Recitation 1

CS 206 Section 03

Atin Srivastava

TA Information

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- Email: as4115@rutgers.edu **(Please use [CS206] as prefix in your email subject)**
- Section 3:
  - Monday 4:05 - 5:00 PM Busch SEC-207
- Office Hour:
  - Friday 12:30 – 1:30 PM - Zoom
  - By Appointment

Problem 0

Let: $A = \{n \in N: n>0, n \text{ is even}, n<12\}$

$B = \{n \in Z: |n|>6, |n|<13\}$

- List elements of set A.

  Solution:

- List elements of set B.

  Solution:

- What is set $A \cup B$?

  Solution:

Problem 0

Let: $A = \{n \in N: n>0, n \text{ is even}, n<12\}$

$B = \{n \in Z: |n|>6, |n|<13\}$

- List elements of set A.

  Solution: $A = \{2,4,6,8,10\}$

- List elements of set B.

  Solution:

- What is set $A \cup B$?

  Solution:

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Let: A = {n ∈ N: n>0, n is even, n<12}

B = {n ∈ Z: |n|>6, |n|<13}

- List elements of set A.

  Solution: A = {2,4,6,8,10}

- List elements of set B.

  Solution: B = {-12,-11,-10,-9,-8,-7,7,8,9,10,11,12}

- What is set A ∪ B?

  Solution:

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Let: $A = \{n \in N: n>0, n \text{ is even}, n<12\}$

$B = \{n \in Z: |n|>6, |n|<13\}$

- List elements of set A.

  Solution: $A = \{2,4,6,8,10\}$

- List elements of set B.

  Solution: $B = \{-12,-11,-10,-9,-8,-7,7,8,9,10,11,12\}$

- What is set $A \cup B$?

  Solution: $A \cup B = \{ -12,-11,-10,-9,-8,-7,2,4,6,7,8,9,10,11,12 \}$

Problem 0

Let: $A = \{n \in N: n>0, n \text{ is even}, n<12\}$

$B = \{n \in Z: |n|>6, |n|<13\}$

- What is set $A \cap B$?

  Solution: $A \cap B =$

- What is set $A \times (A \cap B)$?

  Solution: $A \times (A \cap B) =$

- What is set $A - B$?

  Solution: $A - B =$

- What is $|A|$?

  Solution: $|A| =$

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- What is set A ∩ B?

  Solution: A ∩ B = {8,10}

- What is set A x (A ∩ B)? The symbol × is used to denote the "Cartesian Product" of two sets: it results in a set with ordered pairs.

  Solution: A x (A ∩ B) = {(2,8),(4,8),(6,8),(8,8),(10,8),(2,10),(4,10),(6,10),(8,10),(10,10)}

- What is set A - B?

  Solution: A - B =

- What is |A|?

  Solution: |A| =

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- What is set $A - B$?

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- What is set $A - B$?

  Solution: $A - B = \{2,4,6\}$

- What is $|A|$?

  Solution: $|A| = 5$

Problem 1

For any set A, let P(A) be its power set. Let ∅ denote the empty set.

- Write down all the elements of P({1,2,3}).

  Solution: P({1,2,3}) =

  How many elements are there in P({1,2,3,4,5,6,7,8})?

  Solution: |P({1,2,3,4,5,6,7,8})| =

Problem 1

For any set A, let P(A) be its power set. Let ∅ denote the empty set.

- Write down all the elements of P({1,2,3}). The **power set** is the set that contains all subsets of a given set

  Solution: P({1,2,3}) = {{1},{2},{3},{1,2},{1,3},{2,3},∅,{1,2,3}}

- How many elements are there in P({1,2,3,4,5,6,7,8})?

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Problem 1

For any set A, let P(A) be its power set. Let $\varnothing$ denote the empty set.

- Write down all the elements of P({1,2,3}).

  Solution: P({1,2,3}) = {{1},{2},{3},{1,2},{1,3},{2,3},$\varnothing$,{1,2,3}}

- How many elements are there in P({1,2,3,4,5,6,7,8})?

  Solution: |P({1,2,3,4,5,6,7,8})| = 2^8

(0,0,0,0,0,0,0,0),(0,0,0,0,0,0,0,1), … (1,1,1,1,1,1,1,1)

Problem 2

Is the set {x|x is a real number} well defined?

Solution:

Is the set {x|x is a good athlete} well defined?

Solution:

Is the set {x|x is a difficult course} well defined?

Solution:

Is the set {x|x is a counting number less than 2} well defined?

Solution:

Problem 2

Is the set {x|x is a real number} well defined?

Solution: Yes

Is the set {x|x is a good athlete} well defined?

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Is the set {x|x is a difficult course} well defined?

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Is the set {x|x is a real number} well defined?

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Solution: No, ‘good’ is vague

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Problem 3

Denote the set “the set of all integer numbers smaller than 100”?

Solution:

Denote the set “{1,3,5,...,75}” by set builder notation?

Solution:

Problem 3

Denote the set “the set of all integer numbers smaller than 100”?

Solution: $\{x|x\in Z:x<100\}$

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Solution:

Problem 3

Denote the set “the set of all integer numbers smaller than 100”?

Solution: $\{x | x \in Z : x < 100\}$

Denote the set “{1,3,5,...,75}” by set builder notation?

Solution: $\{x | x \in Z$: $x < 76$, $x > 0$, $x \% 2 = 1$ (x is odd number)$\}$

Problem 4

For following give an example or explain why its impossible.

- Two sets that are neither equal nor equivalent

  Solution:

  Two sets that are equal but not equivalent

  Solution:

- Two sets that are equivalent but not equal

  Solution:

- Two sets that are both equal and equivalent

  Solution:

Problem 4

For following give an example or explain why its impossible.

- Two sets that are neither equal nor equivalent An equivalent set is simply **a set with an equal number of elements**

  Solution: {2}, {3,4}

- Two sets that are equal but not equivalent

  Solution:

  Two sets that are equivalent but not equal

  Solution:

- Two sets that are both equal and equivalent

  Solution:

Problem 4

For following give an example or explain why its impossible.

- Two sets that are neither equal nor equivalent

  Solution: {2}, {3,4}

- Two sets that are equal but not equivalent

  Solution: Impossible, if sets are equal, they have exactly same elements, so the size of the sets must be the same.

- Two sets that are equivalent but not equal

  Solution:

- Two sets that are both equal and equivalent

  Solution:

Problem 4

For following give an example or explain why its impossible.

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  Solution: {2}, {3,4}

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- Two sets that are equivalent but not equal

  Solution: {a,b}, {a,c}

- Two sets that are both equal and equivalent

  Solution:

Problem 4

For following give an example or explain why its impossible.

- Two sets that are neither equal nor equivalent

  Solution: {2}, {3,4}

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- Two sets that are equivalent but not equal

  Solution: {a,b}, {a,c}

- Two sets that are both equal and equivalent

  Solution: {a,b}, {a,b}

Problem 5

Let sets be U={a,b,c,d,e,f,g}, A={a,e}, B={a,b,e,f,g}, C={b,f,g}, D={d,e}. Which statements are true/false?

- $A \subset U$ Solution:
- $D \subseteq B$ Solution:
- $A \subset B$ Solution:
- $\varnothing \not\subset A$ Solution:
- $D \nsubseteq B$ Solution:
- There are exactly 6 subsets of C.
- There are exactly 3 proper subsets of A.

Problem 5

Let sets be U={a,b,c,d,e,f,g}, A={a,e}, B={a,b,e,f,g}, C={b,f,g}, D={d,e}. Which statements are true/false?

The symbol "⊆" means "is a subset of". **The symbol "⊂" means "is a proper subset of"**

- $A \subset U$ Solution: True a,e $\in$ U
- $D \subseteq B$ Solution:
- $A \subset B$ Solution:
- $\varnothing \not\subset A$ Solution:
- $D \not\subseteq B$ Solution:
- There are exactly 6 subsets of C. Solution:
- There are exactly 3 proper subsets of A.

Solution:

Problem 5

Let sets be U={a,b,c,d,e,f,g}, A={a,e}, B={a,b,e,f,g}, C={b,f,g}, D={d,e}. Which statements are true/false?

- $A \subset U$ Solution: True a,e $\in$ U
- $D \subseteq B$ Solution: False d $\notin$ B
- $A \subset B$ Solution:
- $\varnothing \not\subset A$ Solution:
- $D \nsubseteq B$ Solution:
- There are exactly 6 subsets of C. Solution:
- There are exactly 3 proper subsets of A.

  Solution:

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- $D \nsubseteq B$ Solution:
- There are exactly 6 subsets of C. Solution:
- There are exactly 3 proper subsets of A.

Solution: True Proper subsets:

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- $\varnothing \not\subset A$ Solution: False empty set always exists in every set
- $D \nsubseteq B$ Solution:
- There are exactly 6 subsets of C. Solution:
- There are exactly 3 proper subsets of A.

  Solution:

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- $D \not\subseteq B$ Solution: True
- There are exactly 6 subsets of C. Solution:
- There are exactly 3 proper subsets of A.

  Solution:

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- There are exactly 6 subsets of C. Solution: False P(C)=2^3=8 subsets
- There are exactly 3 proper subsets of A.

Solution:

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Let sets be U={a,b,c,d,e,f,g}, A={a,e}, B={a,b,e,f,g}, C={b,f,g}, D={d,e}. Which statements are true/false?

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Solution: True Proper subsets: {a},{e},{$\varnothing$}

$$-2 \in \mathbb{Z}$$

Problem 6: True or False?

$$-2 \in \mathbb{Z}$$

- TRUE

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$$2 \in \mathbb{Q}$$

Problem 6: True or False?

$$2 \in \mathbb{Q}$$

- TRUE

Problem 6: True or False?

$$\emptyset \in \{0, 1\}$$

Problem 6: True or False?

$$\emptyset \in \{0, 1\}$$

- FALSE

Problem 6: True or False?

$$\emptyset \subseteq \{0,1\}$$

Problem 6: True or False?

$$\emptyset \subseteq \{0, 1\}$$

- TRUE

Problem 6: True or False?

$$(A \subseteq B) \Rightarrow (A - B = \emptyset)$$

Problem 6: True or False?

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- TRUE

Problem 6: True or False?

$$(A \subseteq B) \Rightarrow (B - A = B)$$

Problem 6: True or False?

$$(A \subseteq B) \Rightarrow (B - A = B)$$

- FALSE

Problem 6: True or False?

$$(A \cap B \cap C) \subseteq (A \cap B)$$

Problem 6: True or False?

$$(A \cap B \cap C) \subseteq (A \cap B)$$

- TRUE

Problem 6: True or False?

$$|\,\mathcal{P}(\{a, \{b, c\}\})\,| = 8$$

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- FALSE

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- FALSE

Problem 6: True or False?

$$(\forall x \in \mathbb{N})(\forall y \in \mathbb{Z})[x^y \in \mathbb{Z}]$$

Problem 6: True or False?

$$(\forall x \in \mathbb{N})(\forall y \in \mathbb{Z})[x^y \in \mathbb{Z}]$$

- FALSE

Problem 7

You performed a survey asking 60 students if they like cats or dogs. 10 students said they only like cats, 20 said they only like dogs, and 25 students said they don't like either one. Make a Venn diagram to visualize the results of the survey.

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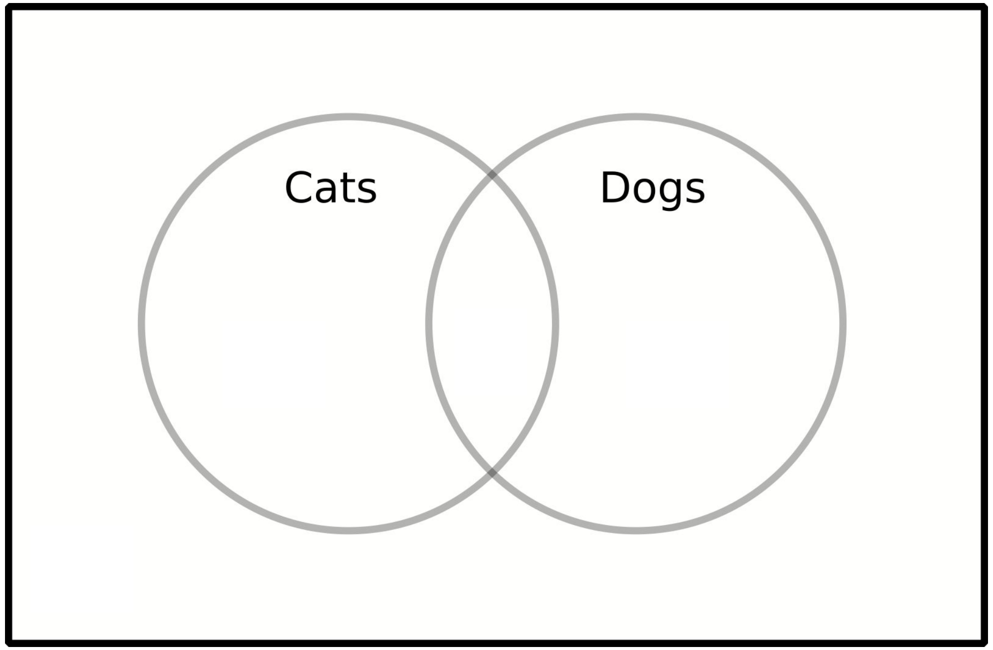

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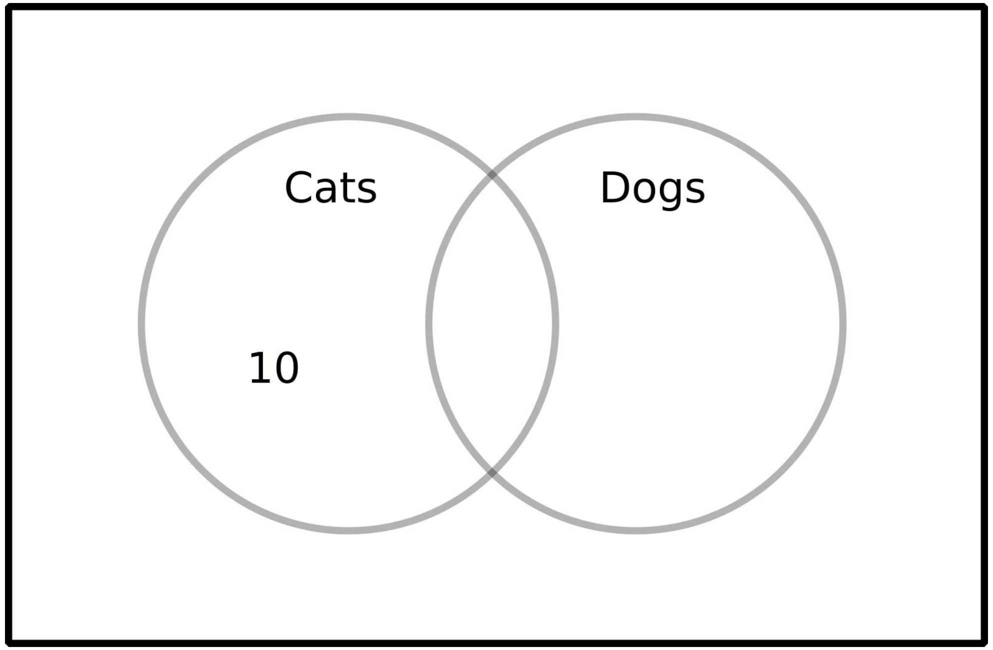

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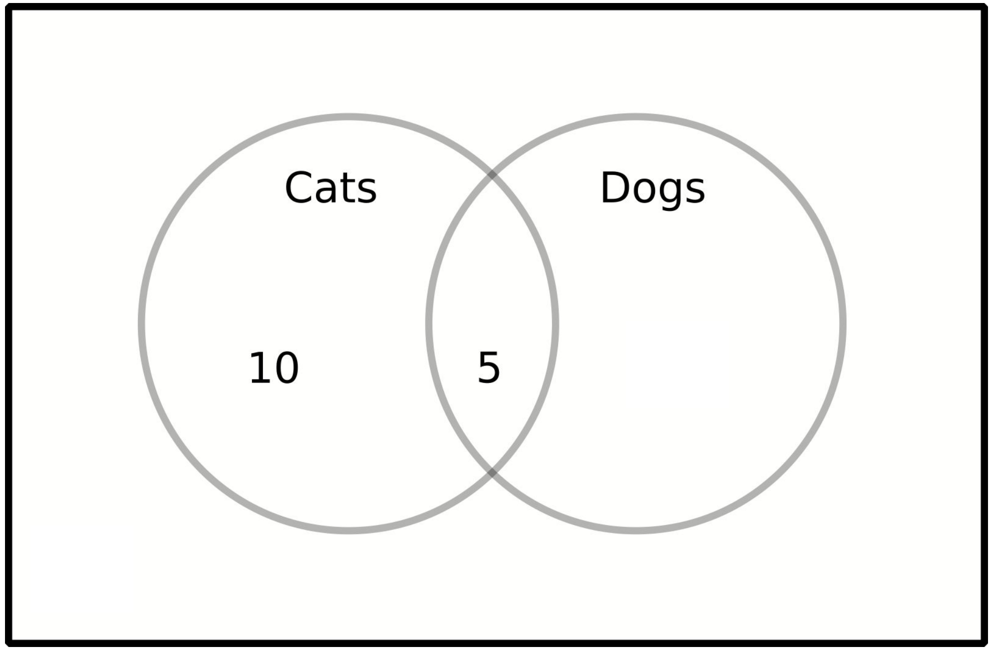

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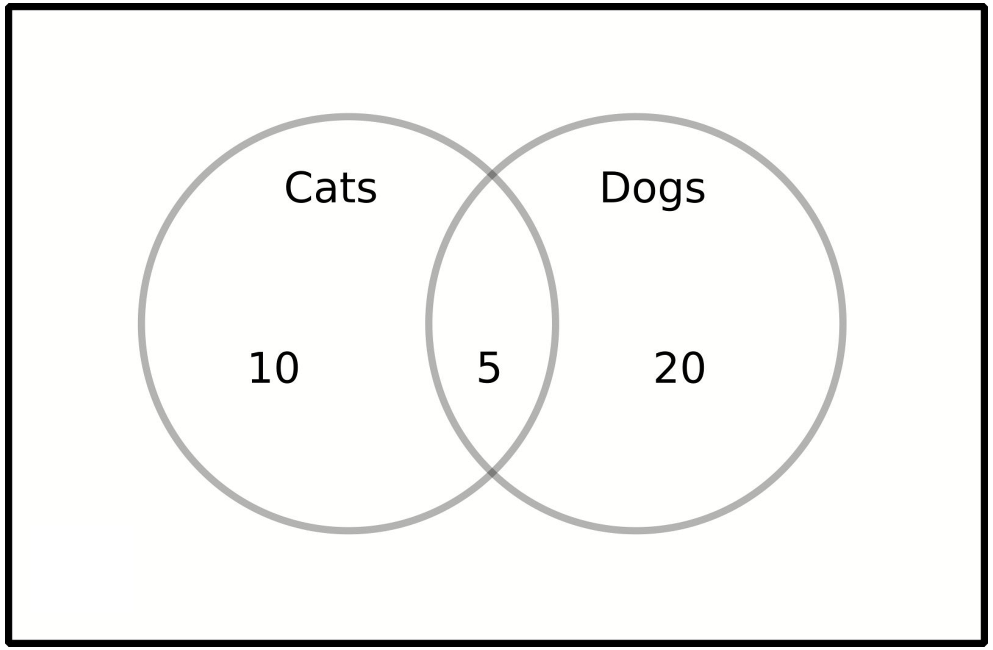

Problem 7

The # of overlap = total # - all the s area = 60 – 10 – 20 –25 = 5

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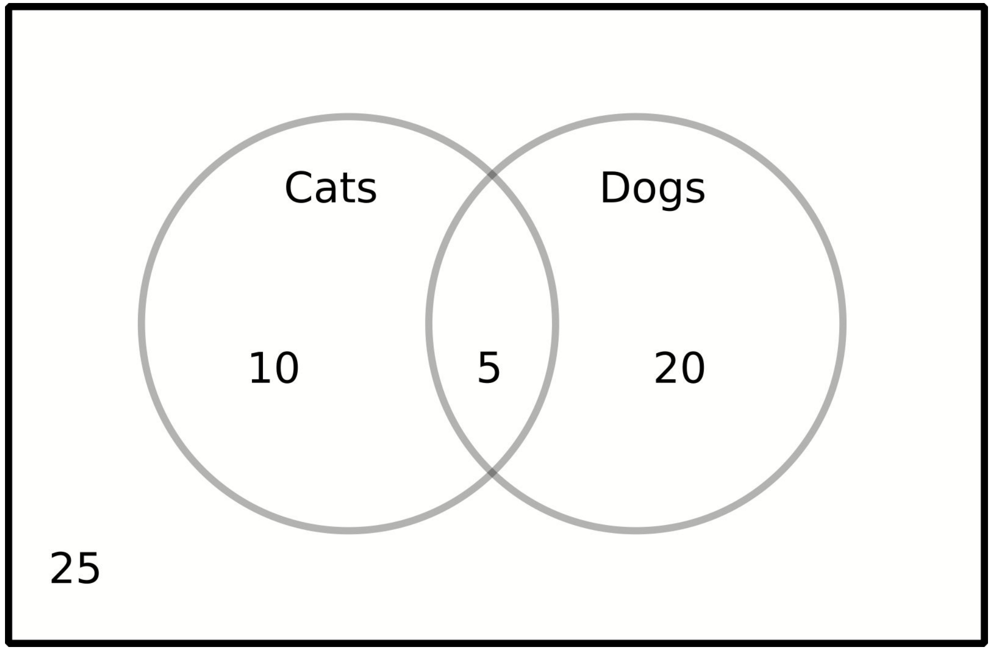


Problem 7

Based on the venn diagram, how many students do not like cats?

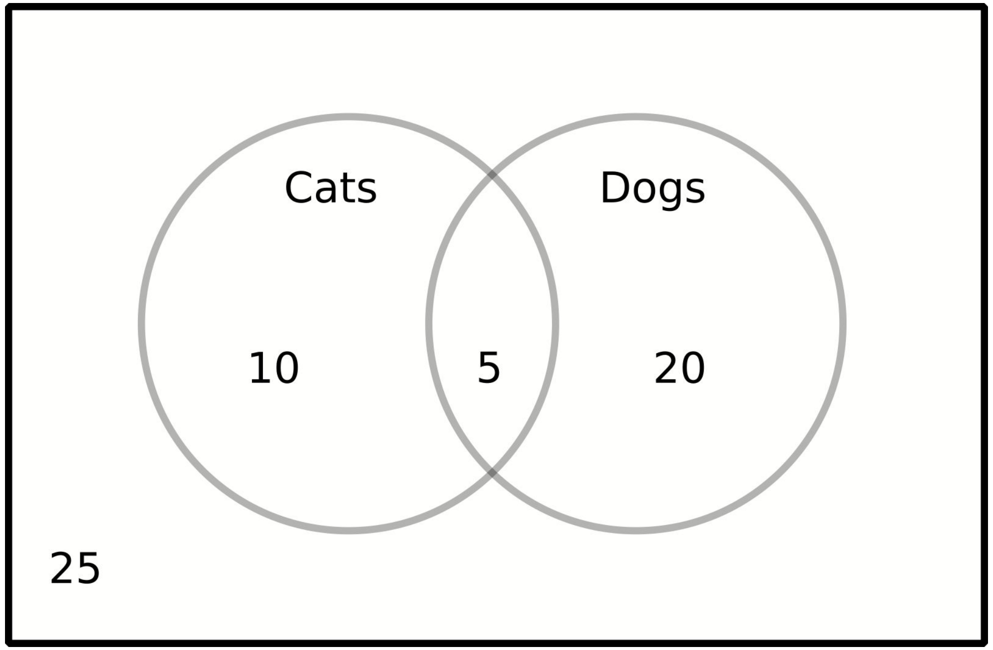
Solution:

What is the union of students that like cats and dogs?

Solution:

What is the complement of students that only like cats?

Solution:



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Based on the venn diagram, how many students do not like cats?

Solution: 25+20=45 students do not like cats.

What is the union of students that like cats and dogs?

Solution:

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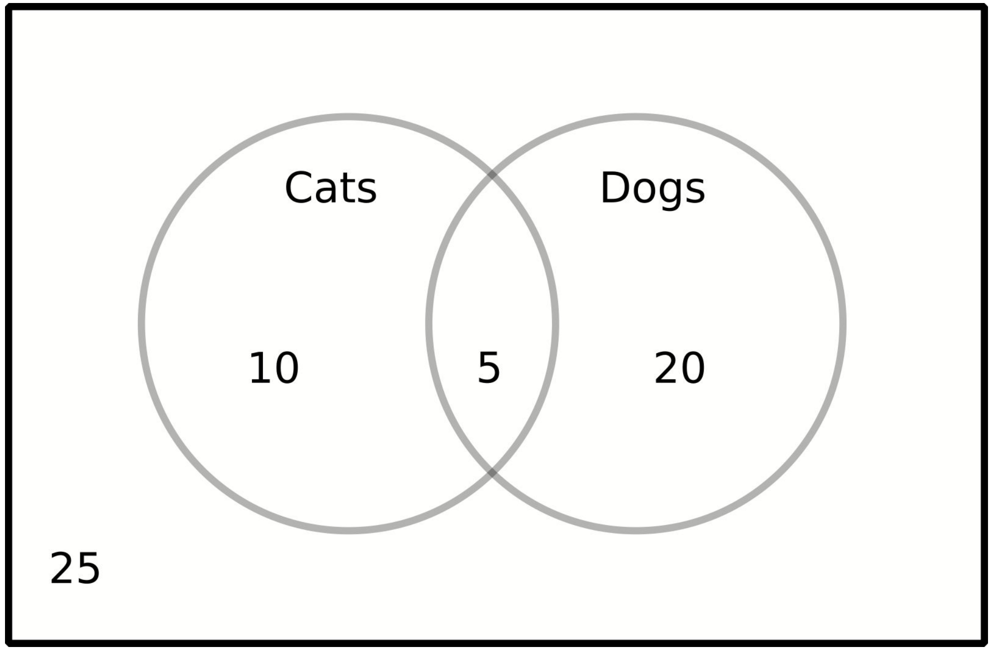

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Solution: 35=10+5+20+5-5

What is the complement of students that only like cats?

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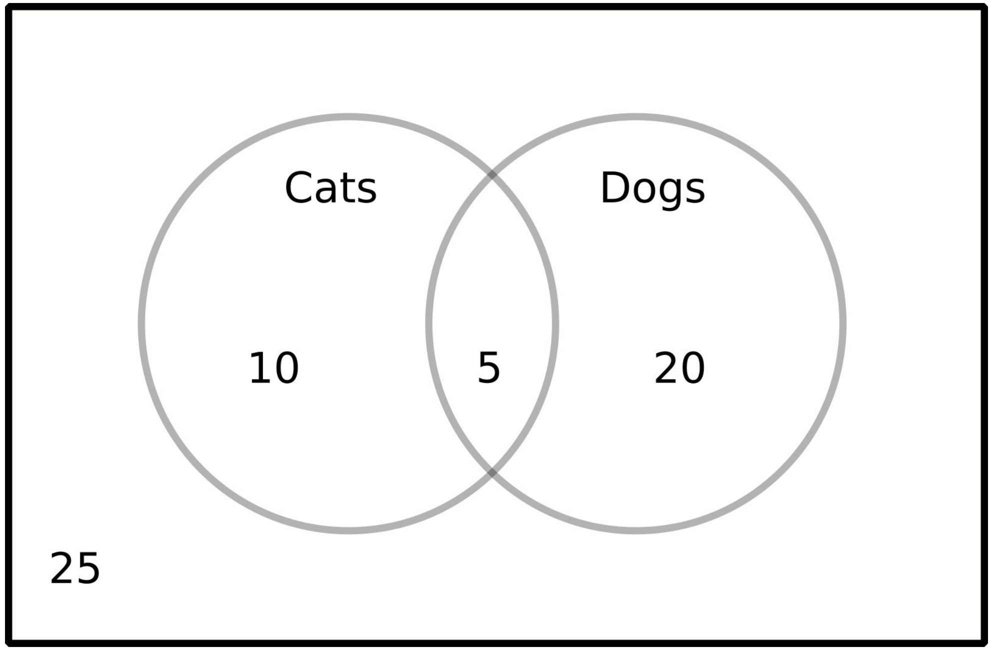

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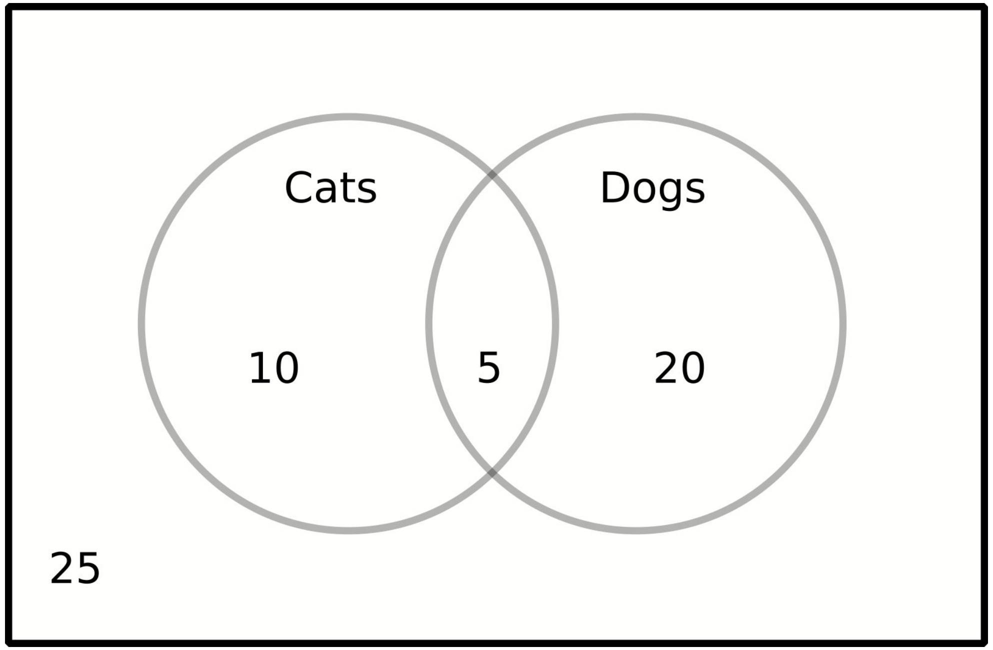

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What is the union of students that like cats and dogs?

Solution: 35=10+5+20+5-5

What is the complement of students that only like cats?

Solution: 60-10=50

Problem 8

Students in CS 206 class all know English and some also known other languages:

- 20 students know French
- 17 students know Russian
- 35 students know Spanish
- 5 students know both Russian and French
- 2 students know Russian and Spanish
- 10 students know Spanish and French
- 2 students know these three languages
- 10 students don't know any other languages

Problem 8

Students in CS 206 class all know English and some also known other languages:

- 20 students know French
- 17 students know Russian
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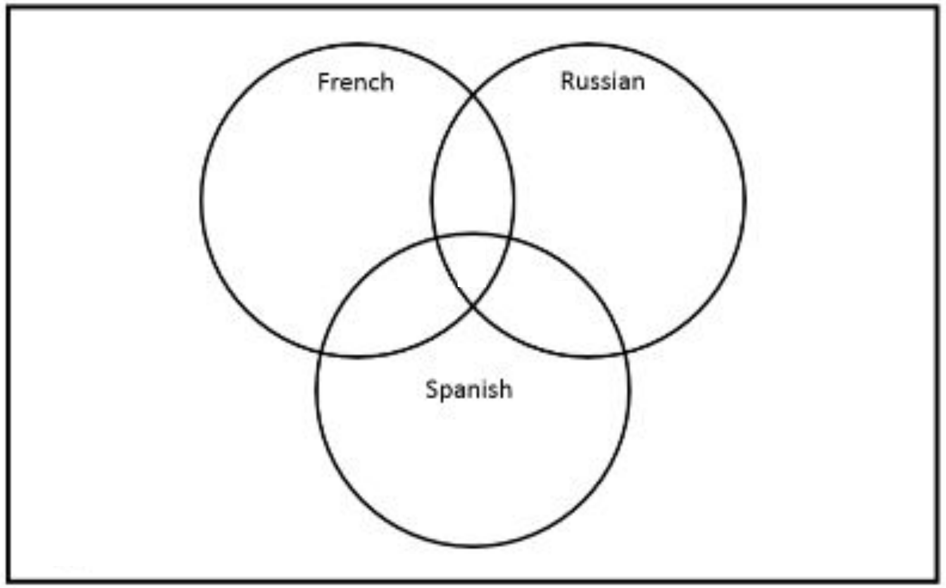

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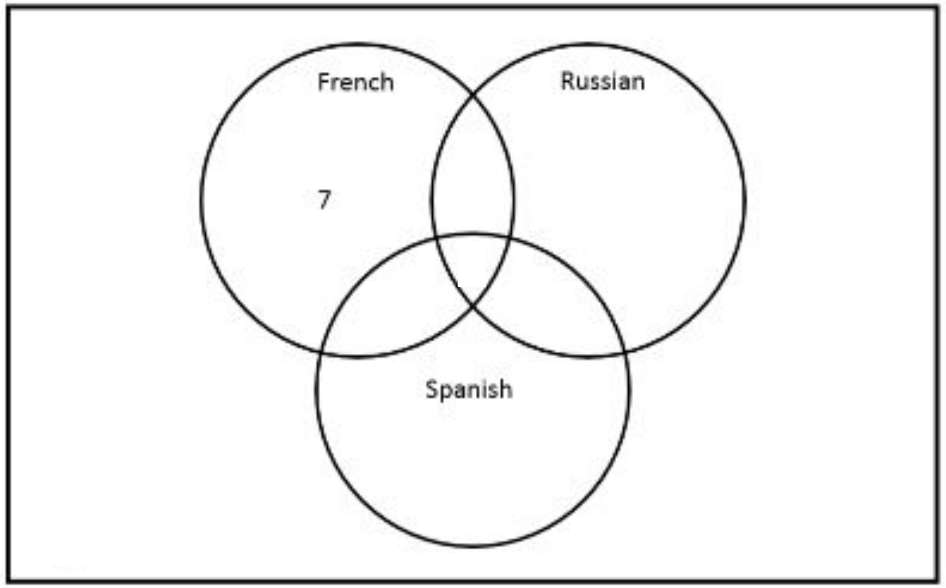

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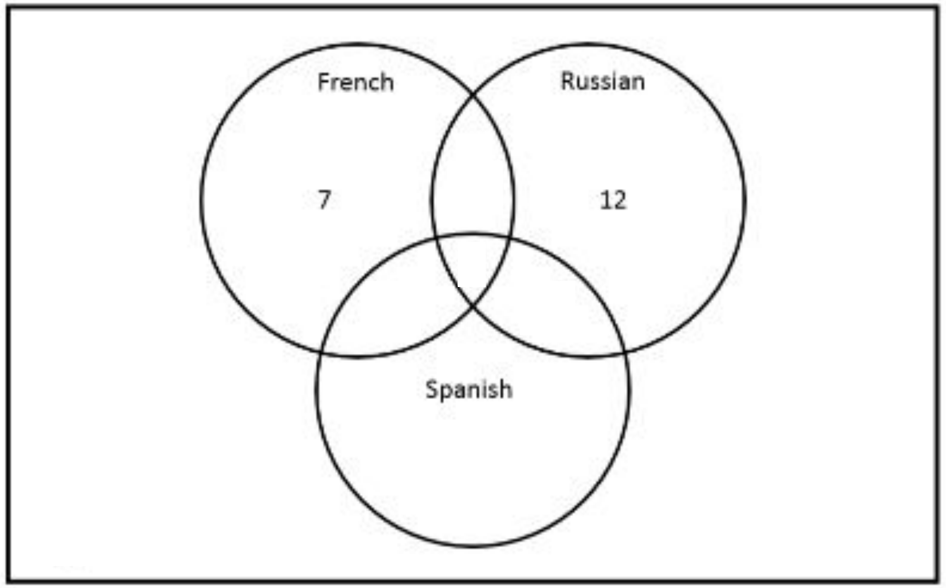

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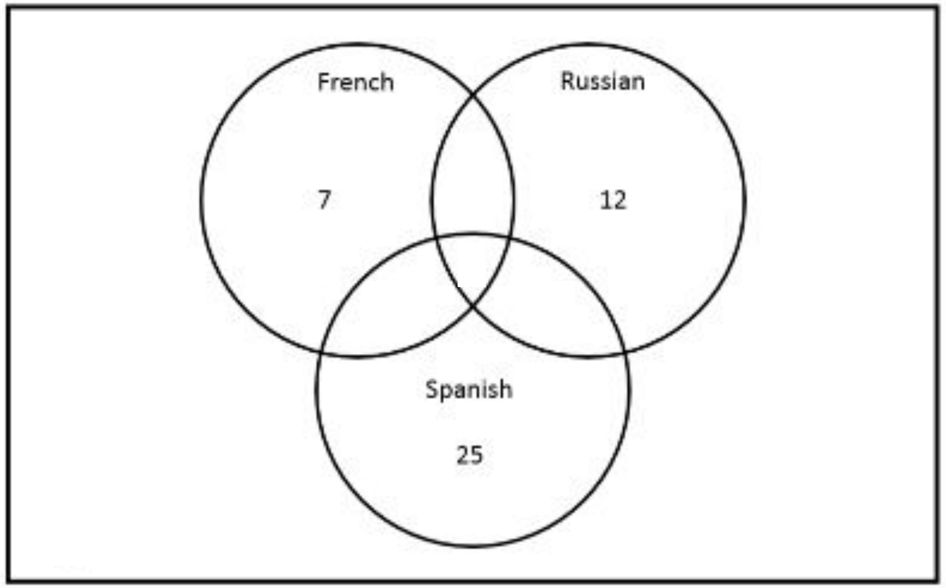

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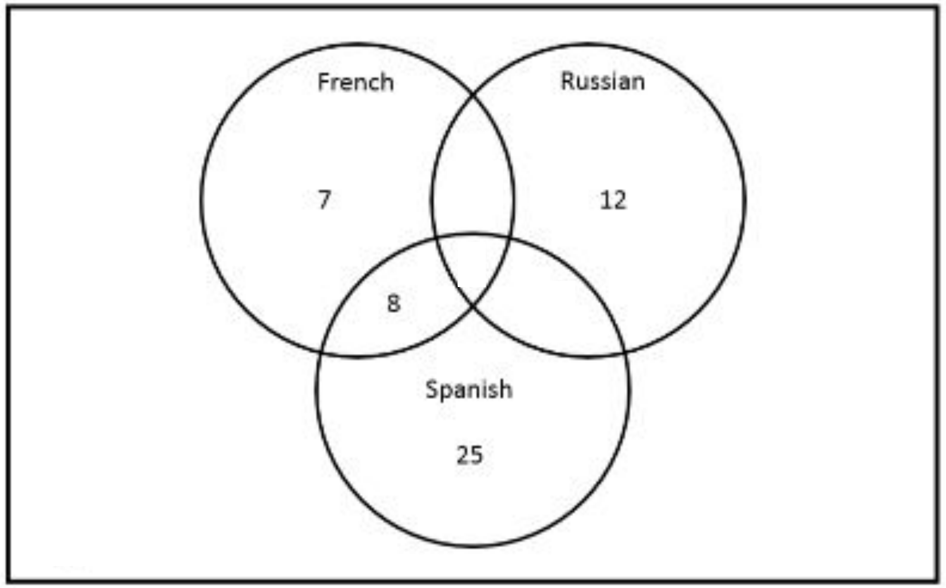
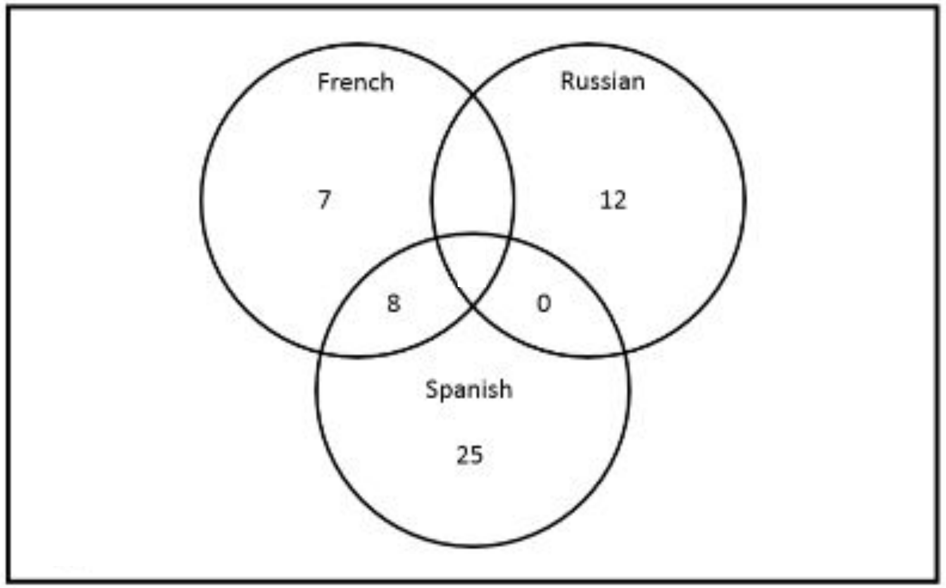


Problem 8

Students in CS 206 class all know English and some also known other languages:

- 20 students know French
- 17 students know Russian
- 35 students know Spanish
- 5 students know both Russian and French
- 2 students know Russian and Spanish
- 10 students know Spanish and French
- 2 students know these three languages
- 10 students don't know any other languages



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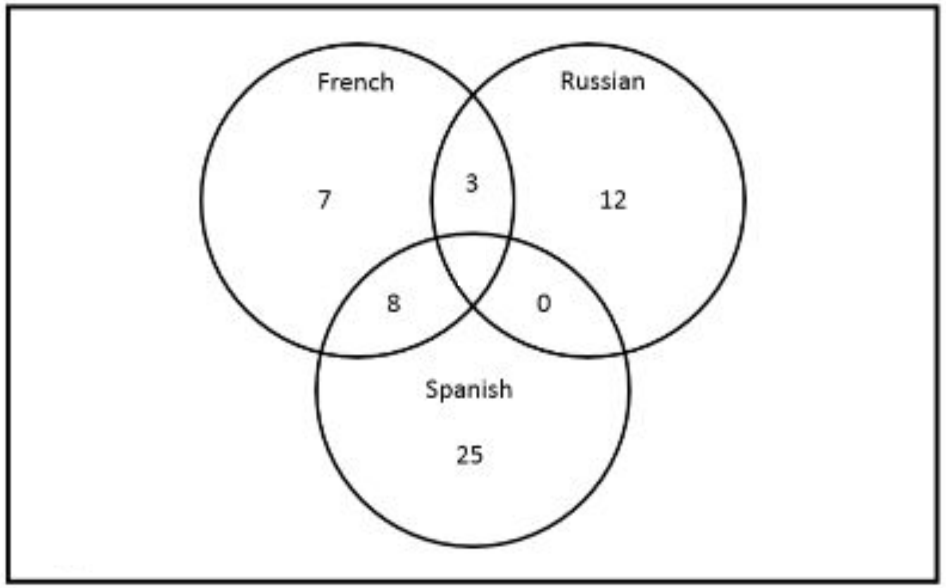

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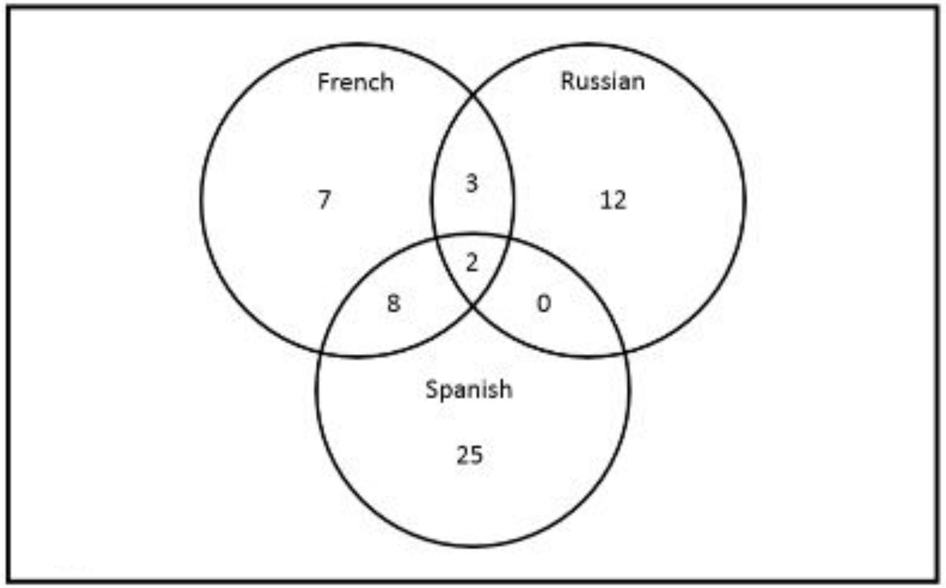

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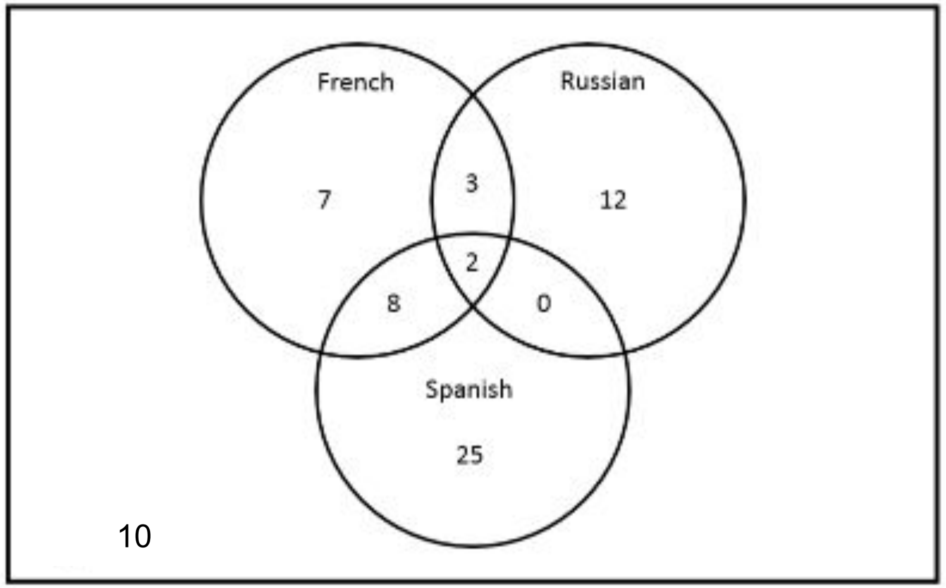


Problem 8

How many students are there in the class?

Solution:

What is the intersection of students that know English, Russian, and Spanish?

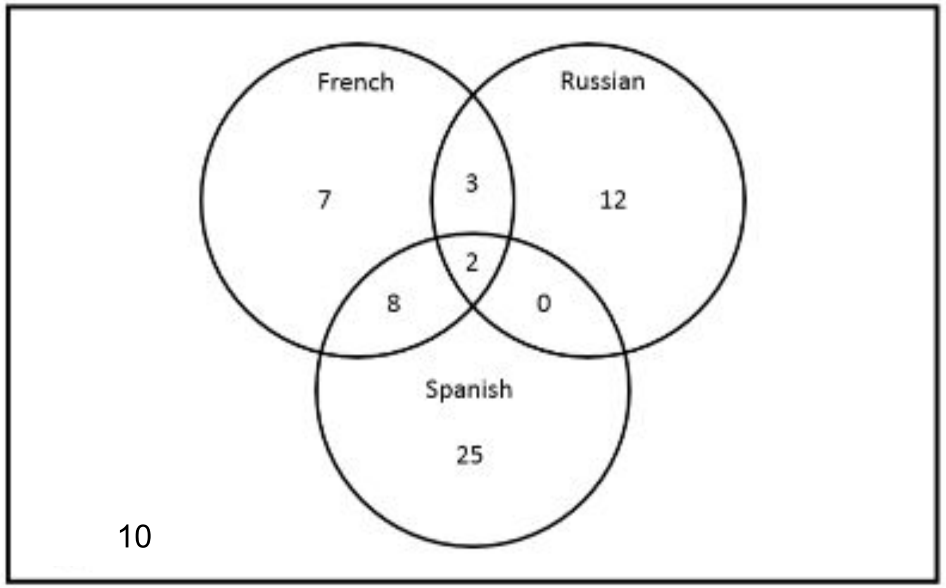
Solution:

What is the intersection of students that know English, Spanish, and French?

Solution:

How many students know all 4 languages?

Solution:



Problem 8

How many students are there in the class?

Solution: 7+12+25+3+8+2+10=67

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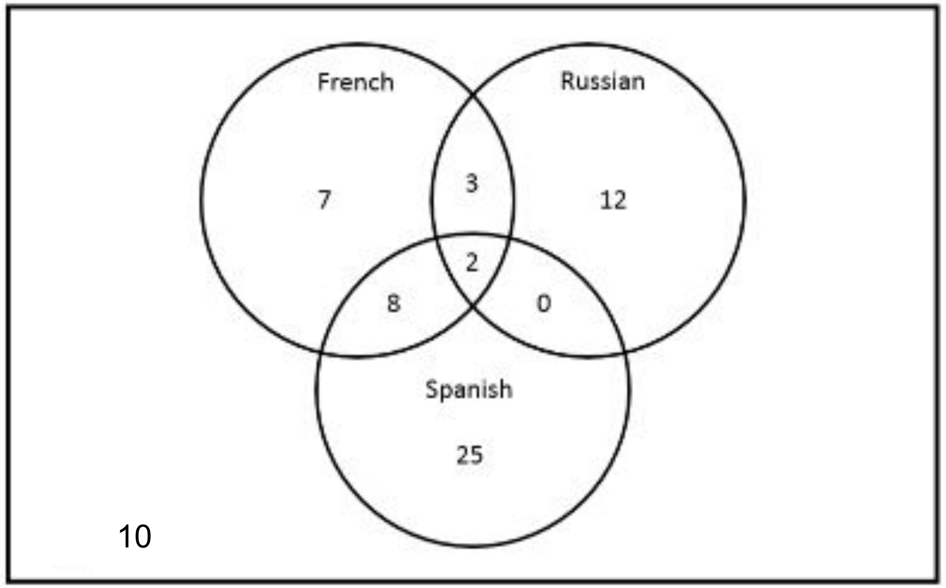

Problem 8

How many students are there in the class?

Solution: 7+12+25+3+8+2+10=67

What is the intersection of students that know English, Russian, and Spanish?

Solution: 0+2=2

What is the intersection of students that know English, Spanish, and French?

Solution:

How many students know all 4 languages?

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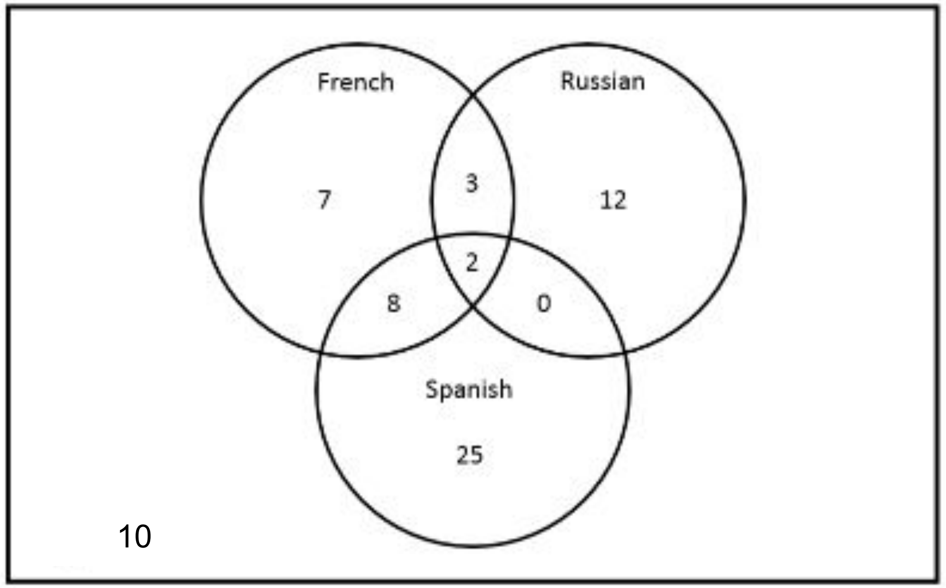

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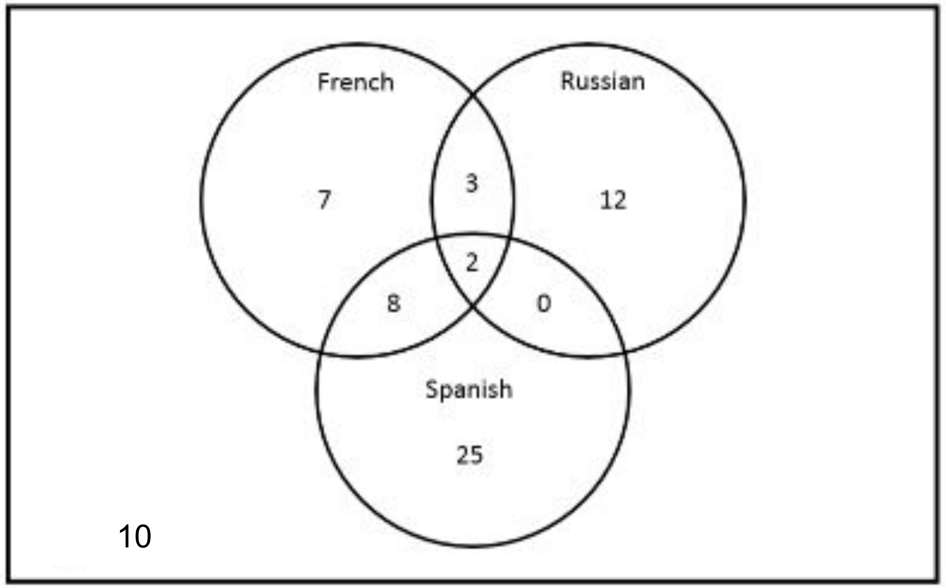
Solution:



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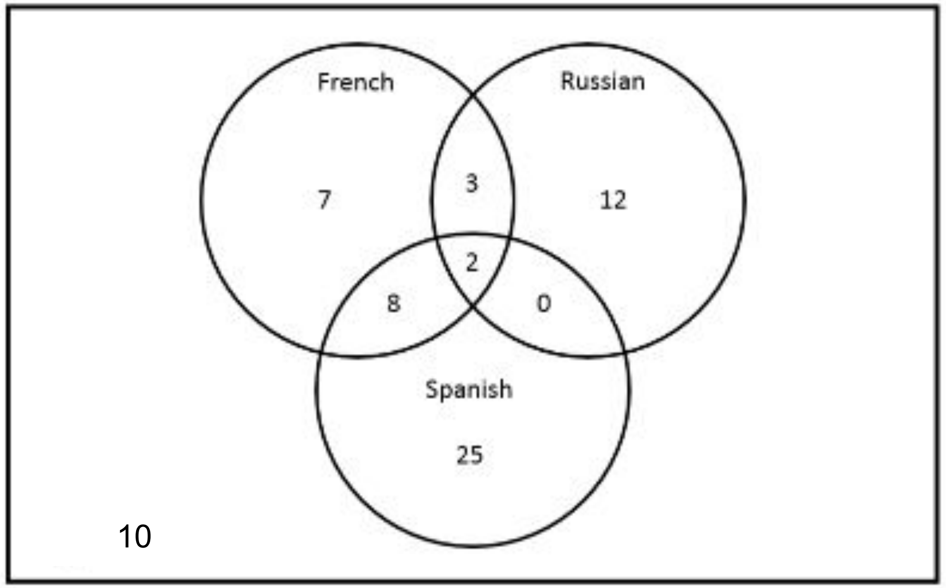
Solution: 8+2=10

How many students know all 4 languages?

Solution: 2



Problem 8

What is the intersection of students that know French and Spanish minus the students that know Russian?

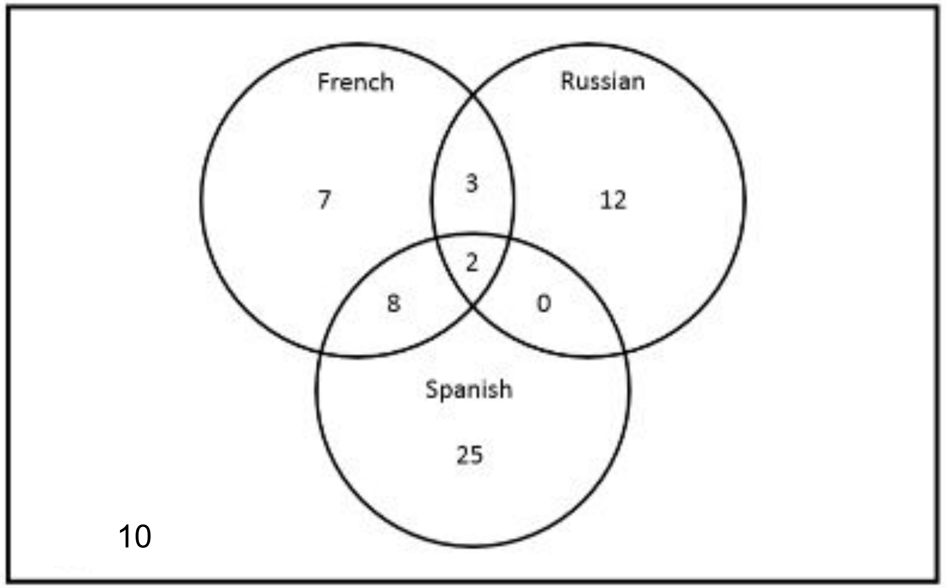
Solution:

What is the intersection of students that know French and Spanish minus the students that know English?

Solution:

What is the union of students that know French and Spanish and Russian minus the intersection of students all 4 languages?

Solution:



Problem 8

What is the intersection of students that know French and Spanish minus the students that know Russian?

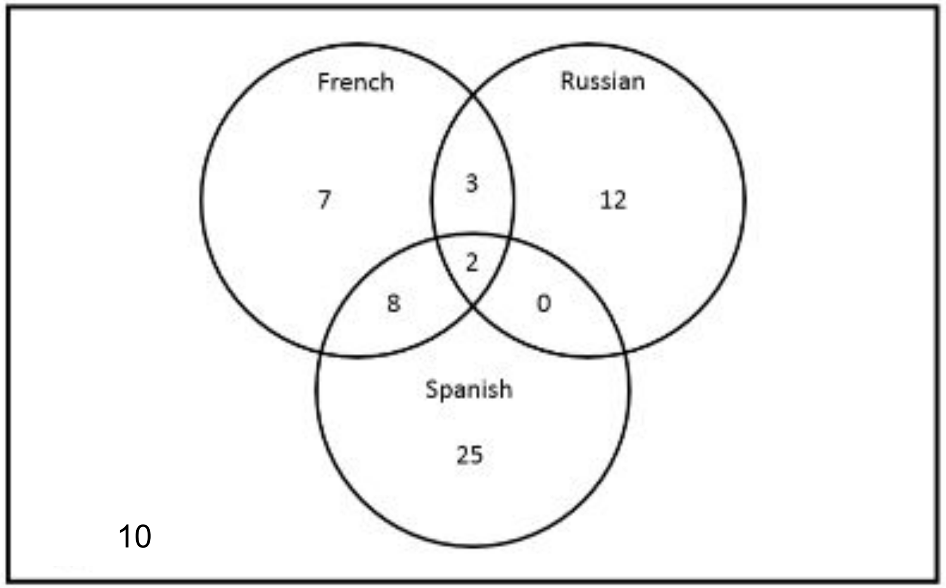
Solution: 8+2-2=8

What is the intersection of students that know French and Spanish minus the students that know English?

Solution:

What is the union of students that know French and Spanish and Russian minus the intersection of students all 4 languages?

Solution:



Problem 8

What is the intersection of students that know French and Spanish minus the students that know Russian?

Solution: 8+2-2=8

What is the intersection of students that know French and Spanish minus the students that know English?

Solution: 8+2-2-8=0

What is the union of students that know French and Spanish and Russian minus the intersection of students all 4 languages?

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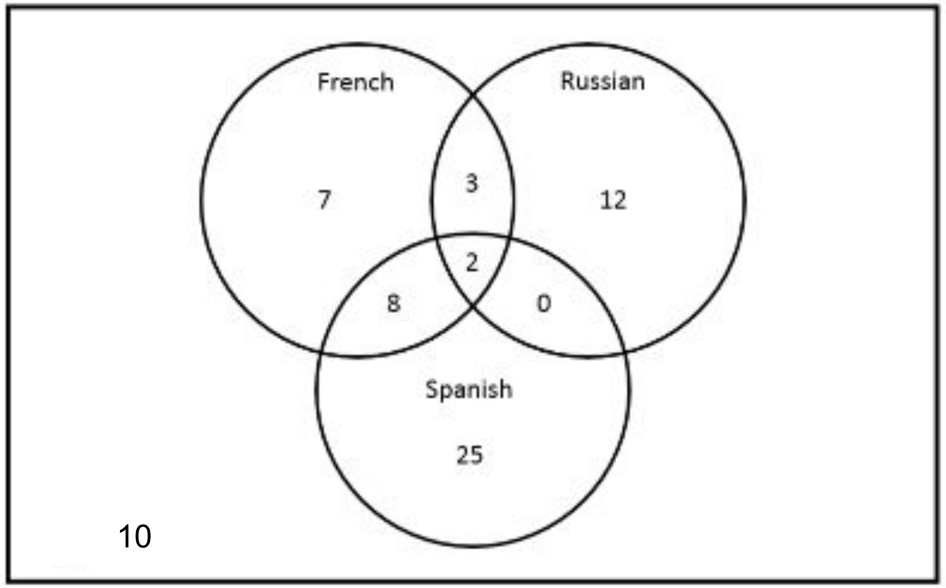

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Solution: 8+2-2=8

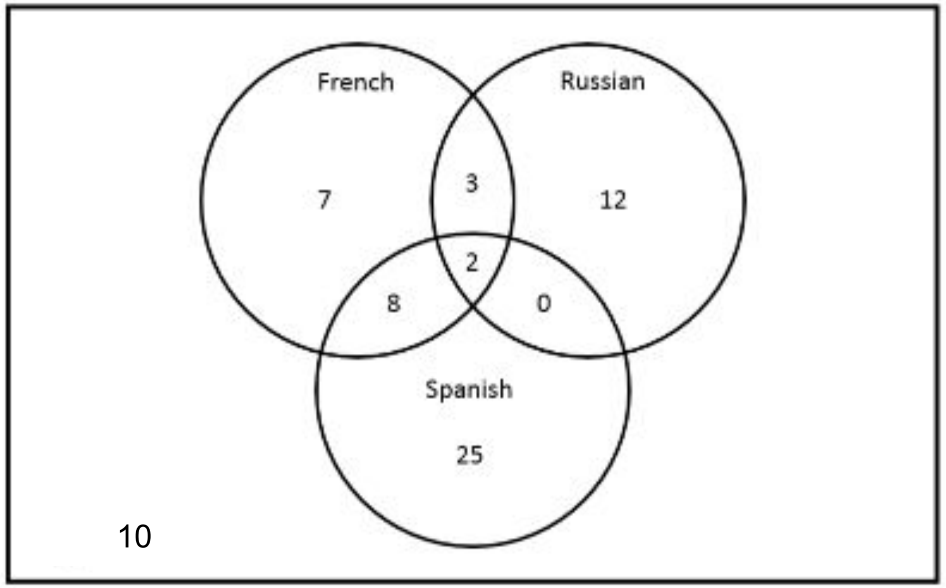
What is the intersection of students that know French and Spanish minus the students that know English?

Solution: 8+2-2-8=0

What is the union of students that know French and Spanish and Russian minus the intersection of students all 4 languages?

Solution:

Union of all 3 languages: 7+12+25+2+8+3=57 students, intersection of all students that know 4 languages: 2, so 57-2=55



Problem 8

What is the subset of English speaking students that know exactly 2 more languages?

Solution:

What is the subset of English speaking students that know 2+ more languages?

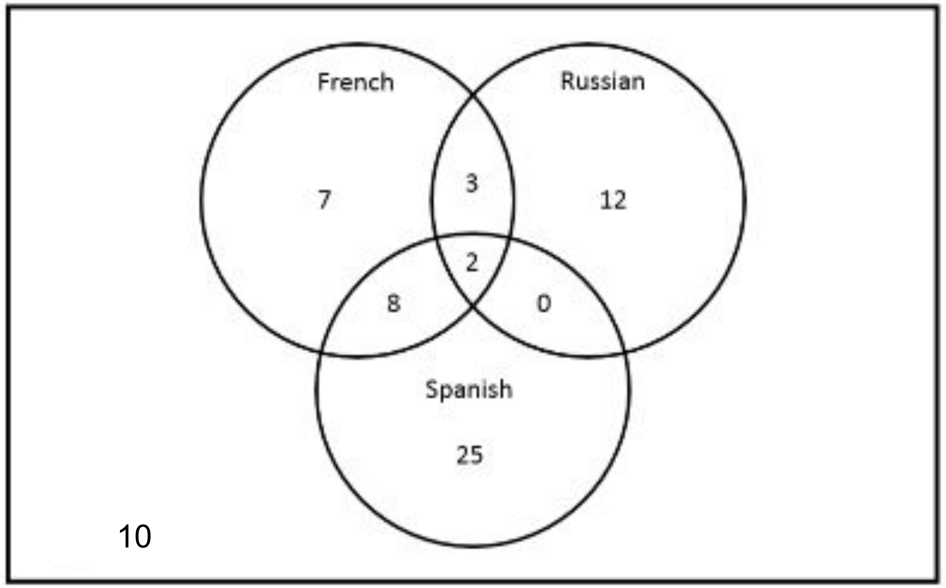
Solution:

What is the subset of Spanish speaking students that exactly 1 more language?

Solution:

What is the subset of Spanish speaking students that exactly 2 more language?

Solution:



Problem 8

What is the subset of English speaking students that know exactly 2 more languages?

Solution: 8+3+0=11 students

What is the subset of English speaking students that know 2+ more languages?

Solution:

What is the subset of Spanish speaking students that exactly 1 more language?

Solution:

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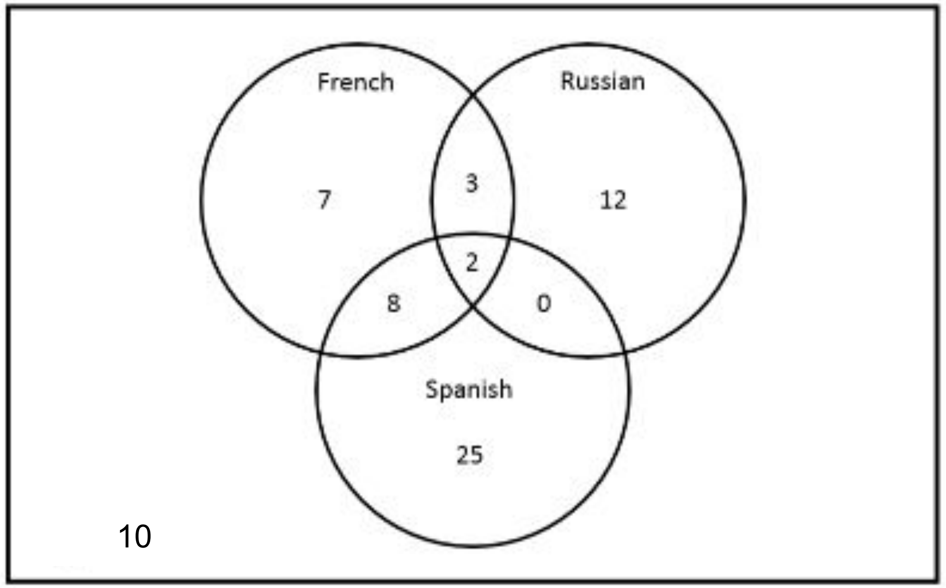
Solution:



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Solution: 8+3+0=11 students

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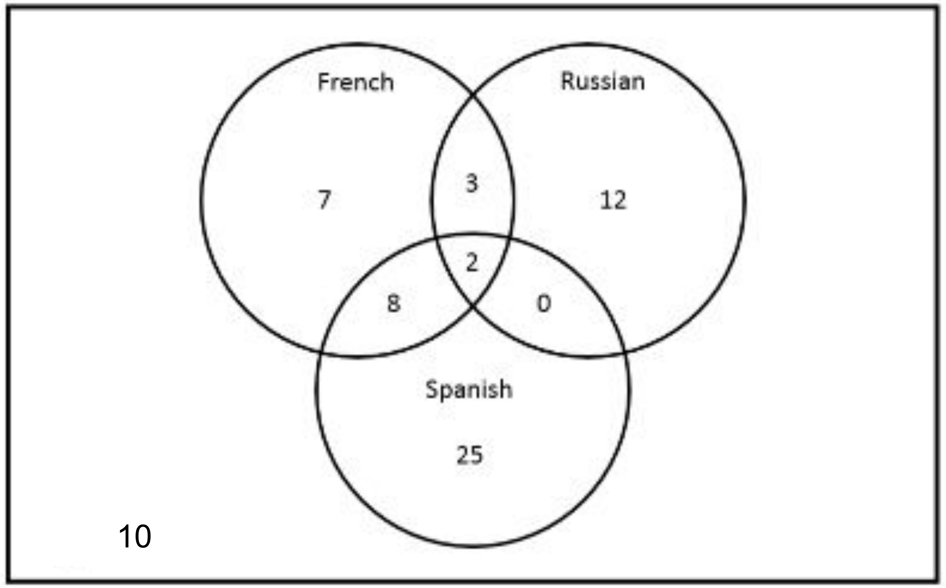
Solution: 8+3+2=13 students

What is the subset of Spanish speaking students that know exactly 1 more language?

Solution:

What is the subset of Spanish speaking students that exactly 2 more language?

Solution:



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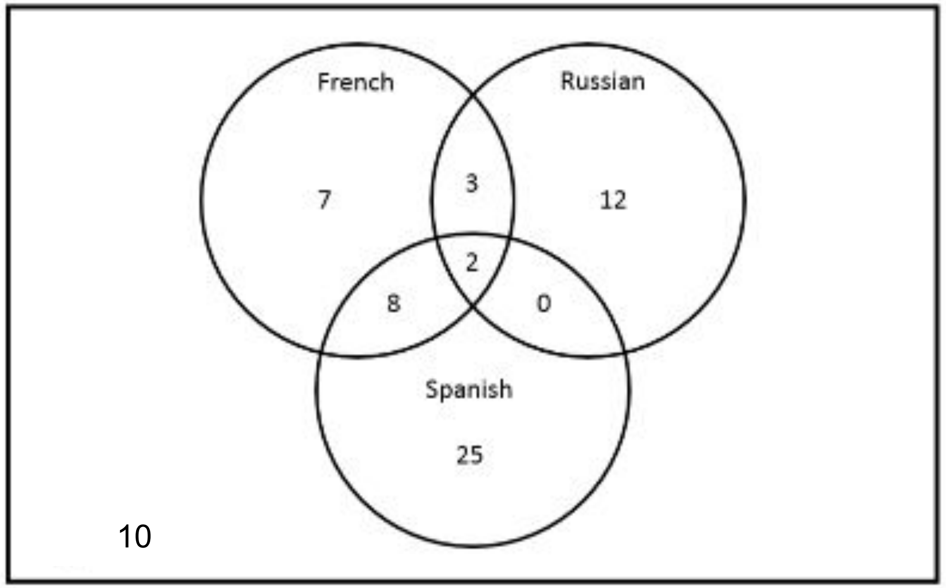

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Solution: 8+3+0=11 students

What is the subset of English speaking students that know 2+ more languages?

Solution: 8+3+2=13 students

What is the subset of Spanish speaking students that know exactly 1 more language?

Solution: 25 students

What is the subset of Spanish speaking students that know exactly 2 more language?

Solution:

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What is the subset of English speaking students that know exactly 2 more languages?

Solution: 8+3+0=11 students

What is the subset of English speaking students that know 2+ more languages?

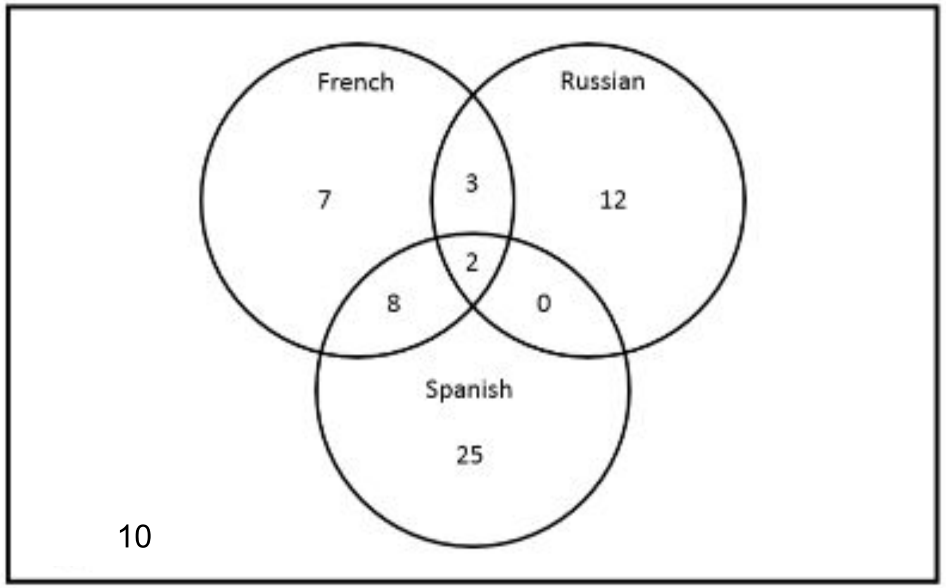
Solution: 8+3+2=13 students

What is the subset of Spanish speaking students that know exactly 1 more language?

Solution: 25 students

What is the subset of Spanish speaking students that know exactly 2 more language?

Solution: 8+0=8 students



Part 1 end

Problem 9

How many different 7-place license plates are possible if the first 3 places are to be occupied by letters and the final 4 by numbers? (hint use product rule)

Solution:

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How many different 7-place license plates are possible if the first 3 places are to be occupied by letters and the final 4 by numbers? (hint use product rule)

Solution:

By the generalized version of the basic principle, the answer is $26 \cdot 26 \cdot 26 \cdot 10 \cdot 10 \cdot 10 \cdot 10=175{,}760{,}000$.

Problem 10

Beethoven wrote 9 symphonies and Mozart wrote 27 piano concertos. If a university radio station announcer wishes to play first a Beethoven symphony and then a Mozart concerto, in how many ways can this be done? (hint use product rule)

Solution:

Problem 10

Beethoven wrote 9 symphonies and Mozart wrote 27 piano concertos. If a university radio station announcer wishes to play first a Beethoven symphony and then a Mozart concerto, in how many ways can this be done? (hint use product rule)

Solution:

There are 9 options for the first music, and 27 for the second. Therefore there are $9 \cdot 27$ possibilities.

Problem 11

The station manager decides that on each successive night (7 days per week), a Beethoven symphony will be played, followed by a Mozart piano concerto, followed by a Schubert string quartet (of which there are 15). For roughly how many years could this policy be continued before exactly the same program would have to be repeated? (hint use product rule)

Solution:

Problem 11

The station manager decides that on each successive night (7 days per week), a Beethoven symphony will be played, followed by a Mozart piano concerto, followed by a Schubert string quartet (of which there are 15). For roughly how many years could this policy be continued before exactly the same program would have to be repeated? (hint use product rule)

Solution:

There are $9 \cdot 27 \cdot 15 = 3645$ possible sequences. Therefore after about 10 years the same program would have to be repeated.

Problem 12

You have 6 marbles: 3 green, 2 red, 1 orange, that you want to give away to your 6 friends in sequence as you encounter them through out the day. For each color, the marbles not distinguishable. How many different ways can you give out the 6 marbles? Use product rule.

Solution:

Problem 12

You have 6 marbles: 3 green, 2 red, 1 orange, that you want to give away to your 6 friends in sequence as you encounter them through out the day. For each color, the marbles not distinguishable. How many different ways can you give out the 6 marbles? Use product rule.

Solution:

Break up the sequence into subsets by marble color. The first subset is the number of ways you can give out the single orange marble to any of your 6 friends: 6. Assume orange the marble has been given to a friend, and now you have 5 friends left for green/red marbles. The second subset is the number of ways you can give out 3 green marbles to your 5 remaining friends: 10 (by enumeration). Last set has size 1 since you have 2 friends left and 2 marbles of the same color. Since these sets are independent, then by product rule the total number of sequences is 6*10*1=60.

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g,g,g,r,r/g,g,r,g,r/g,g,r,r,g/g,r,g,r,g/g,r,r,g,g/g,r,g,g,r/r,g,g,g,r/r,g,g,r,g/r,g,r,g,g/r,r,g,g,g

Last set has size 1 since you have 2 friends left and 2 marbles of the same color. Since these sets are independent, then by product rule the total number of sequences is 6*10*1=60.

Problem 13

You need to make a user name consisting of 4 or 5 characters. You can use lower case English letters and digits. Because of heavy use, usernames can't start with letters "u,v,a" and can't end with digits "4,5". There are also 30,000,000 usernames created already in the system that meet the above constraints. How many different possible usernames are left available?

Solution:

Problem 13

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Solution:

Partition the problem into 2 sets:

1) 4 char usernames,

2) 5 char usernames.

Set 1 is of size ((26-3)+10)*((26)+10)*((26)+10)*((26)+8)=1,454,112.

Set 2 is of size ((26-3)+10)*((26)+10)*((26)+10)*((26)+10)*((26)+8)=52,348,032.

By partition method, total possible usernames meeting the constraints are 1,454,112 + 52,348,032 = 53,802,144. By difference method, there are 53,802,144 - 30,000,000 = 23,802,144 available usernames.