What you will learn about:
Basic Probability

Probability - Likelyhood of some event happening

$P(A) \rightarrow$ Probability of A

half

0 —— 1

Never Always

Fraction, Decimal, Percentage

Probability

$$\frac{\text{Favorable Outcomes}}{\text{total Outcomes}}$$

36 Dice Combinations

1-1	2-1	3-1	4-1	5-1	6-1
1-2	2-2	3-2	4-2	5-2	6-2
1-3	2-3	3-3	4-3	5-3	6-3
1-4	2-4	3-4	4-4	5-4	6-4
1-5	2-5	3-5	4-5	5-5	6-5
1-6	2-6	3-6	4-6	5-6	6-6

Deck of Cards (52)

Hearts (Red)	Diamonds (Red)	Club (Black)	Spade (Black)
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
Jack	Jack	Jack	Jack
Queen	Queen	Queen	Queen
King	King	King	King
Ace	Ace	Ace	Ace
13	13	13	13

Face Cards Jack, Queen, King

Product (multiply)	Using the fact that there are a total of 36 combinations for rolling two dice, answer the following questions. What is the probability of rolling 2 dice and getting a product greater than 15? $\frac{11}{36}$
Sum (Addition)	What is the probability of rolling 2 dice and getting a sum greater than 6? $\frac{21}{36} = \frac{7}{12}$ What is the probability of rolling 2 dice and getting a sum of 7? $\frac{6}{36} = \frac{1}{6}$ What it the probability of rolling 2 dice and getting doubles? $\frac{6}{36} = \frac{1}{6}$ Using the fact that there are 52 playing cards in a deck of cards answer the following questions. What is the probability of drawing a 10 from a deck of 52 cards? $\frac{4}{52} = \frac{1}{13}$

$P(\sim Math)$ ↓ Not	What is the probability of drawing a red jack from a deck of 52 cards? $\frac{2}{52} = \frac{1}{26}$ What is the probability of drawing a club from a deck of 52 card? $\frac{13}{52} = \frac{1}{4}$ What is the probability of drawing a black face card from a deck of 52 cards? $\frac{6}{52} = \frac{3}{26}$ Use the table to answer the following questions. The table shows the favorite subjects of those in the senior class.

Subject	English	Social Studies	Science	Math	Foreign Language	Physical Education	No Preference
Number	35	45	55	40	25	15	30

How many total seniors were surveyed? 245

What is the probability that a student said science?

$$P(\text{Science}) = \frac{55}{245} = \frac{11}{49}$$

What is the probability that a student did not say math? $P(\text{Not math}) = \frac{205}{245} = \frac{41}{49}$

What you will learn about:
The Multiplication Rule for Independent Events

1. About half of all U.S. adults are female. According to a survey published in *USA Today*, three out of five adults sing in the shower.

a. Suppose an adult from the United States is selected at random. From the information above, do you think that the probability that the person is female and sings in the shower is equal to $\frac{3}{5}$, greater than $\frac{3}{5}$, or less than $\frac{3}{5}$.

b. Now examine then situation using the area model shown below,

i. Explain why there are two rows labeled "NO" for "Sings in the Shower" and three labeled "Yes".

Gender

Sings in the Shower	Male	Female
Yes		
Yes		
Yes		
No		
No		

ii. What assumption does this model make about singing habits of males and females?

c. On a copy of this area model, shade in the region that represents the event: *female* and *sings in the shower*.

d. What is the probability that an adult selected at random is female and sings in the shower?

e. What is the probability that an adult selected at random is a male and does not sing in the shower?

2. Consider this problem: What is the probability that it takes exactly two rolls of a pair of dice before getting doubles for the first time?

a. Explain why it makes sense to label the rows of the are model as shown below. On a copy of this area model, label the six columns to represent the possible outcomes on the second roll of a pair of dice.

Second Roll of the Pair of Dice

First Roll of the Pair of Dice

b. On a copy of the area model, shade the square that represents the event *not getting doubles on the first roll* and *getting doubles on the second roll.*

c. What is the probability of not getting doubles on the first roll and then getting doubles on the second roll?

d. Use your area model to find the probability that you will get doubles both times.

e. Use your area model to find the probability that you will not get doubles either time.

3. Use area models to answer these questions:

a. About 25% of Americans put ketchup directly on their fries rather than on the plate. What is the probability that that both your school principal and your favorite celebrity put ketchup directly on their fries?

	b. About 84% of Americans pour shampoo into their hand rather than directly onto their hair. What is the best estimate of the probability that both your teacher and the President of the United States pour shampoo into their hand before putting it on their hair?
Independent Event	4. Suppose Shiomo is playing a game in which he needs to roll a pair of dice and get doubles and then immediately roll the dice again and get a sum of six. He wants to know the probability that this will happen. Explain why the multiplication Rule can be used to find the probability that this sequence of two events will happen. What is the probability?
P(A and B) =	5. A modification of the game in problem 4 involves rolling a pair of dice three times. IN this modified game, Shiomo needs to roll doubles, then a sum of 6, then a sum of eleven. a. Find the probability that this sequence of three events will happen. b. Suppose A, B, And C are three independent everts. Write a rule for calculating P(A and B and C) using the probabilities of each individual events. c. Write the Multiplication Rule for calculating the probability of each individual event.

6. For each of the following questions, explain whether it is reasonable to assume that the events are independent. Then, if it applies, use the Multiplication Rule to answer the question.

a. What is the probability that a sequence of seven flips of a fair coin turns out to be exactly HTHTTHH?

b. What is the probability that a sequence of seven flips of a fair coin turns out to be exactly TTTTTTH?

c. According to the National Center for Education Statistics, 27.9% of public school students live in a small town or rural area. (Source: nces.ed.gov/pub2006/2006307.pdf) If you select 5 students at random, what is the probability that they all live in a small town or rural area?

d. According to the National Center for Education Statistics, the percentage of students who are homeschooled in the United States is 2.2 percent. (Source:nces.ed.gov?pub2006/homeschool/) If you pick 10 students at random in the United States, what is the probability that none of the 10 are home schooled? That half are home schooled?

e. Refer to Part d. You pick a family with two school-age children at random in the United States. What is the probability that both children are home schooled?

	7. *Tree Graphs* are a way of organizing all possible sequences of outcomes. For example, tree graph below shows all possible families of exactly three children (with no twins or triplets). Each G means a girl was born, and each B means a boy was born. In the United States, the probabilities that a girl is born approximately 49%. a. Use the graph to find the probability that a family of three children will consist of two girls and a boy (not necessarily born in that order).

What you will learn about:
Finding Probabilities in Situations with Conditions

1. Count the number of students in your classroom who are wearing sneakers. Count the number of girls. Count the number of students who are wearing sneakers and are girls. Record the number of students who fall into each category.

	Wearing Sneakers	Not Wearing Sneakers	Total
Boy			
Girl			
Total			

a. Suppose you select a student at random from your class. What is the probability that the student is wearing sneakers?

b. Suppose you select a student at random from your class. What is the probability that the student is a girl?

c. Does the Multiplication Rule correctly compute the probability that the student is wearing sneakers and is a girl?

d. How is this situation different from previous situations in which the Multiplication Rule gave the correct probability?

2. The phrase "the probability event a occurs given event B occurs" is written symbolically as P $(A|B)$. This **conditional probability** sometimes is read as "the probability of A given B". The table below categorizes the preferences of 300 students in a junior class about plans for their prom.

		Preference for Location		
		Hotel	Rec Center	Total
Preference for Band	Hip-Hop	73	80	
	Classic Rock	55	92	
Total				

Suppose you pick a student at random from this class. Find each of the following probabilities.

a. P(*prefers hotel*)

b. P(*prefers hip-hop band*)

c. P(*prefers hotel and prefers hip-hop band*)

d. P(*prefers hotel or prefers hip-hop*)

e. $P(prefers\ hotel|prefers\ hip-hop\ band)$

f. $P(prefers\ hip-hop\ band|prefers\ hotel)$

3. Recall that events A and B are independent if knowing whether one of the events occurs does not change the probability that the other event occurs.

a. Using the data from problem 1, suppose you pick a student at random. Find $P(wearing\ sneakers|is\ a\ girl)$. How does this compare to *P(wearing sneakers)*?

b. Are the events *wearing sneakers and is a girl independent*? Why or why not?

c. Consider this table from a different class.

	Wearing Sneakers	Not Wearing Sneakers
Boy	5	9
Girl	10	18

Suppose you pick a student at random from this class.

i. Find P(wearing sneakers).

ii. Find P($wearing\ sneakers|is\ a\ girl$).

iii. Are the events *wearing sneakers and is a girl* independent?

d. If events A and B are independent, how are P(A) and P($A|B$) related?

4. Suppose that you roll a pair of dice.
   a. Which is greater? P(doubles) or P($doubles|sum\ is\ 2$)?

   b. Are the events getting doubles and getting a sum of 2 independent? How would you describe the relationship?

5. Refer to the table in Problem 2.

a. If you select a junior at random, are the events *prefer hotel and prefers hip-hop band* independent? Explain.

b. Recall from Math 1 that two events are **mutually exclusive** if they cannot both occur on the same outcome. If you select a junior at random, are the events prefer hotel and prefers hip-hop band mutually exclusive? Explain.

What you will learn about:
How to find P(A and B) when A and B are not independent

1. About half of all U.S. adults are male. The USA Today-reported data earlier indicated that three out of five adults sing in the shower. Some people think that males are more likely to sing in the shower than females. Suppose that they are right 80% of males sing in the shower, but only 40% of females sing in the shower.

a. Make an area model that represents this situation.

b. Suppose you pick an adult at random. What it the probability that you get a female who sings in the shower?

c. Complete the following equation (in words) that describes how you found the probability in Part b.

P(*female and sings in the shower*) =

d. Suppose you pick and adult at random. What is the probability that you get a male who sings in the shower?

e. Write an equation in words that describes how you found the probability in Part d.

2. As you have seen in Problem 1, if events A and B are not independent, you can find the P(*A and B*) by using either one of the following rules.

P(*A and B*) = $P(A) \cdot P(B|A)$
P(*A and B*) = $P(B) \cdot P(A|B)$

a. For the situation of rolling a pair of dice once, let event A be rolling doubles and event B getting a sum of 8.

i. Using the sample space below, find each of the following probabilities.

Number on Second Die

Number on First Die	1	2	3	4	5	6
1	1, 1	1, 2	1, 3	1, 4	1, 5	1, 6
2	2, 1	2, 2	2, 3	2, 4	2, 5	2, 6
3	3, 1	3, 2	3, 3	3, 4	3, 5	3, 6
4	4, 1	4, 2	4, 3	4, 4	4, 5	4, 6
5	5, 1	5, 2	5, 3	5, 4	5, 5	5, 6
6	6, 1	6, 2	6, 3	6, 4	6, 5	6, 6

- P(A)
- P(B)
- $P(A|B)$
- $P(B|A)$
- P(A and B)

ii. Verify that both rules for P(A and B) hold for the probabilities that you found in part i.

b. Show that both rules work for each of the following situations.

i. You roll a pair of dice once. Event A is rolling doubles. Event B is getting a sum of 7.

ii. You roll a pair of dice once. Event A is getting 1 on the first die. Event B is getting a sum of 7.

3. A Web site at Central Michigan University collects data from statistics students. In one activity, students were asked whether they were right-handed or left-handed. Students were also asked which thumb is on top when they fold their hands (intertwining their fingers). The following table shows the results for the first 80 students who submitted their information.

	Left-Handed	Right-Handed	Total
Left Thumb on Top	2	46	48
Right Thumb on Top	4	28	32
Total	6	74	80

Source: stat.cst.cmich.edu/statact/index.php

Suppose you pick one of these 80 students at random.

a. Find each probability.

i. P(left-handed)

ii. P(left thumb on top)

iii. P($left\ thumb\ on\ top | left - handed$)

iv. P($left - handed | left\ thumb\ on\ top$)

b. Are being left-handed and having the left thumb on top independent events? Are they mutually exclusive events?

c. Use your results from Part a and the formula to find *P(left-handed and left thumb on top).* Check your answer by using the table directly.

	4. Thing about a single roll of tow dice. For each of the situations below, tell whether the two events are mutually exclusive. Then tell whether they are independent. a. Event A rolling doubles. Event B is getting a sum of 8. b. Event A is rolling doubles. Event B is getting a sum of 7. c. Event A is getting 1 on the first die. Event B is getting a sum 7. d. Event A is getting 1 on the first die. Event B is getting doubles. 5. Find the probability of the following. a. P(left-handed or left thumb on top)