

2.2 PROJECT

ONES, ZEROS, AND THE NUMBER OF REGIONS IN A VENN DIAGRAM

A computer chip is basically a collection of transistors, which are electronic components that work as switches. A transistor can be in one of two states: on or off. In computer engineering, the number 1 is used to represent the *on* state while 0 is used to represent the *off* state. Numbers composed only of zeros and ones are called binary numbers.

In this activity, you will investigate the relationship between binary numbers and the regions of a Venn diagram. Consider the one-set Venn diagram in Figure 1. We have labeled each region of the diagram by asking the question, “Does this region contain elements of set *A*?” If the answer is yes, we labeled the region with (1); if the answer is no, we labeled the region with (0). Table 1 shows a summary of the regions.

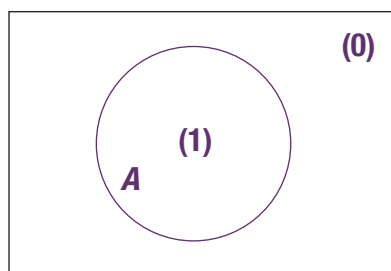


Figure 1: One-Set Venn Diagram

Table 1: Regions in Figure 1

Elements of Set <i>A</i> ?	Region
Yes	(1)
No	(0)

As you can see, we have exactly 2 regions: (1) and (0). We are labeling the Venn diagram using single digit binary numbers. Let’s use the same idea to label a two-set Venn diagram. (Note that some regions in the figures may end up containing no elements when actual sets are considered, but the diagrams take into account all possible regions when considering the relationship between a fixed number of sets.) The region in Figure 2 that contains no elements of set *A* but some of the elements of set *B* is labeled (10), and the region that contains no elements of set *B* but some of the elements of set *A* is labeled (01). This time, we are labeling the Venn diagram using two-digit binary numbers.

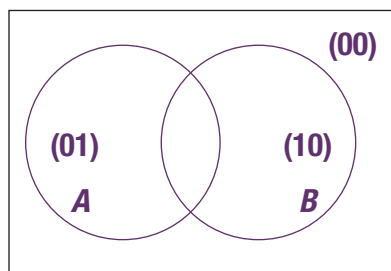


Figure 2: Two-Set Venn Diagram

Table 2: Regions in Figure 2

Elements of Set <i>B</i> ?	Elements of Set <i>A</i> ?	Region
No	No	(00)
No	Yes	(01)
Yes	No	(10)
Yes	Yes	

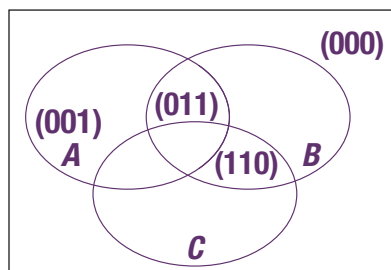


Figure 3: Three-Set Venn Diagram

1. Write 2, which is the number of regions in Figure 1, as a power of 2. In other words, 2 raised to what power is equal to 2?
2. In Figure 2, what should be the label for the intersection of set *A* and set *B*, the region that contains elements that are both in set *A* and in set *B* at the same time?
3. How many regions are in Figure 2? Write this value as a power of 2.
4. Complete Table 3 and label the three-set Venn diagram in Figure 3 using the same process we used with the one-set Venn diagram and the two-set Venn diagram. For this Venn diagram, you will work with three-digit binary numbers.

Table 3: Regions in Figure 3

Elements of Set <i>C</i> ?	Elements of Set <i>B</i> ?	Elements of Set <i>A</i> ?	Region
No	No	No	(000)
No	No	Yes	(001)
	Yes	No	(010)
	Yes	Yes	(011)
			(100)
Yes	No	Yes	
Yes	Yes	No	
Yes	Yes	Yes	

5. How many regions are there in Figure 3? Write the number as a power of 2.
6. How do you determine the number of regions in a Venn diagram for a fixed number of n sets?
7. Without drawing a diagram determine the number of regions in a four-set Venn diagram.
8. List all regions for a four-set Venn diagram using four-digit binary numbers. (**Hint:** Notice that in Tables 1, 2, and 3, if a region contains elements of set A , then the rightmost digit of the region is 1. Look for similar patterns.)