Algebra II/Trig B

Module 4, Unit 8, Lessons 1 & 2 : Probability and Two-Way Tables

With **probability** we attempt to assign a value to how likely an **event** in a chance **experiment** is to occur. The value must always be between **-1 and 1.**

Theoretical Probability

It is calculated by dividing the number of favorable outcomes by the number of possible outcomes. (This calculation is only valid when all outcomes are equally likely.)

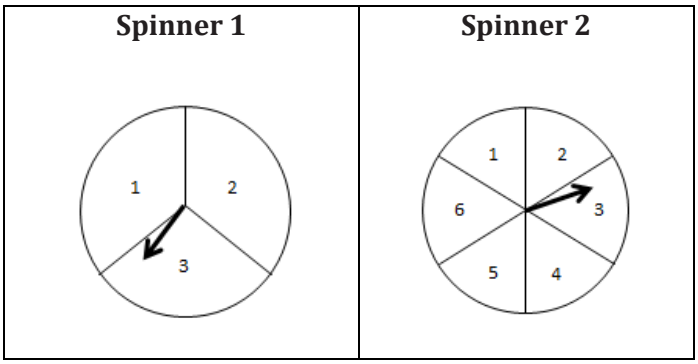
Example 1: Luck of the Spin

Alan is designing a probability game using the spinner below. Introduce Probability notation.

a) For Spinner 1, calculate the probability of event A: spinning an odd number.

b) For Spinner 2, calculate the probability of event B: spinning an odd number.

c) For Spinner 2, calculate the probability of event C: spinning a number greater than 4.



Suggested Video Intro: https://www.learner.org/courses/againstallodds/unitpages/unit13.html

Empirical Probability and Two-Way Tables

Sometimes we have to quantify chance by using observations that have been made in the real world. In this case we talk about **empirical probability.** The fundamental equation is the same.

Example 3: Waldo

The school board of Waldo, a rural town in the Midwest, is considering building a new high school primarily funded by local taxes. They decided to interview eligible voters to determine if the school board should build a new high school facility to replace the current high school building. There is only one high school in the town. Every registered voter in Waldo was interviewed. In addition to asking about support for a new high school, data on gender and age group were also recorded. The data from these interviews are summarized below.

	Should Our Town Build a New High School?					
	Yes		**No**		**No Answer**	
Age (in years)	Male	Female	Male	Female	Male	Female
18–25	29	32	8	6	0	0
26–40	53	60	40	44	2	4
41–65	30	36	44	35	2	2
66 and Older	7	26	24	29	2	0

What makes this table hard to understand/analyze?

Let's create a standard two-way table using the data.

	Yes	No	No Answer	Total
18–25 Years Old				
26–40 Years Old				
41–65 Years Old				
66 Years Old and Older				
Total				

a) What information is no longer available in this version of the table?

b) An eligible voter is picked at random. If this person is 21 years old, do you think he would indicate that the town should build a high school? Why or why not?

c) An eligible voter is picked at random. If this person is 55 years old, do you think she would indicate that the town should build a high school? Why or why not?

d) Based on this survey, do you think the school board should recommend building a new high school? Explain your answer.

e) A local news service plans to write an article summarizing the survey results. Three possible headlines for this article are provided below. Is each headline accurate or inaccurate? Support your answer using the probabilities calculated.

Headline 1: *Waldo Voters Likely to Support Building a New High School*

Headline 2: *Older Voters Less Likely to Support Building a New High School*

Headline 3: *Younger Voters Not Interested in Building a New High School*

Example 4: Smoking and Asthma **This hypothetical 1,000 two-way table is used by many AP Stat teachers. It's not something they made up. ☺**

Health officials in Milwaukee, Wisconsin, were concerned about teenagers with asthma. People with asthma often have difficulty with normal breathing. In a local research study, researchers collected data on the incidence of asthma among students enrolled in a Milwaukee public high school.

Students in the high school completed a survey that was used to begin this research. Based on this survey, the probability of a randomly selected student at this high school having asthma was found to be 0.193*. Students were also asked if they had at least one family member living in their house who smoked. The probability of a randomly selected student having at least one member in his (or her) household who smoked was reported to be* 0.421*.*

Hypothetical 1,000 Two-way Table: It would be easy to calculate probabilities if the data for the students had been organized into a two-way table . But there is no table here, only probability information. One way around this is to think about what the table might have been if there had been 1,000 students at the school when the survey was given. This table is called a ***hypothetical 1000 two-way table***.

What if the population of students at this high school was 1,000? The population was probably not exactly 1,000 students, but using an estimate of 1,000 students provides an easier way to understand the given probabilities. Connecting these estimates to the actual population is completed in a later exercise. Place the value of 1,000 in the cell representing the total population. Based on a hypothetical 1000 population, consider the following table:

	No Household Member Smokes	**At Least One Household Member Smokes**	**Total**
Student Has Asthma	Cell 1	Cell 2	Cell 3
Student Does Not Have Asthma	Cell 4	Cell 5	Cell 6
Total	Cell 7	Cell 8	1,000

a. The probability that a randomly selected student at this high school has asthma is 0.193. This probability can be used to calculate the value of one of the cells in the table above. Which cell is connected to this probability? Use this probability to calculate the value of that cell.

b. The probability that a randomly selected student has at least 1 household member who smokes is 0.421. Which cell is connected to this probability? Use this probability to calculate the value of that cell.

c.

d. In addition to the previously given probabilities, the probability that a randomly selected student has at least one household member who smokes and has asthma is 0.120. Which cell is connected to this probability? Use this probability to calculate the value of that cell.

e. Complete the two-way frequency table by calculating the values of the other cells in the table.

	No Household Member Smokes	At Least One Household Member Smokes	Total
Student Has Asthma			
Student Does Not Have Asthma			
Total			1,000

f. Based on your completed two-way table, estimate the following probabilities as a fraction and also as a decimal (rounded to three decimal places):

a. A randomly selected student has asthma. What is the probability this student has at least 1 household member who smokes?

b. A randomly selected student does not have asthma. What is the probability this student has at least one household member who smokes?

c. A randomly selected student has at least one household member who smokes. What is the probability this student has asthma?

g. Do you think that whether or not a student has asthma is related to whether or not this student has at least one family member who smokes? Explain your answer.