Section 1.7 Applications using Venn Diagrams

In this section we will use Venn diagrams to solve word problems. We will put numbers in the regions of a Venn diagram that represent quantities as opposed to the elements of a set.

We will break 2 set Venn diagrams in to 4 regions, and 3 set Venn diagrams into 8 regions. I will use the following region numbering system when I solve the problems in this section. I will use Roman numerals so as not to confuse the region names with elements in a set.

| 4 regions of a 2 set Venn Diagram | 8 regions of a 3 set Venn Diagram |
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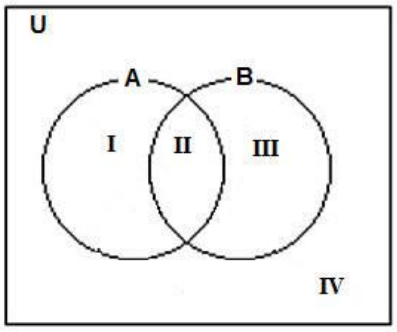
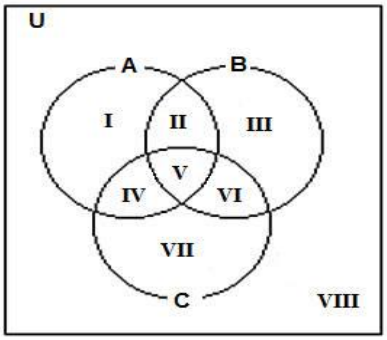
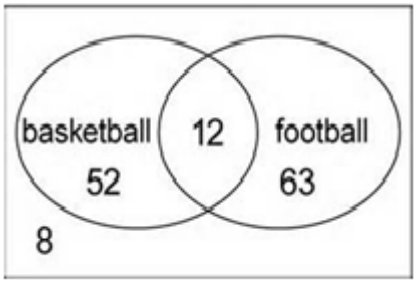
|  |  |





***Example:*** A group of ASU students were asked if they had been to a Sun Devil basketball game or a Sun Devil football game this year. The Venn diagram below summarizes the results.





- Explain what each number in the diagram represents.

Answer:
52 in region I represents the 52 students who had been to a Sun Devil basketball game, but had not been to a Sun Devil football game.

12 in region II represents the 12 students that had been to both a Sun Devil basketball game and a Sun Devil football game.

63 in region III represents the 63 students who had been to a Sun Devil football game, but had not been to a Sun Devil basketball game.

8 in region IV represents the 8 students that had not been to a Sun Devil football game, nor a Sun Devil basketball game.

- How many of the students interviewed had been to a Sun Devil football game?

This can be tricky. Answering 63 would be wrong. This only counts the 63 students that went to a football game and did not go to a basketball game. I need to include both the 63 students that only went to a football game and the 12 that went to both football and basketball to properly count every student that went to a football game.

Answer: 12 + 63 = 75

- How many students went to exactly one of the two sports?

These are the students that are represented in regions I and III.

Answer: 52 + 63 = 115

- How many students went to a football game or a basketball game?

In this case "or" implies that a student had seen at least one of the two sports. This counts the students represented in regions I, II and III. Students that had been to both sports also need to be counted.

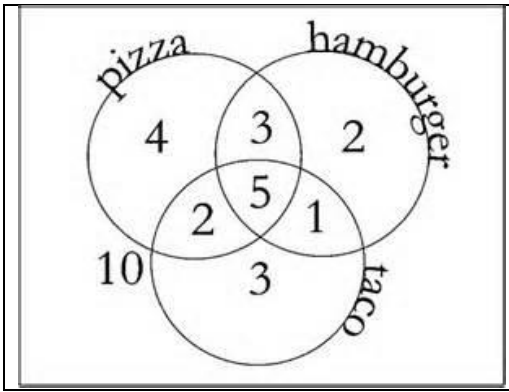
Answer: 52+12+63 = 127

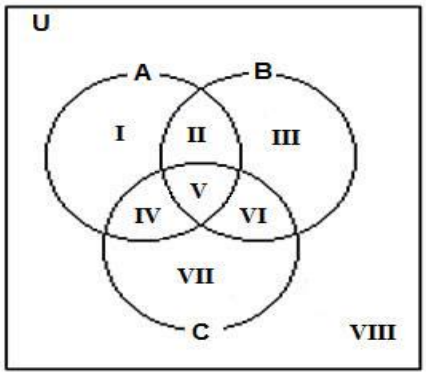
- How many students were surveyed?

I just need to add each number in the diagram to get this answer.

Answer: 52+12+63+8 = 135

***Example:*** A group of students was surveyed to determine which of three types of foods they liked. Some students liked more than one type of food and some didn't like any of the three types of food.




- Explain what each number in the diagram represents.

Answer:

Region I represents the 4 student that liked pizza, but didn't like tacos or hamburgers.

Region II represents the 3 students that liked pizza and hamburgers, but didn't like tacos.

Region III represents the 2 students that liked hamburgers, but didn't like tacos or pizzas.

Region IV represents the 2 students that like pizza and tacos, but didn't like hamburgers.

Region V represents the 5 students that liked all three foods.

Region VI represents the 1 student that liked tacos and hamburgers, but didn't like pizza.

Region VII represents the 3 students that liked tacos, but didn't like hamburgers nor pizza.

Region VIII represents the 10 students that didn't like any of the three foods.

- How many liked hamburgers?

This can be tricky. I need to include every student that liked a hamburger whether or not they liked another food. Any number that is inside the hamburger circle needs to be considered. My answer needs to include the number in regions II, III, V and VI

Answer: 2+3+5+1 = 11 students

- How many students liked exactly one of the three types?

These are the students represented in regions I, III and VII.

Answer: 4+2+3 = 9 students

- How many students liked hamburgers or pizza?

I need to include any student that said they liked one of these foods, whether or not they did or didn't like both of the foods is not a concern. I am adding up all of the regions except regions VII and VIII

Answer: 4 + 3+ 2 + 2 + 5 + 1 = 17 students

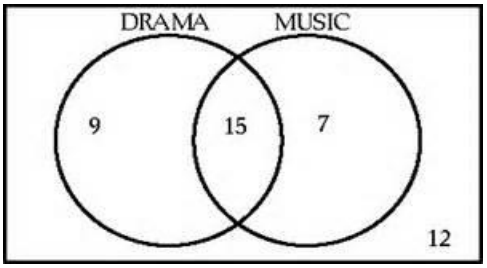
- How many students were surveyed?

I need to add up each number inside the diagram, as they all represent a student that was surveyed.

Answer: 4+3+2+2+5+1+10+3 = 30

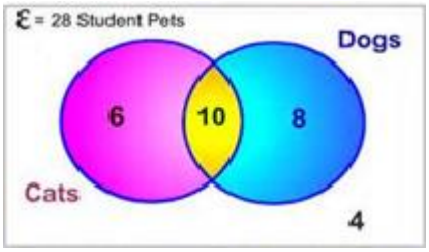
Homework # 1- 5

1) A group of theater majors were asked whether they were in the Drama club or Music club. The results are summarized in the following Venn diagram.



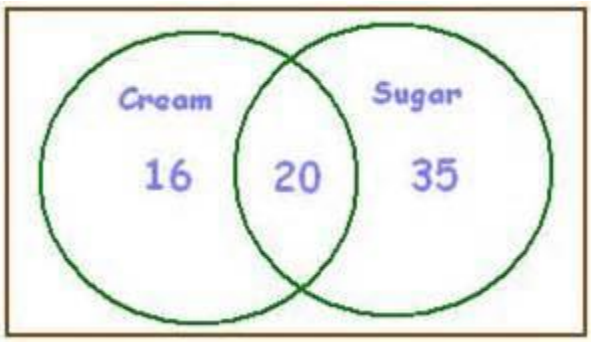

a) Describe what each region in the Venn diagram represents.
b) How many students were in only one of the two clubs?
c) How many students were the drama club or the music club?
d) How many students were surveyed?

2) A group of students were asked what pet they had at home. The results are summarized in the following Venn diagram.



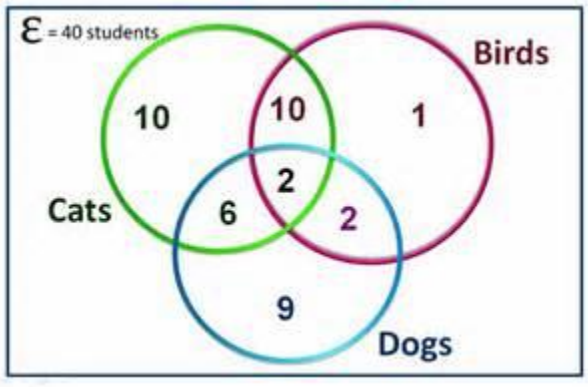

a) Describe what each region in the Venn diagram represents.
b) How many students had exactly one of the two?
c) How many students had at least one of the two?
d) How many had cats or dogs?

3) A group of coffee drinkers were asked what the added to their coffee. The results are summarized in the following Venn diagram.



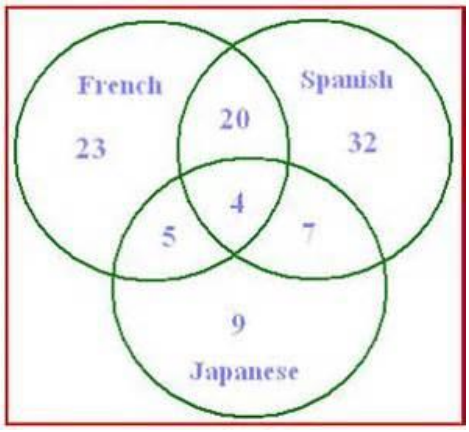

a) Describe what each region in the Venn diagram represents.
b) How many coffee drinkers didn't use either cream or sugar?
c) How many coffee drinkers used cream or sugar?
d) How many coffee drinkers only used one of the two?

4) 40 students were asked what kind of pet they had at home. The results are summarized in the following Venn diagram.




a) Describe what each region in the Venn diagram represents.
b) How many students had exactly one of the three?
c) How many students had cats or dogs?
d) How many students had cats or dogs, but not birds?

5) The International School offers French, Spanish and Japanese classes. A group of students was asked which languages they had studied.




a) Describe what each region in the Venn diagram represents.
b) How many students had studied exactly one of the three?
c) How many students studied Spanish or French?
d) How many students studied Spanish or French, but not Japanese?

The rest of the problems in this section are easiest to solve if we create Venn diagrams to model the problems. It will be important to work from the middle of the diagram out. ***In fact if you do not start in the middle of the Venn diagram your answer will be wrong!!!***

Generally the only number given in the word problems in this section that we put in the Venn diagram without subtracting first is the number that goes directly in the center of the diagram. The rest of the numbers that go in the diagram will require subtracting a number given in the problem from a number or numbers you have already placed in the Venn diagram.

***If any you put any number given in the problem in the Venn diagram other than the number that goes directly in the center you are making a mistake!!!!!! You need to subtract before placing most numbers in your Venn diagram.***

There are many strategies to learn when solving Venn diagram word problems. I tried to make each of the problems below have the same solution strategy so that you can get good with it. The strategy we are about to learn is the most common strategy when solving word problems that require Venn diagrams

This table may help you it you get stuck on the problems to follow. The table won't make much sense until you watch me to a word problem or two.

**Two set Venn diagram (THIS ORDER IS VERY IMPORTANT, FOLLOW IT!)**

| Region ***(follow this order)*** | Formula |
|---|---|
| II | Given number from the problem (NFP) |
| I | NFP – II |
| III | NFP - II |
| IV | NFP – (I + II + III) |
| Total | Add the numbers in the first column and make sure they equal the desired total |

**Three set Venn diagram (THIS ORDER IS VERY IMPORTANT, FOLLOW IT!)**

| Region ***(follow this order)*** | Formula |
|---|---|
| V | Given number from the problem (NFP) |
| IV | NFP – V |
| II | NFP - V |
| VI | NFP - V |
| I | NFP – (II + IV + V) |
| III | NFP – (II + V + VI) |
| VII | NFP – (IV + V + VI) |
| VIII | NFP – (I+II+III+IV+V+VI+VII) |
| Total | Add the numbers in the first column and make sure they equal the desired total |

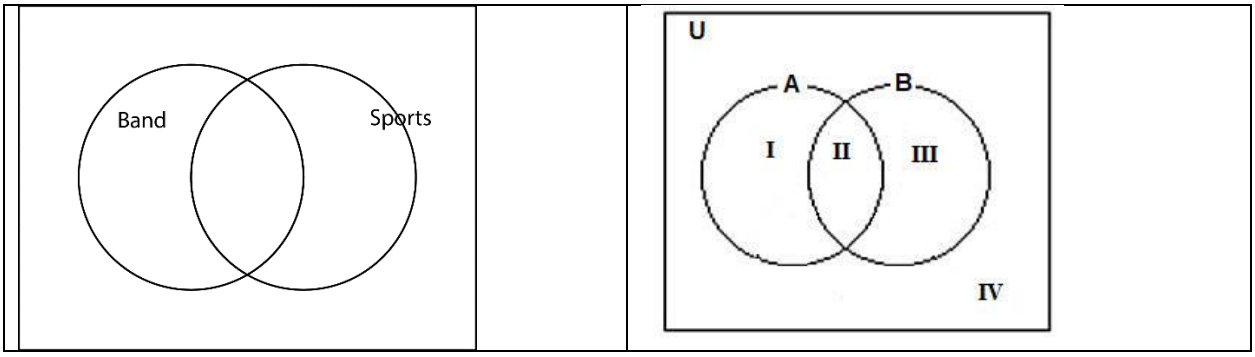
***Example:*** In a school of 320 students:
85 students are in the band
200 students are on a sports teams
60 students participate in both activities

(Notice that the school has 320 students, yet there are 345 student activities that are detailed (85+200+60 = 345). We will need to subtract before we place some of the numbers in our diagram)

a) Create a Venn diagram to model the information.
b) How many students weren't in either?
c) How many students were in band or sports?
d) How many were in band, but not sports?

a) Create a Venn diagram to model the information

I will create a two set Venn diagram. One set will be labeled band, the other sports. I will use the numbering system in the right diagram.




Step 2: Fill in numbers for each region in this order – II, I, III, IV

Region II – 60 (students that do both)

The center region in our problems will be given in the problem.

Region I - 25

There are 85 students in the band. 60 of them also play sports. If I put 85 in region 1 there would be 60 + 85 = 145 students in the band. This is too many, so I need to subtract to get the correct number for this region.
Use the formula from the table: NFP – II 85 – 60 = 25

This breaks the 85 band members down between the 60 that are in the band and play sports and the 25 that are in the band and don't play sports.

Region III – 140

There are 200 students that play sports. 60 of them are also in the band. If I put 200 in region III there would be 60 + 200 = 260 that play sports.
This is too many, so I need to subtract to get the correct number for this region.
Use the formula from the table: NFP – II 200 – 60 = 140

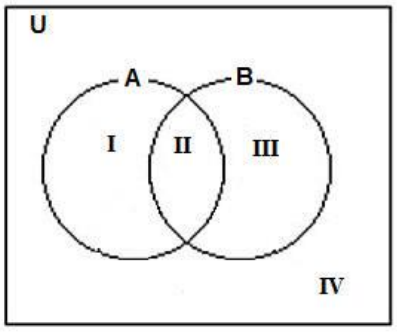
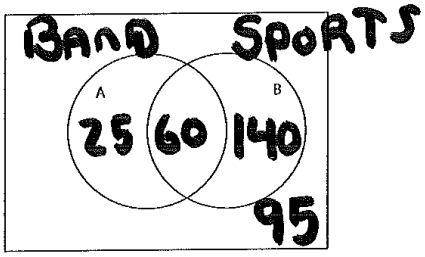
This breaks down the 200 students that play sports into 60 that both play sports and are in the band and the 140 that play sports that are not in the band.

Region IV - 95

To get this region I need to subtract all of the numbers already in the diagram from the total number of students.

Total number of students surveyed – total that were participating in at least one activity

Use the formula: NFP – (I + II + II) = 320 – (25+60+140) = 320 – 225 = 95

| Numbering system I will use. | Answer to part a. |
|---|---|
|   |   |

b) How many students weren't in either?

The number in region IV is the answer to this question.
Answer: 95

c) How many students were in band or sports?
This includes regions I, II and III. This allows for you to be in one or both.
Answer: 25 + 60 + 140 = 225

d) How many were in band, but not sports? This is just the 25 students represented by region I.
Answer: 25

***Example:*** Coach Otis Campbell offered to buy hot dogs for players on his team. Of the 44 players:

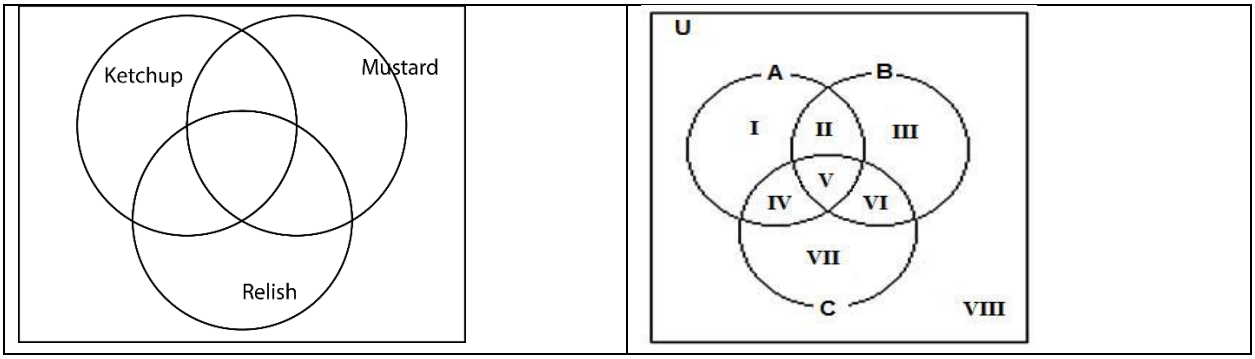
6 wanted all three condiments
11 wanted ketchup and relish
10 wanted ketchup and mustard
8 wanted mustard and relish
28 wanted ketchup
20 wanted mustard
14 wanted relish

(The team has 44 players, yet if you add up the numbers given in the condiment preferences you get 97. Again we will need to subtract before placing most of the numbers in our diagram.)

a) Create a Venn diagram to model the data and answer the following.
How many players wanted?
b. Ketchup only
c. Mustard but not relish
d. Relish but not mustard
e. Ketchup and mustard but not relish

a) Create a Venn diagram to model the data and answer the following.

I will create a three set Venn diagram. One circle will be for each condiment. I will use the numbering system in the right diagram.




Fill in numbers for each region in this order – V,IV,II,VI,I,III,VII,VII

***Region V*** = 6 (these are the player that wanted all 3)

Just like the last example the number for the center of the problem is given in the problem and it is the number I need to place first.

***Region IV*** = (ketchup and relish, but not mustard)

There are 11 players that want ketchup and relish. 6 of these 11 also want mustard.

If I put 11 in region IV I will have 17 players that want both ketchup and mustard.

I need to use the formula from the table: NFP – V = 11 – 6 = 5

This splits 11 that want ketchup and relish to the 5 that want only ketchup and mustard and the 6 that want ketchup mustard and relish.

Region IV = 5 (See this in the final diagram for this problem.)

***Region II*** = (ketchup and mustard, but not relish)

There are 10 players that want ketchup and mustard. 6 of these 10 also want relish. If I put 10 in region IV I will have 16 players that want both ketchup and mustard.

I need to use the formula from the table: NFP – V = 10 – 6 = 4

This splits 10 that want ketchup and mustard to the 4 that want only ketchup and mustard and the 6 that want ketchup mustard and relish.

Region II = 4

***Region VI*** (mustard and relish but not ketchup)

There are 8 players that want mustard and relish. 6 of these 8 also want ketchup. If I put 8 in region VI I will have 14 (8+6) players that want both mustard and relish. This is too many.

I need to use the formula from the table: NFP – V = 8 – 6 = 2

This splits 8 that want ketchup and mustard into the 2 that want only mustard and relish and the 6 that want ketchup mustard and relish.

Region VI = 2

***Region I*** = (only ketchup, no mustard, no relish)

There are 28 players that want ketchup. I have already placed three numbers in my ketchup circle:
6 ketchup, mustard, relish
5 ketchup, relish and no mustard
4 ketchup, mustard and no relish

If I put 28 in this spot I will have 28 + 6 + 5 + 4 = 43 players in the ketchup circle. Thus 43 players would have said they want ketchup. This is too many.

I need to subtract the players that want more than only ketchup to get the amount for this region.

Here is the formula: NFP – (II+IV + 5) = 28 – (5+4+6) = 28 - 15 = 13

Region I = 13

***Region III*** = 1 (mustard only, no ketchup, no relish)

There are 20 players that want mustard. I have already placed three numbers in my mustard circle:
6 ketchup, mustard, relish
4 mustard and ketchup and no relish
2 mustard and relish but no ketchup

If I put 20 in this spot I will have 20 + 6 + 4 + 2 = 32 players in the mustard circle. Thus 32 players would have said they want mustard. This is too many.

I need to subtract the players that want more than only mustard to get the amount for this region.

Here is the formula: NFP – (II + V + VI) = 20 – (6+4+2) = 20 - 12 = 8

Region III = 8

***Region VII*** = relish only
There are 14 players that want relish. I have already placed three numbers in my mustard circle:
6 ketchup, mustard, relish
5 relish and ketchup, not mustard
2 relish and mustard but no ketchup

If I put 14 in this spot I will have 14 + 6 + 5 + 2 = 27 players in the relish circle. Thus 27 players would have said they want relish.

I need to subtract the players that want more than only relish to get the amount for this region.

Here is the formula: NFP – (IV + V + VI) = 14 – (6+5+2) = 14 - 13 = 1

Region VII = 1

**Region VIII** = none of the three

I need to subtract any number that is already in a circle from the 44 total players to get the number that don't want any of the three.

(NFP – (I+II+III+IV+V+VI+VII) = 44 – (13+5+1+4+6+2+8) = 44 – 39 = 5

Region VIII = 5

| Numbering system for the regions. | Answer to part a. |
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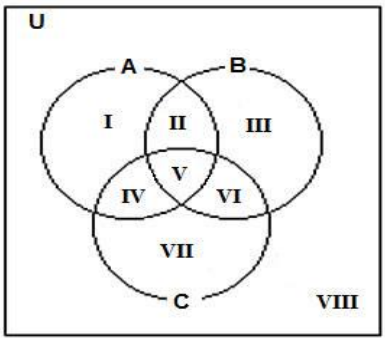
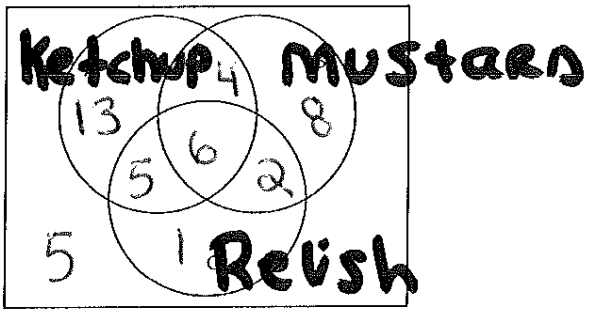
|  |  |





b) Ketchup only
This is the number in region I
Answer: 13

c) Mustard but not relish
These are the numbers in regions IV and V
Answer: 4 + 8 = 12

d) Relish but not mustard

These are the numbers in region II and III

Answer: 5 + 1 = 6

e) Both ketchup and mustard but not relish

This is the number in region IV.

Answer: 4

Homework # 6 – 21

6) 120 coffee drinkers were asked whether they used cream or sugar in their coffee. The summary of the survey was as follows:

55 use sugar
36 use cream
16 use both

a) Create a Venn diagram to summarize the information.
b) How many used cream in their coffee?
c) How many used sugar?
d) How many used sugar but not cream?
e) How many used cream but not sugar?
f) How many used cream and sugar?
g) How many used cream or sugar?

7) A veterinarian surveys 26 of his patrons. He discovers that:
14 have dogs
10 have cats
8 have both cats and dogs.

a) Create a Venn diagram to model the information.
b) How many patrons had dogs or cats?
c) How many patrons had dogs but not cats?
d) How many patrons didn't have either?

8) In a group, 30 persons were asked if they like tea or coffee, of these:

18 like coffee
15 like tea
11 like both coffee and tea. How many like coffee?

a) Create a Venn diagram to model the information.
b) How many people like coffee or tea?
c) How many like coffee but not tea?
d) How many patrons didn't like either?

9) In a survey of 20 students in a class:
10 were liked pineapple juice
15 were liked of orange juice
7 liked to have both

a) Create a Venn diagram to model the information.
b) How many people like pineapple juice or orange juice?
c) How many like orange juice but not pineapple juice?
d) How many patrons didn't like either?

10) In a survey of 120 people, Sam found that:

70 people liked product A
80 liked product B
50 people liked both

a) Create a Venn diagram to model the information.
b) How many liked product A or B
c) How many liked product A but not B
d) How many didn't like either?

11) A gym is thinking about adding more cardio equipment for its members. It is considering two types of equipment, treadmills (T) and Stair Masters (S). The gym surveyed a sample of the members and asked which equipment they used in the previous month. Of 150 gym members surveyed it was found that…

102 used the treadmills
71 used the Stair Masters
40 used both types.

a) Create a Venn diagram to summarize the information.
b) How many did not use either the treadmill or the Stair Master?
c) How many used the treadmill but not the Stair Master?
d) How many used the Stair Master but not the treadmill?
e) How many used at least one of the two?

12) A drug company is considering manufacturing a new toothpaste. They are considering two flavors, regular and mint. In a sample of 120 people, it was found that

- 74 liked regular
- 62 liked mint
- 35 liked both types

a) Create a Venn diagram to model the information.
b) How many liked only regular?
c) How many liked only mint?
d) How many liked exactly one of the two (that is they liked one but not the other)?

13) Out of 40 students:

14 are taking Chemistry
29 are taking English
5 are taking both

a) Create a Venn diagram to model the information.
b) How many students are taking Chemistry, but not English?
c) How many are taking Chemistry or English?
d) How many are taking exactly one of the two classes?

14) In a class of 50 students
18 are in the chorus
26 are in the band
12 are in both

a) Create a Venn diagram to model the information.
b) How many were in chorus or band?
c) How many were in chorus but not band?
d) How many were in exactly one of the two

15) 105 adults were asked whether they had studied French, Spanish or Japanese in school. Here are the results of the survey:

5 are taking all three
9 have studied both Japanese and French
11 have studied both Japanese and Spanish
24 have studied both Spanish and French
52 have studied French
63 have studied Spanish
25 have studied Japanese

a) Create a Venn diagram to model the information.
b**)** How many have studied Spanish but not French?
c) How many have studied Japanese but not French?
d) How many have studied **both** French and Spanish?
e) How many have studied French or Spanish?
f) How many have studied **both** French and Spanish but not Japanese?

16) AAA Travel surveyed 125 potential customers. The following information was gathered.

18 wished to travel to all three destinations
34 wished to travel to Hawaii and Las Vegas
26 wished to travel to Las Vegas and Disney World
23 wished to travel to Hawaii and Disney World
68 wished to travel to Hawaii
53 wished to travel to Las Vegas
47 wished to travel to Disney World

a) Create a Venn diagram to summarize the information.
b) How many did not wish to travel to any of these destinations?
c) How many wished to travel only to Hawaii?
d) How many wished to travel to Disney World **and** Las Vegas, but **not** to Hawaii?
e) How many wished to travel to Disney World **or** Las Vegas, but **not** to Hawaii?
f) How many wished to only travel to exactly one of these locations?

17) 33 U.S. cities with large populations were surveyed to determine whether they had a professional baseball team, a professional football team, or a professional basketball team. The following information was determined.

5 had all three teams
11 had baseball and football
7 had baseball and basketball
9 had football and basketball
16 had baseball
17 had football
15 had basketball

a) Create a Venn diagram to model the information.
b) How many cities had only football?
c) How many cities had baseball or football?
d) How many cities had both baseball and football but not basketball?
e) How many had exactly two teams?

18) In a group of 60 students:

2 students play all three
8 play table tennis and swim
6 play cricket and swim
5 play table tennis and cricket
25 play table tennis
16 swim
22 play cricket

a) Create a Venn diagram to model the information.
b) How many play table tennis and swim and play cricket?
c) How many play table tennis but not cricket?
d) How many play table tennis and cricket but not do swimming?

19) In a survey of 75 people, Sam found that:

9 liked all the three products
24 people liked both products A and B
20 people liked products C and A
18 people liked product B and C
38 people liked product A
36 liked product B
39 liked product C

a) Create a Venn diagram to model the information.
b) How many liked product A or B?
c) How many liked product both A and B, but not C?
d) How many didn't like any of the three products?

20) 150 students were asked which kind of cell phones they have owned in the past. The results of the survey were as follows:

5 have owned all three
20 have owned both a Galaxy and a flip phone
25 have owned both a Galaxy and an I-phone
15 have owned a flip phone and an I-phone
30 have owned a flip phone
50 have owned an I-phone
40 have owned a Galaxy

a) Create a Venn diagram to model the information.
b) How many students have not owned any of the three?
c) How many have owned a Galaxy or an IPhone?
d) How many have only owned exactly one of the three?
e) How many have owned exactly two of the three?

21) 100 students were asked which fast food restaurant they have been to this year. The results of the survey were as follows:

5 have been to all three
20 have been to both McDonald's and Taco Bell
25 have been to both Subway and McDonald's
15 have been to both Taco Bell and Subway
50 have been to McDonald's
40 have been to Taco Bell
45 have been to Subway

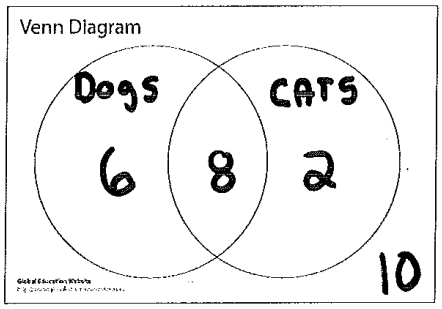
a) Create a Venn diagram to model the information.
b) How many did not go to any of the three?
c) How many have been to McDonald's or Taco Bell?
d) How many have been to McDonald's or Taco Bell, but not Subway?
e) How many have been to exactly two of the three?

Answers:
1a) region I in drama club, not in music club
region II in both clubs,
region III in music, not in drama
region IV not in either club
1b) 16 1c) 31 1d) 43

3a) region I, use cream, do not use sugar
region II use both cream and sugar
region III use sugar, don't use cream
Region IV don't use either
3b) 0 3c) 71 3d) 51

5a) region I taking French, not taking Spanish, not taking Japanese
region II taking both French and Spanish, not taking Japanese
region III taking Spanish, not taking French, not taking Japanese
region IV taking both French and Japanese, not taking Spanish
region V taking all three
region VI taking Spanish and Japanese, not taking French
region VII taking Japanese, not taking French, not taking Spanish
region VIII not taking any of the three
5b) 23+32+9 = 64 5c) 23+5+4+20+7+32 = 91 5d) 23+32+20=75

7a)

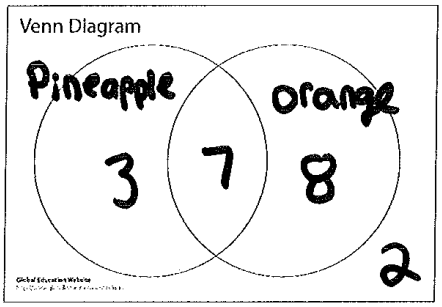



7b) 16

7c) 6

7d) 10

9a)

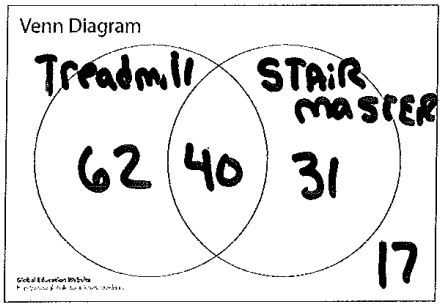



9b) 18

9c) 8

9d) 2

11a)



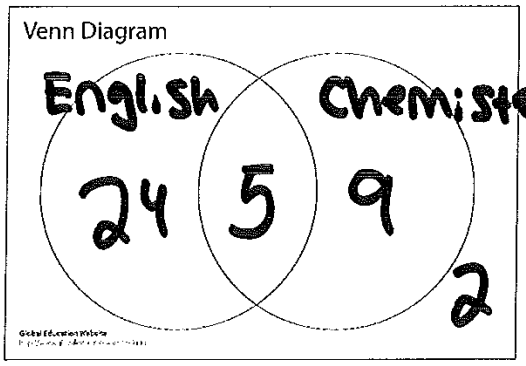

11b) 17

11c) 62

11d) 31

11e) 133

13a)

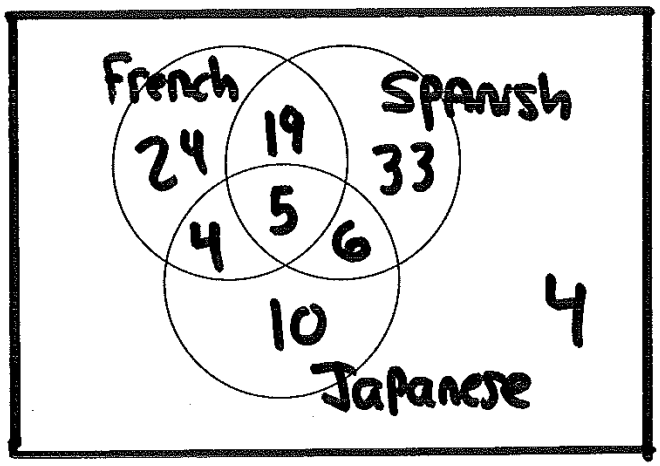



13b) 9

13c) 38

13d) 33

15a)




15b) 39

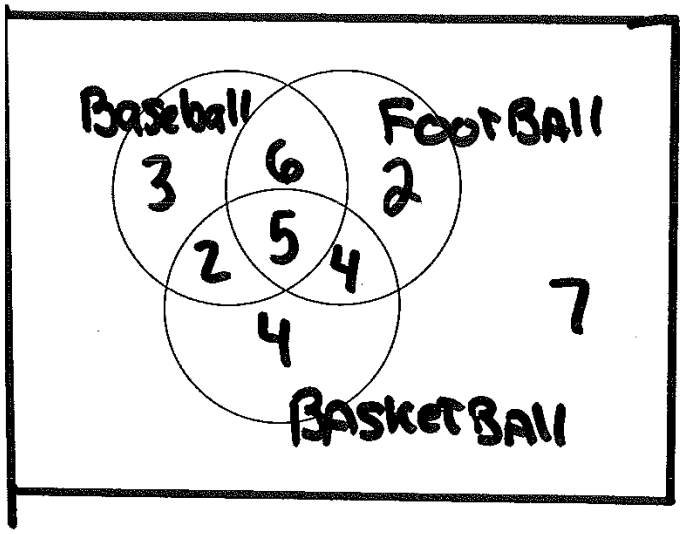
15c) 16

15d) 24

15e) 91

15f) 19

17a)



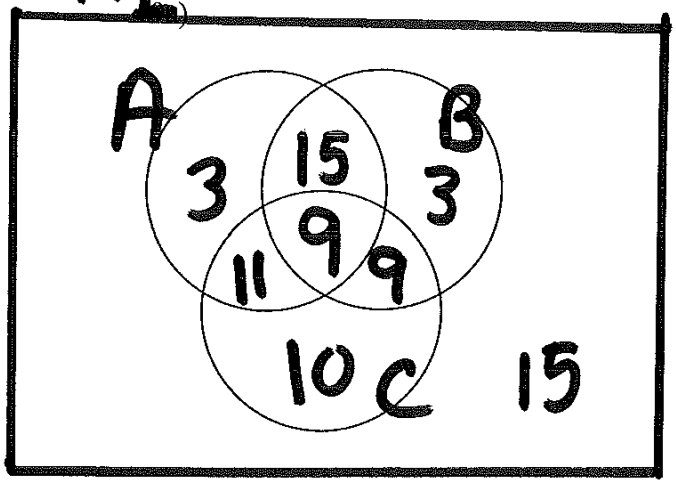

17b) 2

17c) 22

17d) 6

17e) 12

19a)

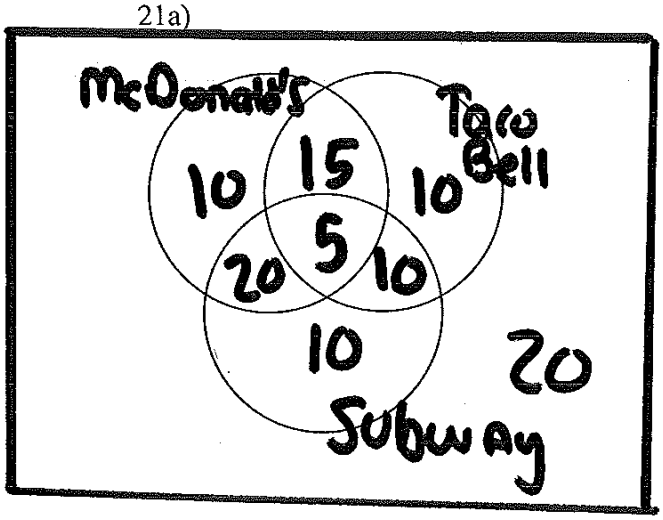



19b) 50

19c) 15

19d) 15

21a)




21b) 20

21c) 70

21d) 35

21e) 45