		Ways to complete the procedure/task	In terms of sets
Product Rule	A procedure is broken up to to two tasks (both of which must be completed).	$x \cdot y$	$\lvert A_1 \times A_2 \times \cdots \times A_m \rvert = \lvert A_1 \rvert \cdot \lvert A_2 \rvert \cdot \ldots \cdot \lvert A_m \rvert$
Sum Rule	A task can be done in one of *x* ways or one of *y* ways (none of the *x* ways are the same as the *y* ways)	$x+y$	$\lvert A_1 \cup A_2 \cup \cdots \cup A_m \rvert = \lvert A_1 \rvert + \lvert A_2 \rvert + \cdots + \lvert A_m \rvert$ where $A_1, A_2, \ldots, A_m$ are disjoint sets
Subtraction Rule	A task can be done in one of *x* ways or one of *y* ways, with *z* ways in common	$x+y-z$	$\lvert A \cup B \rvert = \lvert A \rvert + \lvert B \rvert - \lvert A \cap B \rvert$

- A tree diagram can be used to solve counting problems, where a branch represents a possible choice and the leaves represent possible outcomes.
- A permutation of a set of distinct objects is an ordered arrangement of these objects.
  - An ordered arrangement of *r* elements is called an r-permutation.
  - $P(n,r) = \dfrac{n!}{(n-r)!}$
- An r-combination of elements of a set is an unordered selection of *r* elements from the set.
  - $C(n,r) = \dfrac{n!}{(n-r)!r!} = \dbinom{n}{r}$
  - $C(n,r) = C(n, n-r)$
- A combinatorial proof of an identity is a proof that uses one of the following methods
  - A double counting proof uses counting arguments to prove that both sides of an identity count the same objects, but in different ways
  - A bijective proof shows that there is a bijection between the sets of objects counted by the two sides of the identity
- A binomial expression is the sum of two terms, such as *x+y*

Binomial Theorem: Let x and y be variables and n≥0, then

$$(x+y)^n = \sum_{j=0}^{n} \binom{n}{j} x^{n-j} y^j = \binom{n}{0} x^n + \binom{n}{1} x^{n-1} y + \cdots + \binom{n}{n-1} x y^{n-1} + \binom{n}{n} y^n.$$

Pigeonhole Principle: If *k* is a positive integer and *k+1* objects are placed into *k* boxes, then at least one box contains two or more objects.

Generalized Pigeonhole Principle: If *N* objects are placed into *k* boxes, then there is at least one box containing at least $\lceil N/k \rceil$ objects

Pascal's Identity: If n and k are integers with n ≥ k ≥ 0, then

$$\binom{n+1}{k} = \binom{n}{k-1} + \binom{n}{k}.$$

Pascal's Triangle uses Pascal's Identity to build up a triangular representation of binomial coefficients

$$\begin{array}{ccccccccc}
 & & & & \binom{0}{0} & & & & \\
 & & & \binom{1}{0} & & \binom{1}{1} & & & \\
 & & \binom{2}{0} & & \binom{2}{1} & & \binom{2}{2} & & \\
 & \binom{3}{0} & & \binom{3}{1} & & \binom{3}{2} & & \binom{3}{3} & \\
\binom{4}{0} & & \binom{4}{1} & & \binom{4}{2} & & \binom{4}{3} & & \binom{4}{4}
\end{array}$$

$$\begin{array}{ccccccccc}
 & & & & 1 & & & & \\
 & & & 1 & & 1 & & & \\
 & & 1 & & 2 & & 1 & & \\
 & 1 & & 3 & & 3 & & 1 & \\
1 & & 4 & & 6 & & 4 & & 1
\end{array}$$