Multiplication Counting Principle:
The total number of outcomes is found by multiplying the number of choices each step of the way.

Factorial: $5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$

Factorial is usually used if you are arranging ALL of the available items.

Permutation Formula: When order DOES matter

Ways to arrange n items r at a time. ${}_nP_r$

Four people are running in a race: Amani, Barry, Candice, and, Dylan

How many ways can 1st, 2nd, and 3rd place be awarded?

A 1st	B 1st	C 1st	D 1st
ABCD	BACD	CABD	DABC
ABDC	BADC	CADB	DACB
ACBD	BCAD	CBAD	DBAC
ACDB	BCDA	CBDA	DBCA
ADBC	BDAC	CDAB	DCAB
ADCB	BDCA	CDBA	DCBA

$6 + 6 + 6 + 6 = 24$

$4 \cdot 3 \cdot 2 = 24$

Same answer with two different methods

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1. At the souvenir shop there are 15 hats, 20 t-shirts, and 9 jerseys. Your parents tell you that they will buy you one of each. How many different ways can you pick one of each?

Use the Multiplication Counting Principle: $15 \cdot 20 \cdot 9 = 2700$
(HATS · T-SHIRT · Jersey)

why multiply?

Because this problem really states:
How many different ways can you pick a hat AND a shirt AND a jersey.

What would you do if it asked to find the number of different ways to pick a hat OR a shirt OR a jersey?

$15 + 20 + 9 = 44$

Find the number of different ways can you arrange the letters in the word

GREAT $5!$ or ${}_5P_5 = 120$

GREET $\frac{5!}{2!} = 60$

GREATER $\frac{7!}{2!\,2!} = 1260$

GREETER $\frac{7!}{2!\,3!} = 420$

You want to order a two topping pizza. If there are only 4 toppings to choose from, how many different 2 topping pizzas are possible?

Toppings:

- Pepperoni
- Mushrooms
- Onions
- Green Peppers

Does order matter in this situation? NO

Is this a permuation? NO

Create a systematic list to help answer this question.

PM MO OG
PO MG
PG

there are 6 ways to make a 2 topping pizza when choosing from 4 items

Combination:

Selecting a number of items when order DOESN'T matter.

You order a shake at a shop. There are 7 ingredients to choose from. You buy a shake that contains 4 ingredients. How many different shakes are possible?

Does this situation represent a Combination or a Permuation?

the order you put ingredients in a blender doesn't matter.

If you make a systematic list you'll find that there are 35 different shakes you could create. See the next page for a quicker way to get this answer!

Combination Formula: When order DOESN'T matter

Ways to choose n items r at a time.

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

n= total # items

r = # selecting at a time

Find each.

${}_4C_2 = 6$

this gives you the answer to the # of 2-topping pizzas when choosing from 4 toppings.

${}_7C_4 = 35$

this gives you the answer to the # of 4-ingredient shakes when choosing from 7 ingredients.

${}_3C_8 = 0$

If there are only a total of 3 items you CAN'T take 8 of them!!

Find each.

${}_6C_0 = 1$

If order doesn't matter there is only one way to take nothing!

${}_4C_4 = 1$

If order doesn't matter there is only one way to take everything!