Multiplication Counting Principle:

multiplying the number of choices for each step

There are 5 people running a race. How many different ways can 1st through 5th place be awarded?

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

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

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

There are 15 students in a class..

1. If there are only 15 desks, how many ways could I assign these 15 students to the 15 desks?

$15! = 1.31 \times 10^{12}$

$15 \cdot 14 \cdot 13 \cdot 12 \cdot \cdots \cdot \_\_ \cdot \_\_ \cdot 1$

2. If there are 20 desks, how many ways could I assign these 15 students to the 20 desks?

$20 \cdot 19 \cdot 18 \cdot 17 \cdot \cdots 7 \cdot 6 \cdot 5 = 2.03 \times 10^{16}$

A password for your online credit card access must be 8 characters long.

There must be 3 numbers, 3 letters (case sensitive), and 2 special characters from amongs: ! @ # $ % & *

$10 \cdot 9 \cdot 8 \cdot 52 \cdot 51 \cdot 50 \cdot 7 \cdot 6$

How many different passwords are possible if nothing can repeat?

$4,059,824,000$

How many different passwords are possible if only numbers can repeat?

$10 \cdot 10 \cdot 10 \cdot 52 \cdot 51 \cdot 50 \cdot 7 \cdot 6$

$= 5,569,200,000$

There are 5 people running a race.

What if prizes are only awarded to the top three finishers?

In other words, how many ways can 1st, 2nd, and 3rd places be awarded to 5 people running in the race?

Multiplication Counting Principle: $5 \cdot 4 \cdot 3 = 60$

Permutation: An arrangement of items when order DOES matter.

Permutation Formula: When order DOES matter

Ways to arrange n items r at a time.

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

n= total # items

r = # arranging at a time

${}_5P_3 = 60$

To use the calculator:

- Enter n first
- Press MATH
- Arrow to PRB
- Choose Option 2: ${}_nP_r$
- Press r
- ENTER

At the national convention of a political party they are going to decide who they will nominate for President and Vice-President.

There are a total of 8 candidates. How many ways can they select a President and Vice-President to run in the upcoming elections?

$8 \cdot 7 = 56$ OR ${}_8P_2 = 56$

You want to order a two topping pizza. If there are only 5 toppings to choose from, how many different 2 topping pizzas are possible?

Toppings:

- Pepperoni
- Mushrooms
- Onions
- Green Peppers
- Canadian Bacon

10 pizzas

Create a systematic list to help answer this question.

PM PO PG PB
MO MG MB
OG OB
GB

You want to order a two topping pizza. If there are only 5 toppings to choose from, how many different 2 topping pizzas are possible?

Toppings:

- Pepperoni
- Mushrooms
- Onions
- Green Peppers
- Canadian Bacon

Does order matter in this situation?

NO

Combination:

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

At a resaurant you go up to the salad bar to make a salad. There are 10 different toppings to choose from. Your plate can only hold 5 toppings. How many different salads can you make?

Does this situation represent a Combination or a Permuation?

Combination

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

To use the calculator:
- Enter n first
- Press MATH
- Arrow to PRB
- Choose Option 3: $_nC_r$
- Enter r
- Press ENTER

Find each.

$_5C_2 =$ 10

Pizza problem

$_{10}C_5 =$ 252

Salad problem

$_5C_7 =$ # of items you are selecting can't be larger than the total # of items.

You are playing cards with a friend. You are dealt 6 cards.

1. How many ways can you arrange all 6 cards in your hand?

$6! \quad$ OR $\quad 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 \quad$ OR $\quad {}_6P_6 = 720$

2. When it's your turn you must take 3 of the cards and arrange them on the table in front of you. How many ways can you do this?

$6 \cdot 5 \cdot 4 = 120 \quad$ OR $\quad {}_6P_3 = 120$

3. How many different six card hands can be dealt?

Order doesn't matter:
so this isn't a permuation it's a combination

$_{52}C_6 =$

There are 18 students in the class.

How many ways could I select 2 students to go to the office to get some more chairs?

$_{18}C_2 = 153$

There are 4 problems to work out on the board. How many ways could I select 4 students to do these 4 problems on the board?

$_{18}P_4 = 73,440$

This "combination" lock has the numbers from 0 to 39.

Let's assume a "combo" to this lock is 3 different numbers.

Why is the phrase Combination Lock not a good name? because the order DOES matter so it should be a Permutation Lock!

Find all possible "combos".

$_{40}P_3 = 59,280$

The lottery game Mega Millions requires you to pick 5 numbers from 1 to 56 then pick the Gold Ball which is a number from 1 to 46.

1. If you buy an Easy Pick ticket then the computer picks these numbers for you. How many different Easy Pick tickets are possible?

ways to pick 5 of 56 numbers $(_{56}C_5) \cdot (_{46}C_1)$ # ways to pick 1 of 46 numbers $= 175,711,536$

2. What is the probability that you get a winning ticket?

$$\frac{1}{175,711,536}$$

$= .000000569\%$

1. You have to reshelve 8 books at the library.

a. How many ways can you arrange all of these books on a shelf?

$_8P_8$ or $8! = 40,320$

b. How many ways can you arrange 5 of these books on a shelf?

$_8P_5$ or $8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 = 6720$

2. There are 8 books from the library that you want to read but you can only check out a maximum of three books at a time. How many ways can you check out three of these books?

$_8C_3 = 56$