Section 13.1 Fundamentals of Probability

# Objective 1: Compute Theoretical Probability

Any occurrence for which the outcome is uncertain is called an **experiment**. Tossing a coin is an example of an experiment.

The set of all possible outcomes of an experiment is the **sample space** of the experiment, denoted by *S*. The sample space for tossing a coin is  where *H* represents “lands heads up” and *T* represents “lands tails up”.

An **event** *E* is any subset of a sample space. For example,  is the event of landing tails up when a coin is tossed.

The **probability** of an event is the likelihood that the event will occur. The probability of an event is always between 0 and 1, inclusive. A probability of 0 means the event will not occur, and a probability of 1 means the event is certain to occur. The closer the probability of an event is to 1, the more likely it is that the event will occur. The closer the probability of an event is to 0, the less likely it is that the event will occur.

**Computing Theoretical Probability**

If an event *E* has  equally likely outcomes and its sample space S has equally likely outcomes, the **theoretical probability** of event *E*, denoted , is

 .

For example, when a coin is tossed, .

In general, **the sum of the theoretical probabilities of all possible outcomes in the sample space is one**.

a. A 12-sided die is rolled. The set of equally likely outcomes is .

 i. What is the probability of rolling a 10?

 ii. What is the probability of rolling an even number?

 iii. What is the probability of rolling a 15?

 iv. What is the probability of rolling at least a 9?

 v. What is the probability of rolling a number less than 13?

A **standard deck of playing cards** consists of 52 cards. There are four suits: hearts, diamonds, spades, and clubs. For each suit, there is one each of cards with face value 2, 3, 4, 5, 6, 7, 8, 9, 10, jack (J), queen (Q), king (K), and ace (A). Jacks, queens, and kings are called **face cards**.

b. One card is dealt at random from a standard deck of cards. What is the probability the card is

 i. an ace

 ii. a diamond

 iii. the queen of hearts

c. If *H* represents “lands on heads”, and *T* represents “lands on tails, then the set of equally likely outcomes for three tosses of a fair coin is . Find the probability of

 i. all three tosses land the same way

 ii. there is at least one *T*

 iii. the first toss is *H*

# Objective 2: Compute Empirical Probability

**Empirical probability** applies to situations in which we observe how frequently an event occurs.

**Computing Empirical Probability**

The empirical probability of event *E* is

  .

The **law of large numbers** states that as an experiment is repeated more and more times, the empirical probability of an event tends to get closer to the theoretical probability of that event.

a. The table shows the number, in millions, of citizens of a certain country who moved in 2004, categorized by where they moved (within the same region, to a different region, or to a different country) and whether they were a renter or owner.



Find the probability, expressed as a decimal rounded to the nearest hundredth, that a randomly selected citizen who moved in 2004

 i. was a renter.

 ii. moved to a different country.

 iii. was a renter who moved within the country.