11.2 Permutations

A **permutation** is an arrangement of items selected from a group such that no item from the group is used more than once and the order of items selected is important. Note that if two or more items in the group are identical, they can each be used in the permutation.

# Objective 1: Use the fundamental counting principle to count permutations

When all of the items in the group are used and there are no duplicates in the group, the fundamental counting principle can easily be used. Each group will have one fewer item than the previous group as items are used up.

# Objective 2: Evaluate factorial expressions

The computations involved in using the fundamental counting principle for permutations can be streamlined with **factorial notation**.

**FACTORIAL NOTATION**

If *n* is a positive integer, the notation  means the product of all positive integers from *n* down through 1.



By definition, .

# Objective 3: Use the permutations formula

When the permutations do not contain all of the items in the original group, the permutations formula makes the computation easier.

**PERMUTATIONS OF *n* THINGS TAKEN *r* AT A TIME**

The number of possible permutations if *r* items are taken from *n* items is

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# Objective 4: Find the number of permutations of duplicate items

When two or more elements of the group are identical, they will create permutations that look exactly alike. Dividing by the possible permutations of each repeated element (even though they look alike) gives the number of **distinguishable permutations.**

**PERMUTATIONS OF DUPLICATE ITEMS**

The number of **distinguishable permutations** of *n* items, where *p* items are identical, *q* items are identical, *r* items are identical, and so on, is given by

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