Name: _Answer Key_   Date: _____

Two-way Frequency Charts

MCC9-12.S.ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

There are essentially two types of data: **quantitative** and **categorical**.
- Examples of categorical data: color, type of pet, gender, ethnic group, religious affiliation, etc.
- Examples of quantitative data: age, years of schooling, height, weight, test score, etc.

Researchers use both types of data but in different ways. Bar graphs and pie charts are frequently associated with categorical data. Box plots, dot plots, and histograms are used with quantitative data. The measures of central tendency (mean, median, and mode) apply to quantitative data. Frequencies can apply to both categorical and quantitative.

Bivariate data consists of pairs of linked numerical observations, or frequencies of things in categories. Numerical bivariate data can be presented as ordered pairs and in any way that ordered pairs can be presented: as a set of ordered pairs, as a table of values, or as a graph on the coordinate plane.

- An example would be the number of people that play certain sports or are in certain clubs at your school broken down by gender.

A bivariate or **two-way frequency chart** is often used with data from two categories. Each category is considered a variable, and the categories serve as labels in the chart. Two-way frequency charts are made of cells. The number in each cell is the frequency of things that fit both the row and column categories for the cell. From the two-way chart below, we see that there are 12 males in the band and 3 females in the chess club.

Participation in School Activities			
School Club	**Gender**		
	Male	Female	Totals
Band	12	21	33
Chorus	15	17	32
Chess	16	3	19
Latin	7	9	16
Yearbook	28	7	35
Totals	78	57	135

If no person or thing can be in more than one category per scale, the entries in each cell are called **joint frequencies**. The frequencies in the cells and the totals tell us about the percentages of students engaged in different activities based on gender. For example, we can determine that if we picked at random from the students, we are least likely to find a female in the chess club because only 3 of 135 students are females in the chess club. These frequencies are converted to percents in the chart below.

Participation in School Activities			
School Club	**Gender**		
	Male	Female	Totals
Band	8.9%	15.6%	24.5%
Chorus	11.1%	12.6%	23.7%
Chess	11.9%	2.2%	14.1%
Latin	5.2%	6.7%	11.9%
Yearbook	20.7%	5.2%	25.9%
Totals	57.8%	42.3%	100%

There is also what we call **marginal frequencies** in the bottom and right margins (grayed cells). These frequencies lack one of the categories. For our example, the frequencies at the bottom represent percents of males and females in the school population. The marginal frequencies on the right represent percents of club membership.

Lastly, associated with two-way frequency charts are **conditional frequencies**. These are not usually in the body of the chart, but can be readily calculated from the cell contents. One conditional frequency would be the percent of females that are in the chorus out of the total number of females in some type of club. 17 of the 57 females are in the chorus, so 29.8%. This could also be stated as "Given that a female in a club is selected, what is the probability that she is in the chorus?"

Practice #1:

Elizabeth surveys 9th graders, 10th graders, and 11th graders in her school. She asks each student how many hours they spend doing homework each night. She records the responses in the table below.

Grade	Hours spent on homework			Totals
	0–2	2–4	More than 4	
9	38	12	2	52
10	21	25	9	55
11	14	18	20	52
Totals	73	55	31	159

a) How many 9th graders spend 0–2 hours on homework each night? What frequency is that?

    38          $\frac{38}{159} = 0.239 = 23.9\%$

b) How many 10th graders spend 2–4 hours on homework each night? What frequency is that?

    25          $\frac{25}{159} = 0.157 = 15.7\%$

c) Which response was the most popular among 11th graders?
    0–2 hours, 2–4 hours, or more than 4 hours? **More than 4 hours**

Practice #2:

Cameron surveys students in his school who play sports, and asks them which sport they prefer. He records the responses in the table below.

	Base	Soc	Bask	Tot
M	20.7	21.9	6.8	49.4
F	9.7	27.0	13.9	50.6
Tot	30.4	48.9	20.7	100

Gender	Preferred sport			Total
	Baseball	Soccer	Basketball	
Male	49	52	16	117
Female	23	64	33	120
Total	72	116	49	237

a) What is the joint frequency of male students who prefer soccer? (How many male students prefer soccer?)   21.9%

b) What is the marginal frequency of each type of sport? (Total the number of males and females who played baseball. Then give total for the other two sports.)

    Baseball: 30.4%   Soccer: 48.9%   Basketball: 20.7%

Practice #3:

Abigail surveys students in different grades, and asks each student which pet they prefer. The responses are in the table below.

	B	C	D	F	Tot
9	1.2	20.1	21.7	9.0	52
10	2.9	14.8	26.2	4.1	48
total	4.1	34.9	47.9	13.1	100

Grade	Preferred pet				Total
	Bird	Cat	Dog	Fish	
9	3	49	53	22	127
10	7	36	64	10	117
Total	10	85	117	32	244

a) What is the joint frequency of 10th graders who prefer having fish or a cat as a pet?

    Fish: 4.1%   Cat: 14.8%

b) What is the marginal frequency of each type of preferred pet?

    Bird: 4.1%   Cat: 34.9%   Dog: 47.9%   Fish: 13.1%