Permutations and Combinations

Factorial: Denoted by the exclamation mark (!). Factorial means to multiply by decreasing positive integers. For example, $5! = 5 * 4 * 3 * 2 * 1 = 120$. *Note:* $0! = 1$.

The **Fundamental Counting Rule** allows us to define the idea of factorial: *Given Event A occurring m ways, and Event B occurring n ways, then the way both events can occur is $m \times n$ ways.*
Therefore, if the first event can occur n ways, the second event can occur $n - 1$ ways, the third event can occur $n - 2$ ways, etc. Which we could write as $n!$

Permutations: Arrangements of items where order matters. Therefore, each arrangement of the same items in different order are counted as a separate arrangement.

Combinations: Arrangements of items where order does not matter. Therefore each arrangement of the same items in different order are not counted as a separate arrangement.

Example: Given the letters $\{x, y, z\}$ there are several combinations of two that can be made: $\{xx, xy, xz, yx, yy, yz, zx, zy, zz\}$ Counting these as permutations, we have nine unique arrangements; however, counting these as combinations, the items that are repeat arrangements $\{xy \text{ and } yx; xz \text{ and } zx; yz \text{ and } zy\}$ would only be counted as one arrangement each.

To count the number of **permutations** when you have n available items and you choose r of them **without** replacement:

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

On the TI-83/84 family:
- Type in your value for n on the Home Screen.
- Press **[MATH]**, left arrow once to highlight **PRB.**
- Select 2:nPr
- Press **[ENTER].**
- Type your value for r.
- Press **[ENTER].**

To count the number of **combinations** when you have n available items and you choose r of them **without** replacement:

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

On the TI-83/84 family:
- Type in your value for n on the Home Screen.
- Press **[MATH]**, left arrow once to highlight **PRB.**
- Select 3:nCr
- Press **[ENTER]**
- Type your value for r.
- Press **[ENTER]**