The Basic Counting Principle

The Basic Counting Principle is an easy way to help us figure out how many ways something can be done in a situation that involves several steps.

For example, if someone has 4 pairs of pants and 5 shirts, how many outfits could they make?

There are 4 ways you could choose your pants and 5 ways you could choose your shirt.

The Basic Counting Principle tells us:

$$\begin{aligned}
\#\text{ of Outfits} &= (\#\text{ of Shirts})(\#\text{ of Pants}) \\
&= (5\text{ ways})(4\text{ ways}) \\
&= 20\text{ ways to choose an outfit.}
\end{aligned}$$

Example 2

As another example, Jeff flips a coin and Tina draws a card from a 52-card deck. How many possible outcomes are there?

When you flip a coin there are two possible outcomes, and when you draw a card there are 52 possible outcomes.

$$\begin{aligned}\text{\# of Possible Outcomes} &= (2 \text{ Outcomes})(52 \text{ Outcomes}) \\ &= 104 \text{ Possibilities}\end{aligned}$$

Experimental & Theoretical Probability

Any activity that involves chance is known as an **experiment**. Every time we do a single round of the experiment, we are completing a **trial** and every result of a trial is called an **outcome**. Once we have all of our interested outcomes, we have created a **sample space**. The number of times a certain outcome happens, is called an **event**.

Example 1 - Experimental Probability

We are going to run an experiment about driving a car. This experiment will be completed 10 times and we are interested in whether we will be involved in an accident or not.

The Experiment = Driving a Car Results in an Accident

The Trial = Getting in the car and driving to a destination

Outcome #1 = Accident Occurs

Outcome #2 = Accident Does Not Occur

Sample Space = Accident Occurs or Accident Does Not Occur

Example 1 - Continued (2)

We run our trials, and we get this set of data:

Trial	Outcome
1	Accident
2	No Accident
3	No Accident
4	No Accident
5	No Accident
6	No Accident
7	No Accident
8	No Accident
9	Accident
10	No Accident

Event	Frequency
Accident	2
No Accident	8

According to our data, we can say that the probability, or how often an event will occur, of us getting into an accident when driving a car is less likely. Why? If we look at the frequency, we see that we were in an accident only twice compared to having no accidents 8 times.

Probabilities are written as fractions or percentages. So, in order to complete our experiment, let's find the probabilities for:

(A) An accident occurring

(B) An accident not occurring

Example 1 - Continued (3)

Event	Frequency
Accident	2
No Accident	8

This is called the **Experimental Probability**.

Experimental Probability =

$$\frac{\textbf{the number of times the event occurs}}{\textbf{the number of trials}}$$

Probabilities are written as fractions or percentages. So, in order to complete our experiment, let's find the probabilities for:

(A) An accident occurring

(B) An accident not occurring

$$\textbf{An Accident Occurring} = \frac{2}{10} = \frac{1}{5} \text{ or } 20\%$$

$$\textbf{An Accident Not Occurring} = \frac{8}{10} = \frac{4}{5} \text{ or } 80\%$$

Theoretical Probability

A coin can be used as a Theoretical Probability because both sides of the coin are equal in size and a heads or a tails have the same chance of being flipped. Dice can also be used. Why? There are 6 equal sides with 6 numbers that all have the same chance of occurring.

Example 2 - Theoretical Probability

What would the theoretical probability be if we rolled a die and we needed a number greater than or equal to 2?

Break it down: there are 6 equal sides, each side has a number of 1 - 6. We need a number greater than or equal to 2. This means we can have a 2, 3, 4, 5 or 6. We cannot have a 1. How would we calculate the theoretical probability?

Theoretical Probability

$$= \frac{\text{the number of ways the event occurs}}{\text{total number of equally likely outcomes}}$$

What would the theoretical probability be if we had one rolling cube and we needed a number greater than or equal to 2?

So, with our example:

The probability of us rolling a number greater than or equal to 2

$$= \frac{2,3,4,5,6}{1,2,3,4,5,6} = \frac{5 \text{ ways}}{6 \text{ outcomes}} = \frac{5}{6} \text{ or } 83\frac{1}{3}\%$$