5.2 Probability Rules

Learning Objectives

1. Describe a probability model for a chance process.
2. Use basic probability rules, including the complement rule and the addition rule for mutually exclusive events.
3. Use a two-way table or Venn diagram to model a chance process and calculate probabilities involving two events.
4. Use the general addition rule to calculate probabilities.

Vocabulary: Sample space, probability model, event, mutually exclusive, disjoint, complement rule, addition rule (for mutually exclusive events), general additional rule, Venn diagrams, intersection, union,

Read 305–307

The ____________________________, *S*, of a chance process is the set of all possible outcomes.

A ___________________________________is a description of some chance process that consists of two parts: a ____________________________ and the ____________________________ for each outcome.

An ________________ is any collection of outcomes from some chance process. That is, an event is a __________________________of the sample space (usually denoted with a capital letter).

Imagine flipping a fair coin three times. Describe the probability model for this chance process and use it to find the probability of getting at least 1 head in three flips.

Read 307–308

<u>Five Basic Probability Rules</u>

What does it mean if two events are *mutually exclusive* also referred to as ___________________?

Determine whether these events are mutually exclusive

- Roll a die: get an even number and get a number less than 3
- Roll a die: get a prime number and get an odd number
- Roll a die: get a number greater than 3 and get a number less than 3
- Select a student in the classroom: student has brown hair and blue eyes
- Select a student at a university: student is a sophomore and the student is a business major
- Select any high school course: the course is Calculus and the course is English

P. 315 #43 *Probability models*? In each of the following situations, state whether or not the given assignment of probabilities to individual outcomes is legitimate, that is, satisfies the rules of probability. If not, give a specific reason for your answer.

(a) Roll a 6-sided die and record the count of spots on the up-face: P(1) = 0, P(2) = 1/6, P(3) = 1/3, P(4) = 1/3, P(5) = 1/6, P(6) = 0.

(b) Choose a college student at random and record gender and enrollment status: P(female full-time) = 0.56, P(male full-time) = 0.44, P(female part-time) = 0.24, P(male part-time) = 0.17.

(c) Deal a card from a shuffled deck: P(clubs) = 12/52, P(diamonds) = 12/52, P(hearts) = 12/52, P(spades) = 16/52

Alternate Example: AP Statistics Scores
Randomly select a student who took the 2010 AP Statistics exam and record the student's score. Here is the probability model:

(a) Show that this is a legitimate probability model.

Score	1	2	3	4	5
Probability	0.233	0.183	0.235	0.224	0.125

(b) Find the probability that the chosen student scored 3 or better.

(c) Find the probability that the chosen student didn't get a 1.

#45 *Blood Types*. All human blood can be typed as one of O, A, B, or AB, but the distribution of the types varies a bit with race. Here is the distribution of the blood type of randomly chosen black Americans.

Blood Type	O	A	B	AB
Probability	0.49	0.27	0.20	??

(a) What is the probability of type AB blood? Why?

(b) What is the probability that the person chosen does not have type AB blood?

(c) Maria has type B blood. She can safely receive blood transfusions form people with types O and B. What is the probability that the person chosen does not have type AB blood?

#48 Preparing for the GMAT. A company that offers courses to prepare students for the Graduate Management Admission TEST (GMAT) has the following information about its customers: 20% are currently undergraduate students in business; 15% are undergraduate students in other fields of study; 60% are college graduates who are currently employed; and 5% are college graduates who are not employed. Choose a customer at random.

(a) What is the probability that the customer is currently an undergraduate? Which rule of probability did you use to find the answer?

(b) What is the probability that the customer is not an undergraduate business student? Which rule of probability did you use to find the answer?

HW page 301 # 15, 30*, 31–36, page 315 #43, 45, 47 *Do at least 10 trials

5.2 Two-Way Tables

Read 309–311

Example. Students in a college statistics class wanted to find out how common it is for young adults to have their ears pierced. They recorded data on two variables – gender and whether the student had a pierced ear – for all 178 people in the class. The two-way table below displays the data

Pierced ears?	Male	Female	**Total**
Yes	19	84	**103**
No	71	4	**75**
Total	**90**	**88**	**178**

Suppose we choose a student from the class at random. Find the probability that the student:

(a) has pierced ears.

(b) Is male and has pierced ears.

(c) Is male or has pierced ears.

What is the **GENERAL ADDITION RULE**? Is it on the formula sheet?

What if the events are mutually exclusive?

Alternate Example: Who Owns a Home?

What is the relationship between educational achievement and home ownership? A random sample of 500 people who participated in the 2000 census was chosen. Each member of the sample was identified as a high school graduate (or not) and as a home owner (or not). Overall, 340 were homeowners, 310 were high school graduates, and 221 were both homeowners and high school graduates.

(a) Create a two-way table that displays the data.

Suppose we choose a member of the sample at random. Find the probability that the member

(b) is a high school graduate.

(c) is a high school graduate and owns a home.

(d) is a high school graduate or owns a home.

Read 311–314

Alternate Example: Phone Usage
According to the National Center for Health Statistics, in December 2012, 60% of US households had a traditional landline telephone, 89% of households had cell phones, and 51% had both. Suppose we randomly selected a household in December 2012.
(a) Make a two-way table that displays the sample space of this chance process.

(b) Find the probability that the household has at least one of the two types of phones.

(c)Find the probability that the household has neither type of phone.

(d) Find the probability the household has a cell phone only.

<u>**TRY**</u>:

1. At a community swimming pool there are 2 managers, 8 lifeguards, 3 concession stand clerks and 2 maintenance people. If a person is selected at random, find the probability that the person is either a lifeguard or a manager.

2. At a convention there are 7 math instructors, 5 computer science instructors, 3 statistics instructors and 4 science instructors. If an instructor is selected a random, find the probability of selecting a math or science instructor.

3. Netflix acquired the following number of movies titles in each of these categories: 170 horror; 230 drama; 120 mystery; 310 romance; and 150 comedies. If a person watched one of the movies at random, find the probability that a romance or comedy was watched.

HW page 301 (17, 29*), page 315 49–52 *Do at least 10 trials

5.2 Venn Diagrams

Read 309-311

Complement Rule:

Mutually Exclusive:

Intersection:

Union:

<u>*Who Has Pierced Ears? (cont'd)*</u> Let's refer back to the two-way table from this prior example. Our events of interest were A: is male and B: has pierced ears.

(a) Construct a Venn diagram the displays this information.

Pierced ears?	Male	Female	**Total**
Yes	19	84	**103**
No	71	4	**75**
Total	**90**	**88**	**178**

(b) There are four distinct regions in the Venn diagram. These regions correspond to the four cells in the two-way table (not the margins). We can describe this in the following table.

Region in Venn Diagram	**Count**	**In Words**	**In Symbols**
In the intersection of two circles			
Inside circle A, not inside circle B			
Inside circle B, not inside circle A			
Outside both circles			

Venn Diagram + General Addition Rule:

Example: *Who Reads the Paper?* In an apartment complex, 40% of residents read *USA Today*. Only 25% read the *New York Times*. 5% of residents read both papers. Suppose we select a resident of the apartment complex at random and record which of the two papers the person reads.

(a) Construct a Venn diagram to represent the outcomes of this chance process. Don't forget to define the events!

(b) Find the probability that the person reads at least one of the two papers.

(c) Find the probability that the person doesn't read either paper.

HW p. 316 #53, 55, 57-60