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# Permutations and Combinations

Unit 6 Lesson 7

# PERMUTATIONS AND COMBINATIONS

## Students will be able to:

Understand the concept of permutations and combinations and their usage.

## Key Vocabulary

- **Principle of Counting**
- **Permutation**
- **Combination**
- **Factorial**

# PERMUTATIONS AND COMBINATIONS

**What is the Fundamental Principle of Counting?**

Suppose that a task **1** can be done in $n_1$ ways, and a task **2** can be done in $n_2$ ways, …, and a task $\boldsymbol{k}$ can be done in $n_k$ ways, then all of these tasks can be done in:

$$\boldsymbol{n_1 \times n_2 \times \ldots \times n_k} \text{ ways.}$$

# PERMUTATIONS AND COMBINATIONS

## PROBLEM: 1

Alan bought 7 dress shirts, 5 pants and 3 shoes from a shopping mall. How many different combinations of pants, dress shirts and shoes can he make from his shopping?

Here, there are 7 dress shirts, so they can be selected in 7 different ways, so $\boldsymbol{n_1 = 7}$.

There are 5 pants, so they can be selected in 5 different ways, so $\boldsymbol{n_2 = 5}$.

There are 3 shoes, so they can be selected in 3 different ways, so $\boldsymbol{n_3 = 3}$. Now all the three things can be selected in:

$$\boldsymbol{7 \times 5 \times 3 = 105 \text{ ways}}$$

Hence Alan can make 105 combinations.

# PERMUTATIONS AND COMBINATIONS

**What is Permutation?**

A permutation is the choice of $r$ things from a set of $n$ things without replacement and where the arrangement (order) matters.

**Mathematically,**

$$_{\boldsymbol{r}}^{\boldsymbol{n}}\boldsymbol{P} = \frac{\boldsymbol{n}!}{(\boldsymbol{n}-\boldsymbol{r})!}$$

Where,

$n! = n \times (n-1) \times (n-2) \times \cdots \times 3 \times 2 \times 1$ (Termed as the **n-Factorial)**

Also, $0! = 1$.

# PERMUTATIONS AND COMBINATIONS

## PROBLEM: 2

Find the following:

a) ${}_0^nP$

b) ${}_2^5P$

a) ${}_0^nP = \frac{n!}{(n-0)!} = \frac{n!}{n!} = 1$

b) ${}_2^5P = \frac{5!}{(5-2)!} = \frac{5!}{3!} = \frac{5\times4\times3\times2\times1}{3\times2\times1} = 5 \times 4 = 20$

# PERMUTATIONS AND COMBINATIONS

**What is Combination?**

A combination is the choice of $r$ things from a set of $n$ things without replacement and where the arrangement (order) does not matter.

**Mathematically,**

$$_{r}^{n}C = \binom{n}{r} = \frac{n!}{n!(n-r)!}$$

Where,

$n! = n \times (n-1) \times (n-2) \times \cdots \times 3 \times 2 \times 1$ (Termed as the **n-factorial)**

# PERMUTATIONS AND COMBINATIONS

## PROBLEM: 3

Find the following:

**a)** $\mathbf{{}_{0}^{n}C}$

**b)** $\mathbf{{}_{2}^{5}C}$

**a)** $$\mathbf{{}_{0}^{n}C = \frac{n!}{0!(n-0)!} = \frac{n!}{1\times n!} = 1}$$

**b)** $$\mathbf{{}_{2}^{5}C = \frac{5!}{2!(5-2)!} = \frac{5!}{2!3!} = \frac{5\times4\times3\times2\times1}{(2\times1)\times(3\times2\times1)} = \frac{5\times4}{2} = 10}$$

**Note that** $\mathbf{{}_{0}^{n}C = {}_{0}^{n}P = 1}$