_{10} = \frac{12!}{2!} = 239,500,800$$

$$15. {}_{12}P_5 = 95040$$

$$16. {}_{12}P_1 = 12$$

$$17. {}_5P_2 = 20$$

$$18. {}_7P_4$$

$$840$$

$$19. {}_8P_6 = 20160$$

$$20. {}_6P_2 = 30$$

NORMAL FLOAT AUTO REAL DEGREE MP	
${}_{12}P_5$	95040
${}_{12}P_1$	12

21. In how many ways can four distinct positions for a relay race be assigned from a team of nine runners?

$${}_9P_4 = 3024$$



## COMBINATIONS

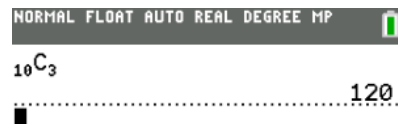
A **combination** is a selection of objects from a group. Order is NOT important.


We use  $n$  for the total number of objects and  $r$  for the number to be chosen.

*the formula:* 
$${}_n C_r = \frac{n!}{r!(n-r)!}$$

If a restaurant offers 10 possible pizza toppings, how many different 3-topping pizzas could you order?

$${}_{10}C_3 = \frac{10!}{(3!7!)} = 120$$



NORMAL FLOAT AUTO REAL DEGREE MP 

${}_{10}C_3$  ..... 120

■

Which is larger, the number of permutations or the number of combinations? Why?

$$22. {}_{12}C_{11} = 12$$

$$23. {}_{12}C_{10} = 66$$

$$24. {}_{12}C_5 = 792$$

$$25. {}_{12}C_1 = 12$$

$$\frac{12!}{1! 11!}$$

$$26. {}_{12}C_{12} = 1$$

**For each situation, determine whether to use a permutation or a combination. Then solve the problem.**

**A.** You draw the names of 5 raffle winners from a basket of 50 names. Each person wins the same prize. How many different groups of winners could you draw?

$${}_{50}C_5 = 2,118,760$$

**B.** A paint store offers 15 different shades of blue. How many different ways could you purchase 3 shades of blue?

$${}_{15}C_3 = 455$$

$${}_{15}P_3 = 720$$

**C.** How many different 5-letter codes can you make from the letters in the word *cipher*?

$${}_6P_5 = 720$$

A traveler can choose from three airlines, five hotels, and four rental car companies. How many arrangements of these services are possible?

(A) 12

(B) 60

(C) 220

(D) 495

$$3 \cdot 5 \cdot 4$$

Which is equivalent to  ${}^9C_5$ ?

(A) 126

(B) 3024

(C) 15,120

(D) 45,000

HW - Probability joke WS  
(both sides)

do all problems  
+ jokes