Each morning you must decide what to wear.
An outfit consists of a pair of shoes, a pair of pants, and a shirt.
You have the following to choose from:
5 pairs of shoes
8 pairs of pants
24 shirts

How many different outfits are possible?

$5 \cdot 8 \cdot 24 = 960$

Multiplication Counting Principle:

multiplying the number of choices for each step

A restaurant has the following menu choices:

Appetizers	Wings, Potato Skins, Onion Rings, Cheese Sticks	4
Entrées	Chicken, Lamb, Steak, Burgers, Ham, Ribs	x 6
Desserts	Ice Cream Cone, Cake, Pie, Cupcake, Brownie, Ice Cream Sundae	x 6
		144

A dinner consists of one Appetizer, one Entrée, and one Dessert. Find the number of different dinners that are possible.

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.

Find each:

1. $7! = 5040$

2. $10! = 3{,}628{,}800$

3. $\frac{8!}{5!} = 336$

$$\frac{8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}$$

There are 12 people on a basketball team and only 12 uniform numbers to pass out.

1. How many different ways can all 12 uniform numbers be passed out to the players?

$12! = 479{,}001{,}600$

$12 \cdot 11 \cdot 10 \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot 1$

2. If there were 12 uniforms but only 10 players, how many ways could the uniforms be passed out?

$12 \cdot 11 \cdot 10 \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot \_ \cdot 3$

OR $\frac{12!}{2!} = 239{,}500{,}800$

How many different four digit sequences can you create using the digits from 0 to 9 if digits can repeat?

$10 \cdot 10 \cdot 10 \cdot 10 = 10{,}000$

How many different four digit sequences can you create using the digits from 0 to 9 if digits CAN'T repeat?

$10 \cdot 9 \cdot 8 \cdot 7$

$= 5040$

In a certain state lisence plates consist of 3 letters then 3 digits.

How many different lisence plates are possible if letters and digits CAN repeat?

$26 \cdot 26 \cdot 26 \cdot 10 \cdot 10 \cdot 10$

$17,576,000$

How many different lisence plates are possible if letters and digits CAN'T repeat?

$26 \cdot 25 \cdot 24 \cdot 10 \cdot 9 \cdot 8$

$11,232,000$

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

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

${}_5P_3 = 60$

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: $5 \cdot 4 \cdot 3 = 60$

OR

Permutation: Arrangment of 5 things 3 at a time $ {}_5P_3 = 60$

You are playing Scrabble. You choose 7 tiles from the pile.

1. How many ways can you arrange all 7 in front of you?

$7! = 5040$ OR ${}_7P_7 = 5040$

2. If you can only play 3 at a time, find the number of ways you can arrange 3 of the 7 tiles on the board.

$7 \cdot 6 \cdot 5$

OR $= 210$

${}_7P_3$

There are 12 members of a club. The club needs to select a President and a Treasurer.

How many different ways can a President and a Treasurer be selected from amongst the 12 members?

${}_{12}P_2 = 132$ OR $12 \cdot 11 = 132$

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 P
- Mushrooms m
- Onions O
- Green Peppers G

Create a systematic list to help answer this question.

PM PO PG MO MG OG → 6

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

Combination:

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

You order a shake at a shop. There are 7 ingrediants 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?

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: $_nC_r$
- Press r
- ENTER

Find each.

$_4C_2 = 6$

Pizza problem

$_7C_4 = 35$

Milkshake problem

$_3C_8 =$

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

There are 24 students in the class.

How many ways could President, Vice-President, and Secretary be assigned?

$_{24}P_3 = 12{,}144$

How many ways could a committee of 3 students be picked to meet with the principal?

$_{24}C_3 = 2024$

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?

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

$$= .000000569\%$$

There are 10 swimmers in a race. How many ways can the gold, silver, and bronze medals be awarded?

$${}_{10}P_3 = 720$$

There are 10 swimmers on a team. How many ways can three co-captains be selected?

$${}_{10}C_3 = 120$$

There are 12 players on a basketball team. How many ways can I pick 5 players to start the game.
Assume everybody can play every position.

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

How many different ways can the 5 starting players be announced at the beginning of the game?

$${}_{12}P_5 = 95,040$$