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Combinations and Permutations

What's the Difference?

In English we use the word "combination" loosely, without thinking if the **order** of things is important. In other words:

"My fruit salad is a combination of apples, grapes and bananas" We don't care what order the fruits are in, they could also be "bananas, grapes and apples" or "grapes, apples and bananas", its the same fruit salad.

"The combination to the safe is 472". Now we **do** care about the order. "724" won't work, nor will "247". It has to be exactly **4-7-2**.

So, in Mathematics we use more *precise* language:

- When the order doesn't matter, it is a **Combination**.
- When the order **does** matter it is a **Permutation**.

So, we should really call this a "Permutation Lock"!

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Fundamental Counting Principle - if one event has **m** possible outcomes and a second independent event has **n** possible outcomes, then there are **m • n** total possible outcomes for the two events together.

Combination - A collections of things in which *order does not matter.*

1) You are placing an order for an Italian beef sandwich. You can select from either white bread or wheat bread. For toppings, you can select sweet peppers, hot peppers, or no peppers. How many different combinations Italian Beef sandwich orders are there?

$2 \cdot 3 = 6$

2) You are placing a t-shirt order for your new club. Options are long-sleeved or short-sleeved; color options are red, blue or white; and sizes can be S, M, or L. How many different combinations of t-shirts selections can you order?

$2 \cdot 3 \cdot 3 = 18$

Permutation - A collections of things in which *order does matter.*

3) How many different ways can you arrange the letters in the word "WHO"?

WHO HWO OWH
WOH HOW OHW

$3 \cdot 2 \cdot 1 = 6$

4) How many different ways can you arrange the letters in the word "CABINET"?

$7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 5040 \quad (7!)$

5) There are a total of 8 children in a class

a. How many ways can all 8 children be lined up?

$8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 40,320$

b. How many ways can 5 of the 8 children be lined up?

$8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 = 6,720$

6) A student activity club at a college has 18 members. In how many different ways can the club select a president, a vice president, a treasurer, and a secretary?

$18 \cdot 17 \cdot 16 \cdot 15 = 73,440$

PRACTICE TIME!