Counting Methods

Methods to count the number of ways items can be arranged

Fundamental Counting Principle: The number of ways a multi-part task can occur equals the product of the number of ways to complete each independent part of the task. *Use this method when: •There are specific placement requirements • Repetition **is** permitted*
Example: Rachel is required to wear clothes that are black and white to work. She owns 4 pairs of pants, 5 shirts and 2 pairs of shoes that all coordinate with each other. How many different outfits can she create from this wardrobe?

$$\text{Task} \rightarrow \underset{\text{Pants}}{\underline{\;4\;}} \bullet \underset{\text{Shirts}}{\underline{\;5\;}} \bullet \underset{\text{Shoes}}{\underline{\;2\;}} = 40$$

Factorials: The number of ways of arranging **all** of a distinct number of items, symbolized by **n!**, multiplying down beginning from the cardinal number n, all the way to 1.

Example: Six students are to occupy 6 desks in a row. How many ways are there to arrange them? $6! = 6\bullet5\bullet4\bullet3\bullet2\bullet1 = 720$

Permutations: An **ordered** arrangement of a given set of items determined by selecting a distinct quantity of items (**r**) from a certain total of items (**n**). **Formula:** $nPr = \dfrac{n!}{(n-r)!}$

*Use this method when: •Repetition is **not** permitted • Order **is** important (i.e. ranking, rating, coding)*

Example: If a club has 7 members, how many different ways are there to choose a President and Vice-President (2 officers)? $_7P_2 = \dfrac{7!}{(7-2)!} = \dfrac{7!}{5!} = \dfrac{7\bullet6\bullet\cancel{5\bullet4\bullet3\bullet2\bullet1}}{\cancel{5\bullet4\bullet3\bullet2\bullet1}} = 42$

Combinations: A given set of items **without** regard to their arrangement determined by selecting a distinct quantity of items (**r**) from a certain total of items (**n**).
Formula: $nCr = \dfrac{n!}{(n-r)!r!}$

*Use this method when: • Repetition **is not** permitted • Order **is not** important (i.e. subsets, committees, random selections, card hands)(When the set of {a,b,c} is the same as {c,b,a})*

Example: If a club has 7 members, how many different ways are there to choose a 2 member sub-committee? $_7C_2 = \dfrac{7!}{(7-2)!\,2!} = \dfrac{7\bullet6\bullet\cancel{5\bullet4\bullet3\bullet2\bullet1}}{\cancel{5\bullet4\bullet3\bullet2\bullet1}\bullet2\bullet1} = \dfrac{42}{2} = 21$

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Tree Diagrams

- A visual representation of all the possible outcomes of a multi-part task.

- Use the Fundamental Counting Principle to determine the total number of outcomes and then set up the tree diagram using each part of the task as headings. List the possible outcomes under each heading. Each possible outcome from the first heading will create a branch to each possible outcome from the next heading. List all the possible outcomes (sample points) under the heading, *Sample Space.*

- *Example*: Ruth is playing a game where she flips a coin and then rolls a die. Construct a tree diagram and list the outcomes in a sample space.

_*2*_ • _*6*__ = 12
Coin Die