Multiplication Rule

When something takes place in several stages, find the total number of ways it can occur (sample size) by multiplying together then number of ways each individual stage can occur.

Box Method: Draw a row of boxes, one box for each stage of the experiment. In each box, write the number of ways that stage can occur. Multiply all numbers together to get sample size.

Examples:

- Scoops of Ice Cream
- Wardrobe
- A Deck of Cards
- License Plates
- Lottery

Standard Deck of 52 Playing Cards

4 Suits, 13 cards per suit (one of each rank)

Spades ♠	Hearts ♥	Diamond ♦	Clubs ♣

13 Ranks, 4 cards per rank (one of each suit)

Ace	2	3	4	5	6	7	8	9	10	Jack	Queen	King

The Jack, Queen, and King are face cards – they have faces on the cards.

Factorials

Factorial means you multiply together all positive integers less than or equal to the number you are taking the factorial of.

Example:

$5! = 5 \times 4 \times 3 \times 2 \times 1$

Permutations

A set of distinct objects (each one is unique) can be arranged in several ways. When the order is important, each arrangement is a permutation.

The total number of ways all n objects can be arranged is n! (n stages with no repetition).

3 Objects: A, B, C
6 Permutations: ABC, ACB, CAB, CBA, BCA, BAC

With permutations, order is important: ABC ≠ ACB ≠ BCA

How many ways can you select a subset of the distinct objects?

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

where:
n is the number of distinct objects in the set
r is the number of objects you want to select from the set

This is read: The permutation of n objects taken r at a time.

In your calculator: Enter n, select math, select prob, select nPr, enter r, press enter.

Distinguishable Permutations

Suppose your objects are not distinct.

When you list all possible arrangements, some will be identical.

3 Objects: A, A, C

6 Permutations: AAC, ACA, CAA, CAA, ACA, AAC

But, we can't distinguish between the first A and the second A. This is calculated by:

$$\frac{n!}{n_1!n_2!n_3!\cdots n_k!}$$

where:
n is the total number of objects
n_1 is the number of objects of the 1st kind
n_2 is the number of objects of the 2nd kind
n_3 is the number of objects of the 3rd kind
n_k is the number of objects of the kth kind