

An Introduction to Probability

**AP Statistics
Chapter 6
Westside High School**

Introductory Assignment
Personal Biography

Your first assignment is to write a one-page (single-spaced) document on the computer, using a word processing package of your choice.

Content. The first paragraph should be a brief autobiographical statement about yourself that will help me get to know you. What are your likes and dislikes? Who are your role models? What makes you unique? What curricular or extracurricular activities are you especially enthusiastic about?

In the second paragraph, tell me about something you remember from a previous math course. It can be a particularly good experience or a particularly bad experience. Or describe a math teacher you've had who stood out in some way.

In the third paragraph, tell me about your plans for college. If you are thinking about a particular major, tell me about that and why you are interested in that field. Tell me about possible career interests in general terms.

In the fourth and last paragraph, tell me something about this statistics course. Possible areas to address: Why are you taking AP Statistics? Is statistics an important tool in the field of study you are considering? Have you had any previous connection with statistics? Can you give an example from the "real world" where statistics is or has been important to you personally?

Requirements:

1. Use **Arial** font, size 11 points.
2. Title the first line "Brief Autobiographical Sketch" in **bold**, and make the second line your name, also in **bold**. Center both lines, and use font size 16.
3. Insert the following paragraph headings, in order: Biographical, Retrospective, College, and AP Statistics, like the paragraph headings I have used on this sheet, and then put these words in **bold**.
4. Separate all paragraphs with a blank line.
5. Before you print the final copy, make sure you proofread your paper on the screen, and then check it for spelling and grammar.

Grading. I will evaluate you on: following instructions, spelling, grammar, general interest, and whether your bio was submitted on time.

Deadline. This introductory report is due on _____.

Sample Space Problems

1. List the sample space for the outcomes for all possible sums you can get by rolling two dice. Use set notation.
2. What is the sample space for rolling a die and then flipping a coin? You may do this with a tree diagram, or with set notation.
3. Belinda will choose either orange juice (o) or grapefruit juice (g) for breakfast. Then she will choose either eggs (e), pancakes (p), or cereal (c). Using these letter versions, create the sample space for all breakfasts Belinda can have using set notation.
4. Describe the sample space using either numbers or words for the following:
 - a) Choose a student in your class at random. Ask how much time that student spent studying during the last 24 hours.
 - b) The Physician's Health Study asked 11,000 physicians to take an aspirin every other day and observed how many of them had a fatal heart attack in a five year period.
 - c) In a test of a new package design, you drop a carton of one dozen eggs from a height of 1 foot and record the number of broken eggs.
 - d) Choose a student in your class at random. Ask how much cash that student is carrying.
 - e) A nutrition researcher feeds a new diet to a young male white rat for eight weeks and records its weight gain.

Permutations, Combinations, and the Fundamental Principle of Counting Problems

1. How many ways can you arrange 4 out of 7 books on a shelf?
2. How many ways can a committee of 3 women and 2 men be chosen from an organization comprised of 10 women and 12 men.
3. How many possible different hands of 5 cards each can be dealt from a standard deck of 52 cards?
4. If a man owns 5 pairs of pants, 7 shirts, and four pairs of shoes, how many outfits can be assembled?
5. If an automobile license plate must consist of three letters followed by three single-digit numbers, how many different license plates are possible?
(Remember that numbers and letters can be duplicated).
6. If a combination lock has a three-digit combination and the wheel on the lock allows any number from 0 to 40, how many different combinations are possible?
7. How many four-digit numbers have both the hundreds and the units digits even?
8. How many ways can a committee of 4 people be chosen from a club of ten members?
9. The summer reading list for AP English includes 10 non-fiction books, 8 novels, and 5 collections of poems. How many different selections of 3 non-fiction, 2 novels, and 1 collection of poems can be chosen from the list?

10. A representative of an environmental protection agency plans to sample water at ten different ponds randomly selected from 25 available ponds. How many different combinations are possible?
11. The science club has challenged the math club to a friendly competition. Each club's team should be comprised of 2 boys and 3 girls. There are 20 boys and 15 girls in the science club and 25 boys and 30 girls in the math club. How many different teams are possible for each club? How many different ways can the competition be held?
12. A manager must choose five secretaries from among 12 applicants and assign them to different stations. How many different arrangements are possible?
13. Barbara is a research biologist for *Green Carpet Lawns*. She is studying the effects of fertilizer type, temperature at time of application, and water treatment after application. She has four fertilizer types, three temperature zones and three water treatments to test. How many different configurations of tests are possible?
14. There are three nursing positions to be filled at Lilly Hospital. Position one is the day nursing supervisor; position two is the night nursing supervisor; position three is the nursing coordinator. There are 15 candidates qualified for all three of the positions. How many different ways can these positions be filled?
15. In the *Cash Now Lottery* game, people choose four numbers from numbers 1 to 30, without repeated numbers. Four numbers are drawn on Friday night and winners must match all four numbers in any order. How many different winning combinations are possible?
16. Given the digits 5, 4, 2, 0, 3, 7, 9, 4, 2. How many three-digit numbers can be formed if the hundreds place must be even and the ones place is at least 5?
17. Data are grouped according to gender (male or female) and according to income level (low, middle, and high). How many different possible categories are there?
18. A computer operator must select four jobs from among ten available jobs waiting to be completed. How many different arrangements are possible?
19. A health inspector has time to visit seven of the 20 restaurants on a list. How many different routes are possible?
20. How many ways can a station manager arrange nine commercials in a show?
21. How many different seven-digit telephone numbers are possible if the first digit cannot be 0 or 1?
22. A six-member FBI investigative team is to be formed from a list of 30 agents. How many different teams are possible?
23. How many different social security numbers are possible? Each social security number is a sequence of nine digits.
24. A union must elect four officers from 16 available candidates. How many different slates are possible if one candidate is nominated for each office?
25. A multiple-choice test consists of ten questions with choices a, b, c, d, and e. How many different answer keys are possible?

Worksheet - Probability Rules

1. Canada has two official languages: English and French. Choose a Canadian at random and ask, "What is your mother tongue?" Here is a distribution of responses:

Language	English	French	Asian/Pacific	Other
Probability	0.63	0.22	0.06	?

- What probability should replace the "?" in the distribution. Why?
 - What is the probability that the Canadian's mother tongue is not English?
 - What is the probability that the Canadian's mother tongue is either French or Asian/Pacific?
2. All humans can be typed as either one of O, A, B, or AB, but the distribution varies a bit with race. Here is the distribution of the blood type of a randomly chosen Black American:

Blood Type	O	A	B	AB
Probability	0.49	0.27	0.20	?

- What is the probability of type AB?
 - What is the probability of randomly choosing an individual having type A or type AB blood?
 - Maria has type B blood. She can safely receive blood transfusions from people with type B or type O blood. What is the probability of choosing a person at random who can donate safely to Maria?
 - What is the probability of randomly choosing an individual with type A **and** type B blood?
3. Jeanie is a bit forgetful, and if she doesn't make a "to do" list, the probability that she forgets something she is supposed to do is .1. Tomorrow she intends to run three errands, and she fails to write them on her list.
- What is the probability that Jeanie forgets all three errands?
 - What is the probability that Jeanie remembers at least one of the three errands?
 - What is the probability that Jeanie remembers the first errand but not the second or third?
4. The Masterfoods company states purple and yellow candies each make up 20% of their plain M&M's, red another 20%, and orange, blue, and green each make up 10%. The rest are brown.
- If you pick an M&M at random, what is the probability that
 - it is brown?
 - it is yellow or orange?
 - it is not green?
 - it is striped?
 - If you pick three M&M's in a row, what is the probability that
 - they are all brown?
 - none are yellow?
 - that the first is red, the second is blue, and the third is yellow?
 - that at least one is green?

5. A Gallup poll in March 2001 asked 1005 US adults how the United States should deal with the current energy situation: by more production, More conservations or both. Here are the results:

Response	Number
More production	332
More Conservation	563
Both	80
No opinion	30
Total	1005

If we select a person at random from this sample of 1005 adults,

- what is the probability that the person responded "More production"?
- what is the probability the person responded "Both" or had no opinion?
- what is the probability the person did not respond "Both"?

If we select three persons at random (assume independence) from this sample

- what is the probability that all three responded "More production"?
- what is the probability that none of the three responded "Both"?
- what is the probability that the first said "More production", the second had no opinion and the third said "Both"?

6. A slot machine has three wheels that spin independently. Each wheel has 10 equally likely symbols: 4 bars, 3 lemons, 2 cherries, and a bell. Determine the following probabilities of getting:

- 3 lemons.
- no fruit symbols.
- 3 bells (a jackpot).
- no bells.
- at least one bar (an automatic lose).

7. Your buddy, Percy (the "Petman") has 6 pets. Four are cats (Felix, Boots, Danzig, Skeeter) and two are dogs (Rover, Xerxes).

- You are interested in figuring out all possible sets of 6 animals taken 2 at a time. List these outcomes using the first letter of the pet's names.

- What is the probability of having any pair being comprised of only cats?

8. New spark plugs have just been installed in a small airplane with a four-cylinder engine, one spark plug per cylinder. For each spark plug, the probability that it is defective and will fail during its first 20 minutes of flight is $1/10,000$, independent of the other spark plugs.
- For any given spark plug, what is the probability that it will not fail during the first 20 minutes of flight?
 - What is the probability that none of the four spark plugs will fail during the first 20 minutes of flight?
 - What is the probability that at least one of the spark plugs will fail?
 - If a plane rental company has 25 of these small airplanes, what is the probability that at least one of the spark plugs will fail?
9. Kath and Peter both drive older cars that don't always work in the wintertime. Suppose that Kathy's car works 80% of the time and Peter's works 65% of the time. What is the probability they will both be working on any given winter morning?

Worksheet - General Addition Rule

1. Call a household prosperous if its income exceeds \$100,000. Call the household educated if the householder completed college. Select an American household at random, and let A be the event that the selected household is prosperous and B the event that the household is educated. According to the Census Bureau, $P(A) = 0.134$, $P(B) = 0.254$, and $P(A \text{ and } B) = 0.080$. What is the probability that the household selected is prosperous or educated, $P(A \text{ or } B)$?
2. For problem #1, create a Venn diagram that shows the relation between events A and B with the respective probabilities. Describe in words the four joint events and indicate the probabilities associated with each.
 - a) $\{A \text{ and } B\}$
 - b) $\{A^c \text{ and } B\}$
 - c) $\{A \text{ and } B^c\}$
 - d) $\{A^c \text{ and } B^c\}$
3. If $P(A) = .55$, $P(B) = .42$, $P(A \cap B) = .40$, then $P(A \cup B) =$ _____
4. Let E denote the event that a randomly selected student at a certain university has a MasterCard credit card, and let F be the event that such a student has a Visa credit card.
 - a) If $P(E) = .40$, $P(F) = .50$ and $P(E \cap F) = .30$, then calculate $P(E \cup F)$.
 - b) If $P(E) = .25$, $P(F) = .40$ and $P(E \cup F) = .50$, then calculate $P(E \cap F)$.
5. Many fire stations handle emergency calls for medical assistance as well as calls requesting fire-fighting equipment. A particular station says that the probability that an incoming call is for medical assistance is .85.
 - a. What is the probability that a call is not for medical assistance?
 - b. Assuming that successive calls are independent, what is the probability that both of two successive calls will be for medical assistance?
 - c. What is the probability that three consecutive calls are not for medical assistance?
 - d. What is the probability that of the next 10 calls, at least one is for medical assistance?
6. Hypothetical records indicate that the probability that a freshman in high school has maturity issues or family issues is 0.71. The probability that a freshman has maturity issues is 0.48. We also know that the chance of a freshman having family issues is 0.34. What is the probability that a freshman has both maturity and family issues?

7. If you eat at Silly Bob's Cafe there's a 40% chance that your food will be cold and a 30% chance your food will taste bad. Assume that these two events are independent.
- What is the probability that both will occur, you food is cold **and** it tastes bad?
 - What is the probability that your food is cold **or** it tastes bad?
8. When spot-checked for safety, automobiles are found to defective tires 15% of the time, defective lights 25% of the time, and both defective tires and lights 8% of the time. Find the probability that a randomly chosen car has defective lights or that its tires are found to be defective.
9. A construction firm has bid on two different contracts. Let B1 be the event that the first bid is successful and B2, that the second bid is successful. Suppose that $P(B1) = .4$, $P(B2) = .6$ and that the bids are independent. What is the probability that:
- both bids are successful?
 - neither bid is successful?
 - is successful in at least one of the bids?
10. There are two traffic lights on the route used by Pickup Andropov to go from home to work. Let E denote the event that Pickup must stop at the first light and F in a similar manner for the second light. Suppose that $P(E) = .4$ and $P(F) = .3$ and $P(E \text{ and } F) = .15$. What is the probability that he:
- must stop for at least one light?
 - doesn't stop at either light?
 - must stop at exactly one light?
 - must stop just at the first light?
11. Jack and Jill have finished conducting taste tests with 100 adults from their neighborhood. They found that 60 of them correctly identified the tap water. The data is displayed below.

Identified Tap Water			
	Yes	No	Total
Male	21	14	35
Female	39	26	65
Total	60	40	100

What is the probability of choosing a person at random and picking a female or someone who could not identify tap water?

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AP Statistics - Venn diagram Practice

1. Consolidated Builders has bids on two large construction projects. The company president believes that the probability of winning the first contract (event A) is 0.6, that the probability of winning the second contract is 0.5, and that the probability of winning both jobs (event $\{A \text{ and } B\}$) is 0.3. Draw a Venn diagram which illustrates all the joint probabilities in terms of A and B along with their respective probabilities.
2. A survey of 1000 newly constructed homes was taken regarding whether or not each had a sprinkler system, alarm, or ceiling fans installed. Use the following results to fill in a Venn diagram with the number of homes located in each section of the diagram.

177 have none of the options

101 have only ceiling fans

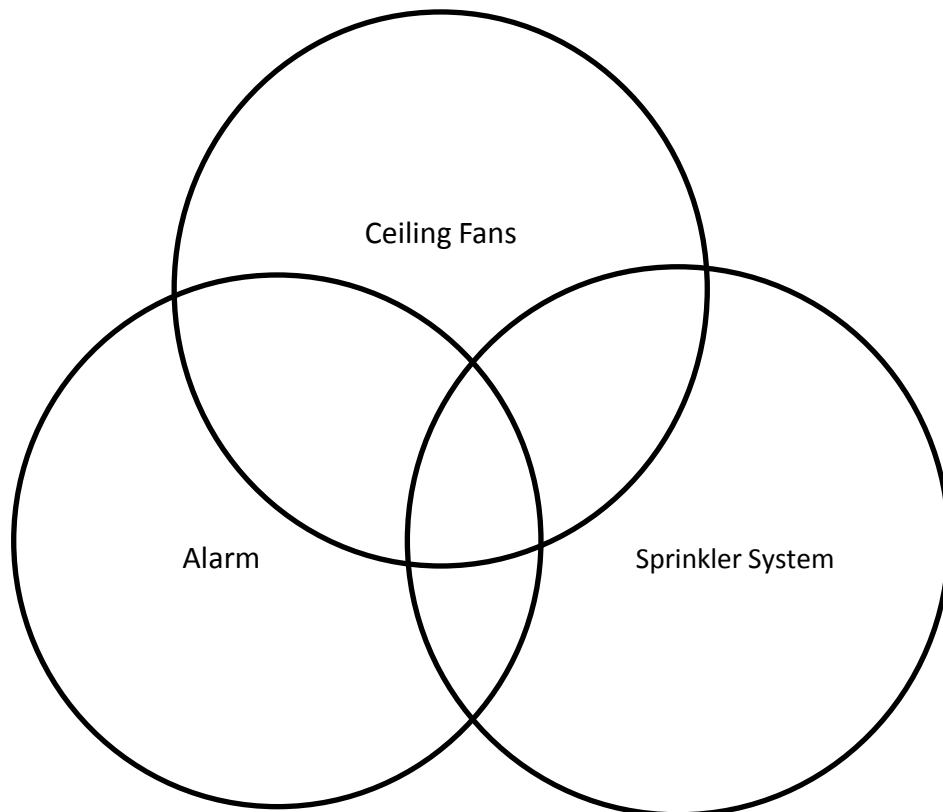
439 have a sprinkler system

72 have an alarm and ceiling fans, but do not have a sprinkler system

289 have a sprinkler system, but do not have ceiling fans

463 have an alarm

137 have only a sprinkler system



3. There are 100 students enrolled in various AP courses at American High School. There are 31 students in AP European History, 52 students in AP Calculus, and 15 students in AP Spanish. Ten students study both AP European History and AP Calculus, five students study both AP European History and AP Spanish, eight students study both AP Calculus and AP Spanish, and three students study all three. What is the probability that a student takes an AP course other than these three?
(Hint: Use a Venn diagram to answer this question!)

Also do textbook problem 6.51 on page 365,

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Conditional Probability Worksheet #1

In a statistics class there are 18 juniors and 10 seniors. 6 of the seniors are females and 12 of the juniors are males.

1. Make a two-way table for this categorical data.
2. What is the probability of selecting one student at random and getting a senior and a male?
3. What is the probability of selecting one student at random and getting a junior and a male?
4. What is the probability of selecting one student at random and getting a senior and a female?
5. What is the probability of selecting one student at random and getting a junior and a female?

A certain model car comes in a two-door version, a four-door version, and a hatchback version. Each version can be equipped with either an automatic transmission or a manual transmission. The accompanying table gives the relevant proportions for purchases.

	Two-Door	Four-Door	Hatchback
Automatic	.32	.27	.18
Manual	.08	.04	.11

A customer who has purchased one of these cars was randomly selected.

1. What is the probability that this customer has purchased a car with an automatic transmission?
A four door car?
2. Given that a customer purchased a four-door car, what is the probability that it has an automatic transmission?
3. Given that a customer purchased a manual transmission car, what is the probability that it is a hatchback?
4. Given that a customer did not purchase a hatchback, what is the probability that the car has a manual transmission?
5. Given that a customer purchased a two-door or a four door, what is the probability that the car has an automatic transmission?
6. What is the probability that a customer purchased a hatchback, a two-door, or a four-door model?

Conditional Probability #2

1. At a fictional high school Statistics High, after-school activities can be classified into three types: athletes, fine arts, and other. The table gives the number of students participating in each of these types of activities by grade. For the purpose of this example, we will assume that any given student is in exactly one of these after-school activities.

	9 th	10 th	11 th	12 th	Total
Athletes	150	160	140	150	600
Fine Arts	100	90	120	125	435
Other	125	140	150	150	565
Total	375	390	410	425	1600

- What is the probability that a student selected is a 9th grader?
- What is the probability that a student selected is an athlete?
- What is the probability that a student selected is an upper classmen (11th or 12th grader)?
- What is the probability that a student selected is not an athlete?
- What is the probability that a student selected is a 9th grader and an athlete?
- What is the probability that a student selected is an upper classmen and in fine arts?
- What is the probability that a student selected is a 9th grader, given the student selected is an athlete?
- What is the probability that a student selected is an athlete, given the student selected is a 9th grader?
- What is the probability that a student selected is an upper classmen, given the student is in fine arts?
- What is the probability that a student selected is in fine arts, given the student is an upper classmen?

2. Data on marital status of U.S. adults can be found in Current Population Reports, a publication of the U.S. Bureau of Census. The table provides a joint probability distribution for the marital status of U.S. adults by gender.

	Never Married M_1	Married M_2	Widowed M_3	Divorced M_4	$P(G_M)$
Male G_1	0.129	0.298	0.013	0.040	0.480
Female G_2	0.104	0.305	0.057	0.054	0.520
$P(M_G)$	0.233	0.603	0.070	0.095	1.000

- Determine the probability that the adult selected is divorced.
 - Determine the probability that the adult selected is male.
 - Determine the probability that the adult selected is divorced and male.
 - Determine the probability that the adult selected is divorced, given that the adult selected is male.
 - Determine the probability that the adult selected is male, given that the adult is divorced.
- 3, If $P(A) = .1$, $P(B) = .6$, and $P(B|A) = .5$, then $P(A \text{ and } B) = \underline{\hspace{2cm}}$

4. Members of a group of 50 college students were classified according to their hometown and ethnicity:

Hometown	Anglo	Hispanic	Asian	African-Amer.
Houston	7	4	11	6
San Antonio	8	7	4	3

- What is the probability a member is Asian?
- What is the probability a member is Hispanic and from San Antonio?
- What is the probability a member is African-American or from Houston?
- What is the probability a member from San Antonio is Anglo?
- Name two events that are mutually exclusive.
- Are being from Houston and being Asian independent?

5. One exciting aspect of increased communication using the Internet is that diverse individuals from widely scattered places all over the world can form an electronic chat room. A side effect of such conversation is negative criticism of others' contributions to the conversation. Investigators are interested in the effect that personal criticism has on an individual. Would being criticized make one more likely to criticize others?

	Have Been Personally Criticized	Have Not Been Personally Criticized
Have Criticized Others	19	8
Have Not Criticized Others	23	143

We will assume that the table from the article is indicative of the larger group of chat room users. Suppose that a chat room user is randomly selected. Let C = event that the individual has criticized others and let O = event that the individual has been personally criticized by others.

Write the following events out in words and then solve the probability.

- $P(C) =$
 - $P(O) =$
 - $P(C \cap O) =$
 - $P(C|O) =$
 - $P(O|C) =$
6. If $P(A) = .41$, $P(B) = .49$, and $P(A|B) = .45$, then $P(A \cap B) =$ _____
7. If $P(A) = .35$, $P(B) = .55$, and $P(B|A) = .72$, then $P(A \cap B) =$ _____
8. A GFI (ground fault interrupt) switch will turn off power to a system in the event of an electrical malfunction. A spa manufacturer currently has 25 spas in stock, each equipped with a single GFI switch. The switches are supplied by two different companies, and some of them are defective.

	<i>Nondefective</i>	<i>Defective</i>
<i>Company 1</i>	10	5
<i>Company 2</i>	8	2

- a. What is the probability of a GFI switch from a selected spa is from company 1?
- b. What is the probability of a GFI switch from a selected spa is defective?
- c. What is the probability of a GFI switch from a selected spa is defective and from company 1?
- d. What is the probability of a GFI switch from a selected spa is from company 1 given that it is defective?
- e. What is the probability of a GFI switch is defective knowing the switch is from Company 2?

Probability Rules Summary

Basic Probability Rules

The probability $P(A)$ of any event A satisfies $0 \leq P(A) \leq 1$.

The probability of all possible outcomes total 1.

If S is the sample space in a probability model, then $P(S) = 1$.

Complement Rule

The complement of any event A is the event that A does not occur, written as A^c . The complement rule states that $P(A^c) = 1 - P(A)$.

"At Least One" Rule

$P(\text{At least one}) = 1 - P(\text{none})$

Addition Rule for Disjoint Events

Two events A and B are disjoint if they have no outcomes in common and so can never occur simultaneously. If A and B are disjoint, $P(A \text{ or } B) = P(A) + P(B)$.

Multiplication Rule for Independent Events

Two events A and B are independent if knowing that one occurs does not change the probability that the other occurs. If A and B are independent, $P(A \text{ and } B) = P(A)P(B)$.

General Addition Rule

For any two events A and B , $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

General Multiplication Rule

The joint probability that both of two events A and B happen together can be found by

$P(A \text{ and } B) = P(A)P(B|A)$.

$P(B|A)$ is the conditional probability that B occurs given the information that A occurs. A little algebra gives us:

$P(B|A) = P(A \text{ and } B)/P(A)$

and...

$P(A|B) = P(A \text{ and } B)/P(B)$

$$P(A \text{ and } B) = P(A \cap B)$$

and

$$P(A \text{ or } B) = P(A \cup B)$$

Vocabulary Chapter 6

Read 6.1-6.2 and start compiling vocabulary and notes.

1. Probability
2. Randomness
3. Experiment
4. Outcomes
5. Sample Space
6. Theoretical Probability
7. Empirical Probability
8. Multiplication Principle

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Probability Practice

Find the requested probabilities using the given information.

1. A and B are events. $P(A) = .6$, $P(B) = .5$, and $P(A \cup B) = .9$. Find:

$$P(A \cap B)$$

$$P(A|B)$$

2. A and B are events. $P(A) = .2$, $P(B) = .4$ and $P(A \cup B) = .5$. Find:

$$P(A \cap B)$$

$$P(B|A)$$

3. A and B are events. $P(A) = .3$, $P(B) = .6$, and $P(B|A) = .4$. Find:

$$P(A \cap B)$$

$$P(A \cup B)$$

$$P(A|B)$$

$$P(A^c \cup B^c)$$

4. A and B are events. $P(A) = .4$, $P(B) = .5$, and $P(B|A) = .8$. Find:

$$P(A \cap B)$$

$$P(A \cup B)$$

$$P(A|B)$$

$$P(A^c \cup B^c)$$

5. Events A and B are mutually exclusive. $P(A) = .25$ and $P(B) = .6$. Find:

$$P(A \cap B)$$

$$P(A \cup B)$$

$$P(A|B)$$

6. Events A and B are independent. $P(A) = .25$ and $P(B) = .6$. Find:

$$P(A|B)$$

$$P(B|A)$$

$$P(A \cap B)$$

$$P(A \cup B)$$

7. Events A and B are disjoint. $P(A) = .15$ and $P(B) = .4$. Find:

$$P(A \cap B)$$

$$P(A \cup B)$$

$$P(B|A)$$

8. Torstein is determining probabilities using a standard deck of 52 playing cards (4 suits, two colors, 13 cards per suit). Let event H be the event that a heart is drawn, and let event F be the event that the card drawn is a face card. Help Torstein determine the following:

1) $P(H)$

2) $P(F)$

3) $P(H|F)$

4) $P(F|H)$

Given your answers to the second and the fourth questions, what does it say about the two events H and F ?

9. A fair die is rolled. What is the probability that a number rolled is less than 4 given that the outcome is even?

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Tree Diagrams

1. Leah is flying from Boston to Denver with a connection in Chicago. The probability her first flight leaves on time is 0.15. If the flight is on time, the probability that her luggage will make the connecting flight is 0.95, but if the first flight is delayed, the probability that the luggage will make it is only 0.65.

What is the probability that her luggage arrives in Denver with her?

2. Suppose that 23% of adults smoke cigarettes. It's known that 57% of smokers and 13% of non-smokers develop a certain lung condition by the age of 60.

What is the probability that a randomly selected 60-year-old has this lung condition?

3. The probability of having a certain disease is .05. The probability of testing positive if you have the disease is .98; the probability of testing positive when you do not have the disease is .10. Use a tree diagram to answer the following:

What is the probability that you will test positive for the disease given that you actually have it?

What is the probability that you won't test positive for the disease given that you have it?

What is the probability that you will test positive for the disease given that you don't have it?

What is the probability that you won't test positive for the disease given that you don't have it?

Find all of the joint probabilities, then find the probability of not testing positive for the disease.

4. Let $A = \{\text{student studies}\}$ with $P(A) = .5$ and let $B = \{\text{student does well on a test}\}$. Also, let the following be true:

$$P(\text{Student studies and does well on a test}) = .35$$

$$P(\text{Student studies and does poorly on a test}) = .15$$

$$P(\text{Student doesn't study and does well on a test}) = .05$$

$$P(\text{Student doesn't study and does poorly on a test}) = .45$$

What is the probability that a student does poorly, given that he/she didn't study?

What is the probability that any student does well?

5. Binge drinking on college campuses. Binge drinking is 4 or more drinks in a row. 44% of the college students binge drink, 37% drink moderately and 19% abstain from drinking. Among binge drinkers aged 21-34 17% have been involved in an alcohol related auto accident and 9% of non binge drinkers have been in an alcohol related auto accident. Find the probability that a randomly selected college student will be a binge drinker if they had an alcohol-related auto accident.

6. After surveying 995 adults, 81.5% of who were over 30, the National Sleep Foundation reported that 38.8% of all adults snored. 32% of the respondents were snorers over the age of 30.

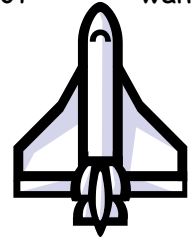
What percent of the respondents were under 30 and did not snore?

Is snoring independent of age? Explain.

Conditional Probability & Tree Diagrams



- 1) A survey of CRHS students found that 36% said that they would be interested in going to Saturn. Of those who wanted to go to Saturn, 60% were not seniors. Of those who did not want to go to Saturn, 30% were seniors. Create a tree diagram for this situation.



Fill in the two-way (contingency) percent table with the information.

	Saturn	Not Saturn	Totals
Senior			
Not senior			
Totals			100%

What is the probability that a randomly selected

(a) Student wanted to go to Saturn?

(b) Was a senior and wanted to go to Saturn?

(c) Student was a senior?

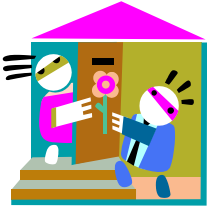
(d) Senior wanted to go to Saturn?

(e) Saturn wannabe was a senior?

If 500 students were surveyed, fill in the two-way (contingency) counts table with the information.

	Saturn	Not Saturn	Totals
Senior			
Not senior			
Totals			500

- 2) When the male students at CRHS were asked, 50% said they do not date someone from CRHS. When the female students were asked, 40% said they do not date someone from CRHS. The male students make up 52% of the student population. Draw a tree diagram to represent this situation.



Fill in the two-way (contingency) percent table with the information.

	Date CRHS student	Don't date CRHS student	Totals
Male			
Female			
Totals			100%

What is the probability that a randomly selected

- Student does not date someone from CRHS?
- Student is female?
- Student is female and does not date someone from CRHS?
- Student who dates someone from CRHS is male?

If 500 students were surveyed, fill in the two-way (contingency) counts table with the information.

	Date CRHS student	Don't date CRHS student	Totals
Male			
Female			
Totals			500

- How many were male?
- How many were females who did not date someone from CRHS?

- 3) Mrs. Chipman's and Mr. Garner's Statistics classes collected information on their gender and handedness. The two-way table below gives the percents of the statistics students who fall into each category.

	Male	Female	Totals
Right-handed	.35	.3	.65
Left-handed	.15	.2	.35
Totals	.5	.5	100%



probability

If a student is chosen at random from the Statistics classes, what is the probability of a

- (a) Student being female, if the student is right-handed?

- (b) Student being female and right-handed?

- (c) Student being left-handed, if the student is a male?

If there are 140 Statistics students, complete the two-way counts table below.

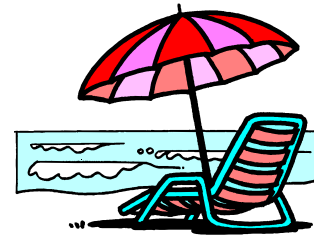
	Male	Female	Totals
Right-handed			
Left-handed			
Totals			

- (d) How many are male and left-handed?

Can you draw a tree diagram with correct probabilities to represent this situation?

- 4) The following counts were provided concerning people in rural, suburban, and urban areas and the length of their vacations (1-7 days or 8+ days).

	Rural	Suburban	Urban	Totals
1-7 days	80	39	37	156
8+ days	43	32	19	94
Totals	123	71	56	250



Complete the two-way percent table with the information.

	Rural	Suburban	Urban	Totals
1-7 days				
8+ days				
Totals				100%

What is the probability that a randomly selected

- (a) Person spends 8+ days on vacation, given that he/she is from a rural area?

- (b) Person is from a rural area, given that he/she spends 8+ days on vacation?

- (c) Person spends 1-7 days on vacation, given that he/she is from a suburban area?

- (d) Person is from an urban area, given that he/she spends 1-7 days on vacation?

Can you draw a tree diagram with correct probabilities to represent this situation?

- 5) We wish to look at probabilities concerning whether students own a dog or have a cell phone. We poll 400 students at CRHS. One hundred thirty-two own a dog. Eighty-four students owning a dog have a cell phone. One hundred forty students without a dog have a cell phone.

Complete the two-way table of counts for this situation.



		Cell Phone		Totals
		Yes	No	
Dog	Yes			
	No			
	Totals			400

Complete the two-way percent table for this situation.

		Cell Phone		Totals
		Yes	No	
Dog	Yes			
	No			
	Totals			100%



- (a) What is the probability that a student has a dog and a cell phone?
- (b) What is the probability that a student does not have a dog or a cell phone?
- (c) What is the probability that a student does not have a dog, if he/she does not have a cell phone?
- (d) What is the probability that a student with a cell phone has a dog?
- (e) What is the probability that a dog-owning student has a cell phone?

8) A box contains four red tags numbered 1 through 4 and six blue tags numbered 1 through 6.

(a) What is the sample space?

(b) Find the following probabilities:

P(red)

P(odd)

P(Red or Even)

P(Blue or even)

P(Not Red nor Even)

P(Even | Blue)

9) You work at Circuit City. You track your customer's buying habits. Let event A={buying a DVR} and event B={buying recordable DVD's}. If the following probabilities are given:

$$P(\text{buying a DVR}) = .6$$

$$P(\text{buying recordable DVD's}) = .7$$

$$P(\text{Buying a DVR and recordable DVD's}) = .36$$

Determine if events A and B are independent.

10) Refer to the data in this chart.

Degrees Earned by Gender

	Bachelor	Master's	Professional	Doctorate	Total
Female	616	194	30	16	856
Male	529	171	44	26	770
Total	1145	365	74	42	1626

Calculate the following probabilities:

(a) P(Bachelor's)

(b) P(Female | Doctorate)

(c) P(Male or Professional)

11) When two numbered cubes are rolled, find the following probabilities:

(a) Rolling a sum of 7

(b) Rolling a sum greater than 10

(c) Rolling a sum of 13

(d) Rolling a sum less than 13

(e) Rolling a sum less than 3 or greater than 10

Also consult textbook problems 6.79 – 6.87 (odd) in your textbook. Recall that all odd numbered problems have answers provided in the back of the book.

AP Statistics

- 1) Suppose a box contains 3 defective light bulbs and 12 good bulbs. Two bulbs are chosen from the box without replacement. What is the probability that one of two bulbs drawn is defective and one is not?
- 2) Of voters in a recent election, 57% were male, 64% were Democrat, and 35% were both male and Democrat.
- What is the probability that a voter chosen at random is female?
 - What is the probability that a voter chosen at random is either male or Democrat?
 - Is being male or Democrat independent of each other?
- 3) A rocket being launched has three engines that are independent of each other. The probability of an engine firing is .97. What is the probability of at least one engine not firing?
- 4) The probability of rain on Monday is .3 and on Thursday is .4. Assuming these are independent, what is the probability that
- it rains on both days?
 - it does not rain on Monday?
 - it rains on Monday, but not Thursday?
 - it rains on at least one of these days?
 - it doesn't rain on either day?
- 5) Student Life at a college did a survey asking students if they were part-time or full-time students. Another question was if the student voted or not in the most recent student elections. The results follow:
If a student is selected at random, what is the probability that
- | | | |
|--------------|-----------|-----------|
| | Part-time | Full-time |
| Voted | 15 | 20 |
| Did not vote | 25 | 30 |
- the student voted in the most recent election?
 - the student voted in the most recent election or is a part-time student?
 - if the student is a part-time student, they voted in the most recent election?
- 6) If the $P(A) = .5$, $P(B) = .6$, and $P(A \text{ or } B) = .85$, then what is
- $P(A \text{ and } B)$?
 - $P(B|A)$?
 - $P(A|B)$?
- 7) If a person is vaccinated properly, the probability of his/her getting a certain disease is 0.05. Without a vaccination, the probability of getting the disease is 0.35. Assume that 40% of the population is properly vaccinated.
- If a person is selected at random from the population, what is the probability of that person's getting the disease?
 - If a person gets vaccinated, what is the probability that he/she got the disease?
 - If a person gets the disease, what is the probability that he/she was vaccinated?

- 8) Consider the following table taken from *The Practice of Statistics* about years of education completed by age.

	25 to 34	35 to 54	55 & over	Total
Did not complete high school	5325	9152	16035	30512
Completed high school	14061	24070	18320	56451
1 to 3 years of college	11659	19926	9662	41247
4 or more years of college	10342	19878	8005	38225
Total	41387	73026	52022	166435

If a person is chosen at random from this population:

- What is the probability that the person is between 25 and 34 years of age?
 - What is the probability that the person is between 25 and 34 years of age **and** 55 & over years of age?
 - What is the probability that a person is between 25 and 34 years of age **or** 55 & over years of age?
 - What is the probability that a person is between 25 and 34 years of age **and** that they have completed 1 to 3 years of college?
 - What is the probability that a person is 35 to 54 years of age **or** has 4 or more years of college?
 - If the person is 55 & over years of age, what is the probability that they completed 1 to 3 years of college?
- 9) It is known that 2% of the population has the serious disease. Suppose a test for diagnosing a certain serious disease is successful in detecting the disease in 95% of all persons infected, but that it incorrectly diagnoses 4% of all healthy people as having the serious disease. Find the probability that a person selected at random has the serious disease if the test indicates that he or she does.
- 10) The probability that a football player weighs more than 230 pounds is 0.69, that he is at least 75 inches tall is 0.55, and that he weighs more than 230 pounds and is at least 75 inches tall is 0.43. Find the probability that he is at least 75 inches tall given that he weighs more than 230 pounds.

Multiple Choice:

- 1) Given the Venn diagram to the right, which portion(s) should be shaded to represent the event that a randomly chosen student is a mathematics major or a statistics major?

- a) B & C only
- b) A & C only
- c) A only
- d) D only
- e) A, B & C

- 2) Refer to the diagram in question 1, which portion(s) should be shaded to represent the event that a randomly chosen student is not a mathematics major and is a statistics major?

- a) C & D only
- b) B & C only
- c) B only
- d) C only
- e) B, C, & D

- 3) The probability that an engine will not start is 0.04. A rocket has four independent engines. What is the probability that at least one of the engines does not start?

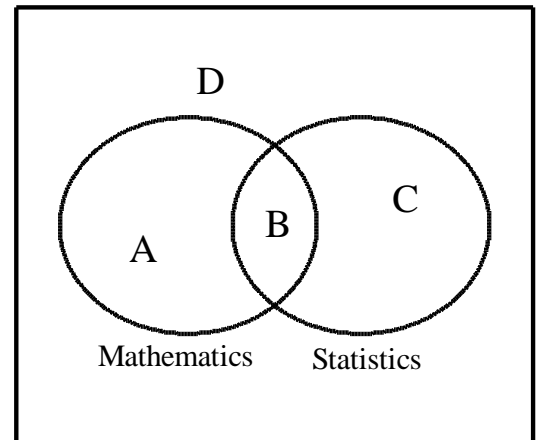
- a) .8154
- b) .00006
- c) .1507
- d) .0354
- e) .0015

- 4) The probability that thunderstorms are in the area near DFW airport and that planes will land on time is 0.56. If there are thunderstorms in the area of DFW, the probability that the plane lands on time is 0.80. What is the probability that there are thunderstorms in the area of DFW?

- a) .7
- b) .448
- c) 1.429
- d) 1.36
- e) cannot be calculated

- 5) Which of the following statements is not true?

- a) In calculating permutations, the order in which the events occur does matter.
- b) A chance experiment is any activity or situation in which there is uncertainty concerning which of two or more possible outcomes will result.
- c) Two events are disjoint if they cannot occur simultaneously.
- d) In order to calculate the compound event "or", the events must be independent.
- e) The probabilities of complementary events are always equal to one.



6) If a peanut M&M is chosen at random, the chances of it being a particular color are shown in the following table.

Color	Brown	Red	Yellow	Green	Orange	Blue
Probability	.3	.2	.2	.2	.1	?

The probability of randomly drawing a blue peanut M&M is

- a) 1.0
- b) .1
- c) .2
- d) .3
- e) According to this distribution, it's impossible to draw a blue M&M.

7) Which of the following are true?

- a) The event "buying a TI calculator" is considered a simple event.
- b) If two events, A and B, are mutually exclusive, then $P(A \text{ and } B) = P(A) \times P(B)$.
- c) The probability of the union of two events is the sum of the probabilities of those events.
- d) The sum of the probabilities of events in a sample space can be any number between 0 and 1.
- e) The probability that an event happens is equal to 1 minus the probability that the event does not happen

8) The chances that you will be ticketed for illegal parking on campus on any given day is about $1/3$. During the last nine days, you have illegally parked every day and have NOT been ticketed (you lucky person)! Today, on the 10th day, you again decide to park illegally. The chances that you will be caught are:

- a) equal to $9/10$ since you were not caught in the last nine days.
- b) greater than $1/3$ since you were not caught in the last nine days.
- c) less than $1/3$ since you were not caught in the last nine days.
- d) still equal to $1/3$ since each day is independent of the other days.
- e) equal to $1/10$ since you were not caught in the last nine days.

9) In one card game, three-card hands are dealt. What is the probability that the hand of three Kings will be dealt?

- a) .0129
- b) .0139
- c) 0
- d) .0002
- e) cannot be determined from the information given

10) A combination lock has a three-digit combination. If the digits (0-9) can be repeated, how many different combinations are possible?

- a) 120
- b) 720
- c) 1000
- d) 729
- e) 504

11) Identify why this assignment of probabilities cannot be legitimate: $P(A) = .4$, $P(B) = .3$, $P(A \text{ and } B) = .5$.

- a) $P(A \text{ and } B)$ cannot be greater than either $P(A)$ or $P(B)$.
- b) A and B are not given as mutually exclusive events.
- c) A and B are not given as independent events.
- d) $P(A|B)$ is not known.
- e) The assignment is legitimate.

12) If the $P(A) = .3$, $P(A \text{ or } B) = .65$, and events A & B are independent, find the $P(B)$.

- a) .8
- b) .35
- c) .15
- d) .5

1) A fair coin is tossed six times, resulting in 6 heads being thrown. What is the probability that a head will be thrown on the seventh toss? Explain.

2) In some states license plates consist of 4 letters followed by 2 or 3 digits. How many license plates are possible if letters and digits can repeat?

3) Doc Worker is a regular customer at the Waterfront Coffee Shop. The manager has figured that Doc's probability of ordering ham is 0.5 and of ordering eggs is 0.85. Assuming that Doc orders food independently of each other, what is the probability of the following?

a) He orders ham but not eggs.

b) He orders at least one of the two.

4) Four percent of the welds on an automobile assembly line are defective. The defective welds are found using an X-ray machine. The machine correctly rejects 92% of the defective welds and correctly accepts 99% of all of the good welds.

a) Make a table or a tree to represent this situation.

b) What is the probability that the X-ray machine will detect a defective weld in a randomly chosen automobile?

c) If the X-ray machine detects a defective weld, what is the probability that the weld really is defective?

Bonus: . If $A \cup B = S$ (sample space), $P(A \text{ and } B^c) = 0.25$, and $P(A^c) = 0.35$, the $P(B) =$

Probability Practice

Choose the best answer.

1. The ants are marching through the house and have many different paths from their anthill to the pantry. There are 3 different paths to get inside the house, 7 different paths to get inside the kitchen once inside the house, and 4 different paths to the food pantry. How many direct routes are there to the pantry from outdoors going through the kitchen?
 - a) 14
 - b) 31
 - c) 40
 - d) 48
 - e) 84

2. Steven has a box of LED's containing 2 blue one, 3 white ones, 7 red ones, and 3 green ones. If two LED's drawn at random from the box without replacement, what is the probability that both LED's are not red?
 - a) $\frac{4}{15}$
 - b) $\frac{56}{225}$
 - c) $\frac{23}{30}$
 - d) $\frac{64}{225}$
 - e) $\frac{11}{15}$

3. Ryan is choosing an outfit to wear to school (consisting of a shirt, a pair of shorts or pants, a pair of socks, and a pair of shoes). He has seven shirts, four pairs of pants, three pairs of shorts, eight pairs of socks, and two pair of shoes available today. How many different outfits can Ryan choose from?
 - a) 1512
 - b) 3528
 - c) 5040
 - d) 490
 - e) 784

4. In how many different ways can 4 semi-finalists be chosen from a set of 18 contestants?
 - a) 1,530
 - b) 3,060
 - c) 18,360
 - d) 73,440
 - e) 104,976

5. In how many ways can the letters in the word "HELLO" be arranged?
- a) 60
 - b) 120
 - c) 180
 - d) 360
 - e) 720
6. In a single throw of a black die and a blue die, what is the probability of having the number shown on the black die greater than the number shown on the blue die?
- a) $\frac{5}{12}$
 - b) $\frac{4}{9}$
 - c) $\frac{1}{2}$
 - d) $\frac{14}{36}$
 - e) $\frac{17}{36}$
7. There are 12 horses running in a race. In how many ways could the first four horses finish?
- a) 48
 - b) 495
 - c) 1,320
 - d) 4,670
 - e) 11,880
8. A university reports that there are 5,500 female students in the 10,000 member student body. The History Department reports 50% of the 1,500 students taking World Civilization courses are female. What is the probability that a randomly selected female student is taking a World Civilization course?
- a) $\frac{1}{6}$
 - b) $\frac{3}{22}$
 - c) $\frac{3}{20}$
 - d) $\frac{3}{11}$
 - e) $\frac{3}{40}$

9. A wheel has 20 slots. There is one slot with the number zero on it. There is one slot with the number one on it. There are three slots with the number two on them. There are six slots with the number three on them. There are nine slots with the number 4 on them. What is the probability of spinning the wheel and the wheel stopping on an even number?

- a) $\frac{11}{20}$
- b) $\frac{13}{20}$
- c) $\frac{7}{20}$
- d) $\frac{2}{5}$
- e) $\frac{3}{5}$

10. A collection contains the following types of movies: 7 comedies, 9 adventures, 4 horror movies, and 6 romances. One movie is randomly selected from the collection. What is the probability that a horror movie is selected?

- a) $\frac{2}{13}$
- b) $\frac{1}{22}$
- c) $\frac{3}{22}$
- d) $\frac{4}{27}$
- e) $\frac{1}{4}$

11. An ice cream store has 25 flavors of ice cream. A customer wants to always purchase a pint each of three different flavors of ice cream. How many possible purchases could the customer make?

- a) 75
- b) 600
- c) 2,300
- d) 4,200
- e) 13,800

12. An automobile has 10 choices for exterior color, 3 choices for interior color, 2 types of engines, and 5 choices of option packages. A prospective buyer must choose one from each of the exterior colors, interior colors, engines, and option packages. How many different styles of automobile are possible?

- a) 20
- b) 80
- c) 240
- d) 300
- e) 330

13. Two antibiotics are available as treatment for a common ear infection in children.

- Antibiotic A is known to effectively cure the infection 60 percent of the time.
- Antibiotic B is known to effectively cure the infection 90 percent of the time.

The antibiotics work independently of one another. Both antibiotics can be safely administered to children. A health insurance company intends to recommend one of the following two plans of treatment for children with this ear infection.

- Plan I: Treat with antibiotic A first. If it is not effective, then treat with antibiotic B.
- Plan II: Treat with antibiotic B first. If it is not effective, then treat with antibiotic A.

- (a) If a doctor treats a child with an ear infection using plan I, what is the probability that the child will be cured?
- (b) If a doctor treats a child with an ear infection using plan II, what is the probability that the child will be cured?