



CHAPTER 9 - COUNTING PRINCIPLES AND PROBABILITY

Probability is the chance an event will occur.

Probability is used in many real-world fields, such as insurance, medical research, law enforcement, and political science.

SECTION 9-1 INTRODUCTION TO PROBABILITY

Objectives:

Find the theoretical probability of an event.

Apply the Fundamental Counting Principle.

How do some businesses, such as life insurance companies and gambling establishments, make dependable profits on events that seem unpredictable? The answer is that the overall likelihood, or **probability**, of an event can be discovered by observing the results of a large number of repetitions of the situation in which the event may occur.

The terminology used for probability is given below. The sample is the rolling of a number cube.

DEFINITION	EXAMPLE
Trial: A systematic opportunity for an event to occur	rolling a number cube
Experiment: one or more trials	rolling a number cube 10 times
Sample space: the set of all possible outcomes of an event	1, 2, 3, 4, 5, 6
Event: an individual outcome or any specified combination of outcomes	rolling a 3 rolling a 3 or rolling a 5



Probability is expressed as a number from 0 to 1. It is often written as a fraction, decimal, or percent.

Experimental probability is determined by performing trials and recording the ratio of the # of occurrences to the number of trials.

Theoretical probability is based on the assumption that all outcomes occur randomly.

Outcomes are **random** if all possible outcomes are equally likely. (no bias or favorites)

Theoretical Probability

If all outcomes in a sample space are equally likely, then the theoretical probability of event A, denoted $P(A)$, is defined by

$$P(A) = \frac{\text{number of outcomes in event } A}{\text{number of outcomes in sample space}}$$

Probability of A →

Ex. 1 A bag contains 2 white marbles, 4 red marbles, and 10 green marbles. What is the probability of drawing a red marble?, a blue marble? a white marble or a red marble out of the bag?

$$P(\text{Red}) = \frac{4}{16} = \frac{1}{4} = .25 = 25\% \quad P(\text{Green}) = \frac{10}{16} = \frac{5}{8} = .625 = 62.5\%$$

$$P(\text{Blue}) = \frac{0}{16} = 0 = 0\%$$

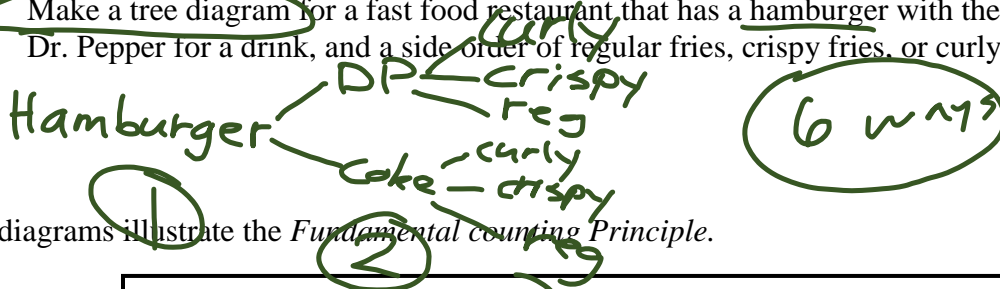
Remember that probability is between $0 \leq P(A) \leq 1$.

- An impossible event has a probability of 0.
- An event that must occur has a probability of 1.
- The sum of the probabilities of all outcomes in a sample space is 1.

Ex. 2 A bag contains 10 red, 5 black, 4 yellow and 2 blue jellybeans. Find the probability of selecting a red, a black, a yellow, a blue, a purple, a red or black or yellow or blue jellybean.

There are several ways to determine the size of a sample space for an event that is a combination of two or more outcomes. One way is a tree diagram.

Ex. 3 Make a tree diagram for a fast food restaurant that has a hamburger with the choice of Coke or Dr. Pepper for a drink, and a side order of regular fries, crispy fries, or curly fries.



Tree diagrams illustrate the *Fundamental Counting Principle*.

Fundamental Counting Principle

If there are m ways that one event can occur and n ways that another event can occur, then there are $m \times n$ ways that both events can occur.

Ex. 4 In order to purchase a Power Ball Ticket you have to choose 5 numbers 1 through 69 and a "power ball" number that is 1 through 26. How many different tickets can you purchase?

$$69 \cdot 69 \cdot 69 \cdot 69 \cdot 69 \cdot 26 = 4.07 \times 10^7$$

Ex. 5 How many Utah license plates can be made? (3 numbers followed by 3 letters)

$$26 \cdot 26 \cdot 26 \cdot 10 \cdot 10 \cdot 10 = 17,576,000$$

The **odds** in favor of an event are defined as the number of ways the event can happen ***a*** compared to the number of ways it can fail ***b***. We write as the ratio ***a:b***

Ex. 8 Find the odds of a team winning if it wins 15 games and loses 5 games

What is the probability of winning if the odds in favor of an event are $a:b$, or a to b , then the probability of the event is $\frac{a}{a+b}$.

Ex. 9 Find the probability of the event if the given odds in favor of the event is 2 to 7.
