

CHAPTER

4

Operations on Sets

You will learn

- ▶ Intersection of Sets
- ▶ Union of Sets
- ▶ Combined Operations on Sets

The agriculture sector is one of the sectors contributing to the income of Malaysia. The use of modern and high technology in agriculture not only enables this sector to increase its output, it even attracts the new generation to this sector in the future.

Do you know what other economy sectors that are the main contributors to the income of our nation?

Why Study This Chapter?

Operations on sets are used in representing, grouping and analysing similar data in our daily life. This knowledge is the basis to various fields such as programming, statistics, economics and stock markets, which need analytical skills.



 **Walking Through Time**



Georg Ferdinand Ludwig Philipp Cantor
(1845 – 1918)

Georg Cantor is a German mathematician who pioneered the theory of set. He also introduced the ideas of ordinal numbers, cardinal numbers and the arithmetic of infinite sets.



<http://bt.sasbadi.com/m4095>

WORD BANK

- union
- intersection
- complement
- set
- empty set
- subset
- set notation
- element
- *kesatuan*
- *persilangan*
- *pelengkap*
- *set*
- *set kosong*
- *subset*
- *tatatanda set*
- *unsur*

4.1 Intersection of Sets

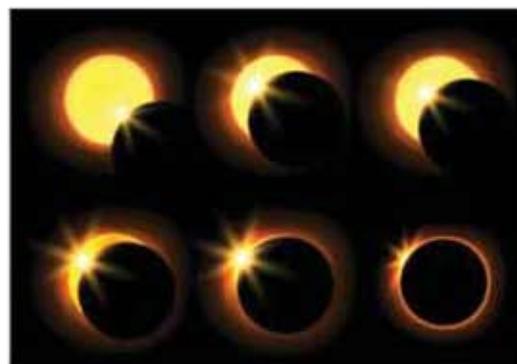
Q How do you determine and describe the intersection of sets using various representations?

An intersection of sets exists when there are more than one set. The intersection of sets P and Q is written using the symbol \cap . Set $P \cap Q$ contains the common elements of both sets P and Q .



Learning Standard

Determine and describe the intersection of sets using various representations.



Eclipse of the sun occurs when the moon is in between the sun and the earth, in a straight line. The intersection between the moon and the sun can be seen when parts of the moon and the sun are at the same position.



Mind Stimulation 1

Aim: To determine and describe the intersection of sets using various representations.

The table below shows a group of pupils who prefer to eat local fruits.

Nabil prefers to eat durian.

Hani prefers to eat durian.

Navin prefers to eat rambutan.

Yan Kit prefers to eat durian.

Raj prefers to eat durian and rambutan.

Mei Yee prefers to eat durian.

Afiq prefers to eat durian and rambutan.

Amirul prefers to eat rambutan.

Meena prefers to eat durian.

Benjamin prefers to eat rambutan and durian.

Jenny prefers to eat durian.

Khairi prefers to eat rambutan.



Steps:

- Based on the above table, write the names of the pupils using set notations.

$$A = \{\text{pupils who prefer to eat durian}\}$$

$$A = \{\text{Nabil, Hani, Yan Kit, Raj, Mei Yee, Afiq, Meena, Benjamin, Jenny}\}$$

$$B = \{\text{pupils who prefer to eat rambutan}\}$$

$$B = \{\text{ }, \text{ }, \text{ }, \text{ }, \text{ }, \text{ }\}$$

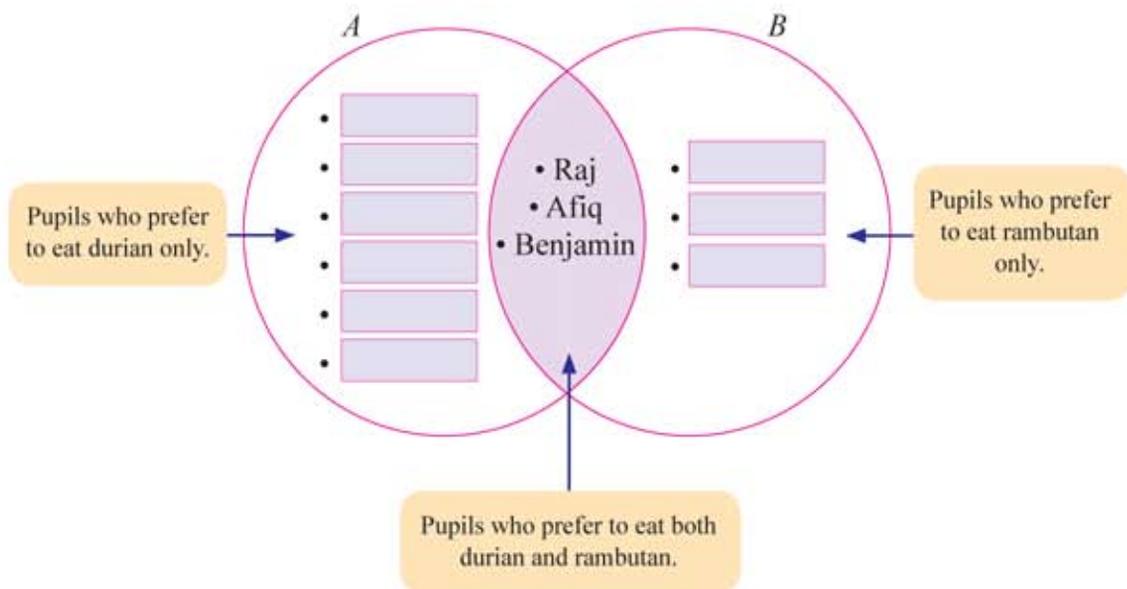
$$A \cap B = \{\text{pupils who prefer to eat both durian and rambutan}\}$$

$$A \cap B = \{\text{ }, \text{ }, \text{ }\}$$

2. Complete the following table with names of pupils who prefer to eat durian only, rambutan only and both durian and rambutan.

Names of pupils who prefer to eat durian only	Names of pupils who prefer to eat rambutan only	Names of pupils who prefer to eat both durian and rambutan
 <ul style="list-style-type: none"> • Nabil • Hani • Yan Kit • Mei Yee • Meena • Jenny 	 <ul style="list-style-type: none"> • Navin • <input type="text"/> • <input type="text"/> 	<ul style="list-style-type: none"> • Raj • Afiq • Benjamin 

3. Complete the following Venn diagram based on the information above.



Discussion:

How can you determine the intersection of sets based on the above activity?

From the activity in Mind Stimulation 1, it is found that:

The intersection of set A and set B contains common elements, that are Raj, Afiq and Benjamin who prefer to eat both durian and rambutan.

Example 1

It is given that the universal set, $\xi = \{x : x \text{ is an integer, } 1 \leq x \leq 10\}$, set $P = \{x : x \text{ is an odd number}\}$, set $Q = \{x : x \text{ is a prime number}\}$ and set $R = \{x : x \text{ is a multiple of } 3\}$.

(a) List all the elements of the following intersections of sets.

- (i) $P \cap Q$ (ii) $P \cap R$ (iii) $Q \cap R$ (iv) $P \cap Q \cap R$

(b) State the number of elements of the following sets.

- (i) $n(P \cap Q)$ (ii) $n(P \cap R)$ (iii) $n(Q \cap R)$ (iv) $n(P \cap Q \cap R)$

Solution:

(a) (i) $P \cap Q$

$$P = \{1, 3, 5, 7, 9\}$$

$$Q = \{2, 3, 5, 7\}$$

$$P \cap Q = \{3, 5, 7\}$$

(ii) $P \cap R$

$$P = \{1, 3, 5, 7, 9\}$$

$$R = \{3, 6, 9\}$$

$$P \cap R = \{3, 9\}$$

(iii) $Q \cap R$

$$Q = \{2, 3, 5, 7\}$$

$$R = \{3, 6, 9\}$$

$$Q \cap R = \{3\}$$

(iv) $P \cap Q \cap R$

$$P = \{1, 3, 5, 7, 9\}$$

$$Q = \{2, 3, 5, 7\}$$

$$R = \{3, 6, 9\}$$

$$P \cap Q \cap R = \{3\}$$

(b) (i) $P \cap Q = \{3, 5, 7\}$

$$n(P \cap Q) = 3$$

(ii) $P \cap R = \{3, 9\}$

$$n(P \cap R) = 2$$

(iii) $Q \cap R = \{3\}$

$$n(Q \cap R) = 1$$

(iv) $P \cap Q \cap R = \{3\}$

$$n(P \cap Q \cap R) = 1$$

**MY MEMORY**

$$B \subset A$$

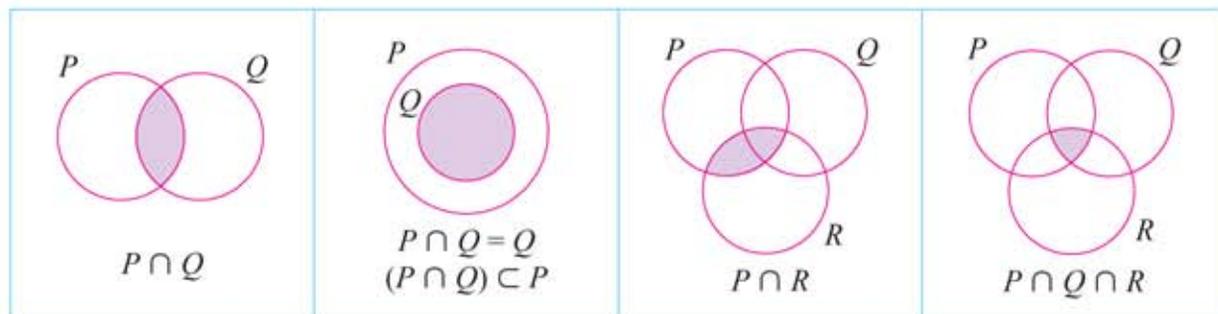
Set B is a subset of set A when all the elements of set B are found in set A .

**INFO ZONE**

The symbol \subseteq can also be used to denote subset.

How do you determine the intersections of two or more sets using Venn diagrams?

The intersections of two or more sets are represented by the shaded regions, as shown in the following Venn diagrams.

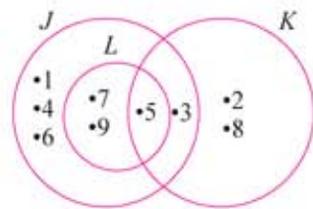


Example 2

The Venn diagram shows set J , set K and set L such that the universal set, $\xi = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$.

List all the elements of the following intersections of sets.

- (a) $J \cap K$ (b) $J \cap L$ (c) $K \cap L$ (d) $J \cap K \cap L$



Solution:

- (a) $J \cap K = \{3, 5\}$
 (b) $J \cap L = \{7, 9\}$
 (c) $K \cap L = \{5\}$
 (d) $J \cap K \cap L = \{5\}$

**MY MEMORY**

An empty set is a set that has no element and is represented by the symbol ϕ or $\{\}$.

Example 3

It is given that set $A = \{\text{numbers on a dice}\}$, set $B = \{\text{even numbers on a dice}\}$ and set $C = \{7, 8, 9\}$.

(a) List all the elements of the following intersections of sets.

- (i) $A \cap B$ (ii) $B \cap C$ (iii) $A \cap C$

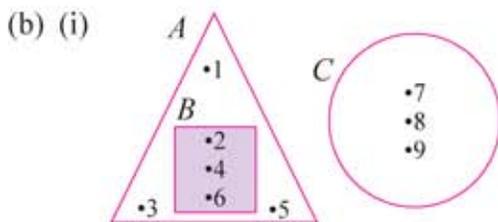
(b) Draw a Venn diagram to represent sets A , B and C , and shade the region that represents each of the following intersections of sets.

- (i) $A \cap B$ (ii) $B \cap C$

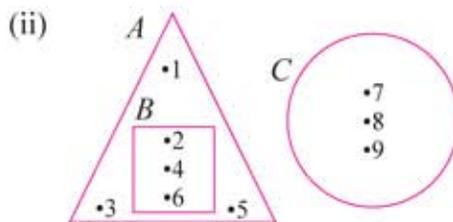
Solution:

- (a) $A = \{1, 2, 3, 4, 5, 6\}$
 $B = \{2, 4, 6\}$
 $C = \{7, 8, 9\}$

- (i) $A \cap B = \{2, 4, 6\}$
 (ii) $B \cap C = \{\}$
 (iii) $A \cap C = \phi$



All the elements of set B are in set A .
 $A \cap B = B$



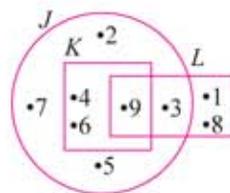
Set B and set C do not have common elements.

Self Practice 4.1a

1. Given $\xi = \{x : x \text{ is an integer, } 1 \leq x \leq 10\}$, set $M = \{x : x \text{ is an odd number}\}$ and set $N = \{x : x \text{ is a multiple of } 3\}$, list all the elements of the following sets.

- (a) set M (b) set N (c) $M \cap N$

2. The Venn diagram shows sets J , K and L such that the universal set, $\xi = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$. List all the elements of the following intersections of sets.



- (a) $J \cap K$ (b) $J \cap L$ (c) $K \cap L$ (d) $J \cap K \cap L$

3. It is given that the universal set, $\xi = \{x : x \text{ is an integer, } 1 \leq x \leq 20\}$, set $P = \{x : x \text{ is a prime number}\}$, set $Q = \{x : x \text{ is a multiple of } 5\}$ and set $R = \{x : x \text{ is a factor of } 10\}$.

- (a) Draw a Venn diagram to represent all the given sets.
 (b) Based on the diagram in (a), shade the region that represents the set $P \cap Q \cap R$.

4. Given set $A = \{x : x \text{ is a letter in the word "GIGIH"}\}$, set $B = \{x : x \text{ is a letter in the word "DEDIKASI"}\}$ and set $C = \{x : x \text{ is a letter in the word "JUJUR"}\}$. State the number of elements by listing all the elements of the following intersections of sets.

- (a) $n(A \cap B)$ (b) $n(A \cap C)$ (c) $n(B \cap C)$ (d) $n(A \cap B \cap C)$

How do you determine the complement of an intersection of sets?

The complement of an intersection of sets is written using the symbol “'”. $(A \cap B)'$ is read as “the complement of the intersection of sets A and B ”. $(A \cap B)'$ refers to all the elements not in the intersection of sets A and B .



Learning Standard

Determine the complement of the intersection of sets.

Example 4

Given the universal set, $\xi = \{x : x \text{ is an integer, } 1 \leq x \leq 8\}$, set $A = \{1, 2, 3, 4, 5, 6\}$, set $B = \{2, 4, 6\}$ and set $C = \{1, 2, 3, 4\}$, list all the elements and state the number of elements of the following sets.

- (a) $(A \cap B)'$ (b) $(A \cap C)'$ (c) $(A \cap B \cap C)'$

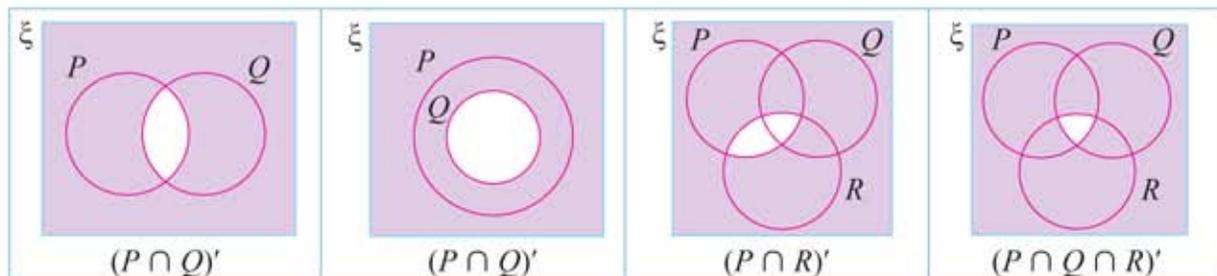
Solution:

$$\xi = \{1, 2, 3, 4, 5, 6, 7, 8\}$$

- (a) $A \cap B = \{2, 4, 6\}$ (b) $A \cap C = \{1, 2, 3, 4\}$ (c) $A \cap B \cap C = \{2, 4\}$
 $(A \cap B)' = \{1, 3, 5, 7, 8\}$ $(A \cap C)' = \{5, 6, 7, 8\}$ $(A \cap B \cap C)' = \{1, 3, 5, 6, 7, 8\}$
 $n(A \cap B)' = 5$ $n(A \cap C)' = 4$ $n(A \cap B \cap C)' = 6$

How do you determine the complements of the intersections of two or more sets on Venn diagrams?

The complements of the intersections of two or more sets are represented by the shaded regions, as shown in the following Venn diagrams.



Example 5

The co-curricular activities participated by three pupils are given in set P , set Q and set R such that the universal set, $\xi = \{\text{Scouts, Mathematics, Hockey, Football, History, Badminton, Police Cadet}\}$.

$$P = \{\text{Scouts, Mathematics, Hockey}\}$$

$$Q = \{\text{Police Cadet, History, Badminton}\}$$

$$R = \{\text{Scouts, History, Football}\}$$

(a) List all the elements of the following sets.

(i) $(P \cap R)'$

(ii) $(R \cap Q)'$

(iii) $(P \cap Q \cap R)'$

(b) Draw a Venn diagram to represent sets P , Q and R , and shade the region that represents each of the following complements of intersections of sets.

(i) $(P \cap R)'$

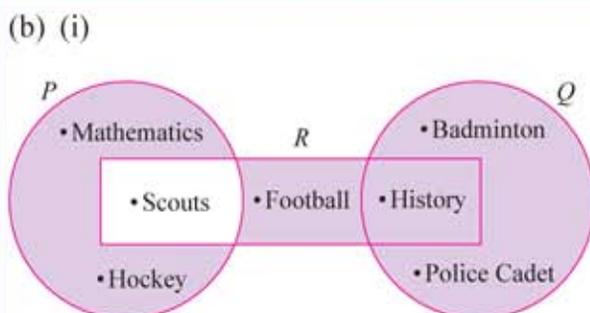
(ii) $(R \cap Q)'$

(iii) $(P \cap Q \cap R)'$

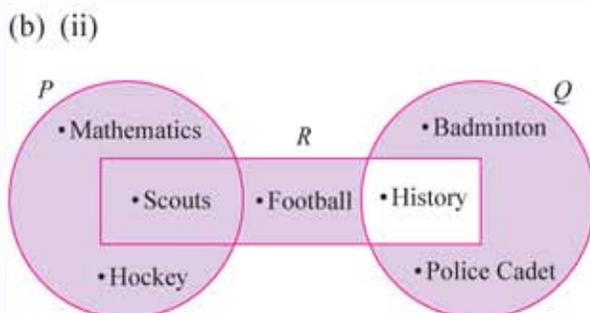
Solution:

$\xi = \{\text{Scouts, Mathematics, Hockey, Football, History, Badminton, Police Cadet}\}$

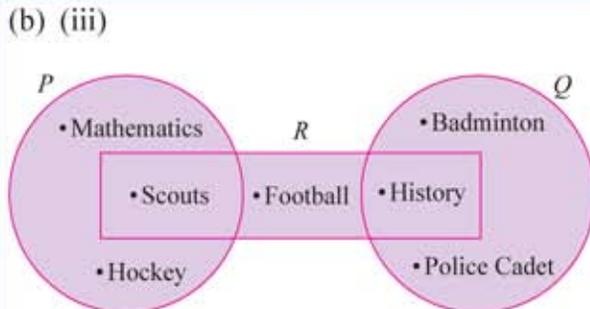
(a) (i) $P \cap R = \{\text{Scouts}\}$
 $(P \cap R)' = \{\text{Mathematics, Hockey, Football, History, Badminton, Police Cadet}\}$



(a) (ii) $R \cap Q = \{\text{History}\}$
 $(R \cap Q)' = \{\text{Scouts, Mathematics, Hockey, Football, Badminton, Police Cadet}\}$



(a) (iii) $P \cap Q \cap R = \{\}$
 $(P \cap Q \cap R)' = \{\text{Scouts, Mathematics, Hockey, Football, History, Badminton, Police Cadet}\}$



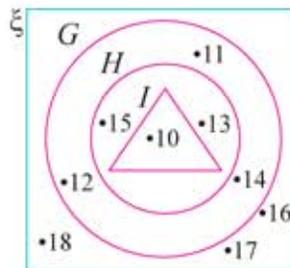
Self Practice 4.1b

1. Given the universal set, $\xi = \{2, 3, 4, 5, 6, 7, 8, 9, 10\}$, set $P = \{3, 5, 7, 9\}$, set $Q = \{2, 3, 5, 7\}$ and set $R = \{2, 4, 6, 8, 10\}$, list all the elements of the following sets.

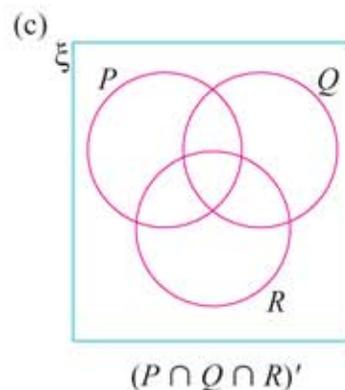
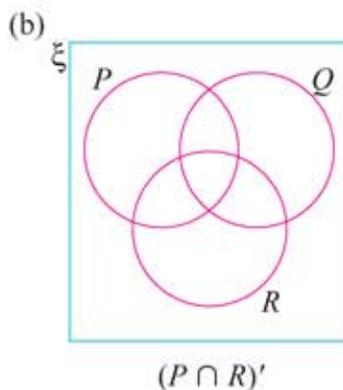
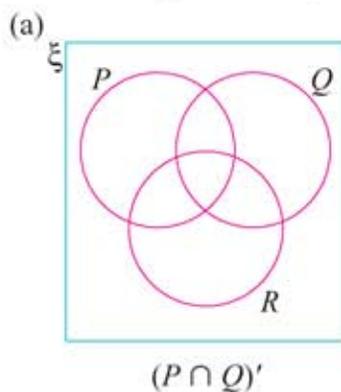
(a) $(P \cap Q)'$ (b) $(Q \cap R)'$ (c) $(P \cap Q \cap R)'$

2. The Venn diagram shows set G , set H , set I and the universal set, ξ . List all the elements of the following sets.

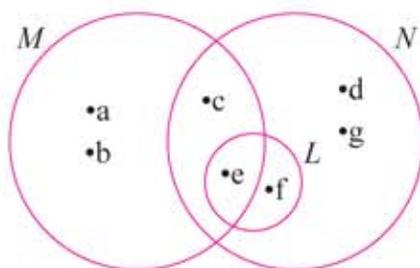
(a) $(G \cap H)'$
 (b) $(G \cap I)'$
 (c) $(H \cap I)'$
 (d) $(G \cap H \cap I)'$



3. Shade the regions that represent the given sets.



4. The Venn diagram shows set L , set M , set N and the universal set, $\xi = \{a, b, c, d, e, f, g\}$.



List all the elements of the following sets.

(a) $(M \cap L)'$
 (b) $(N \cap L)'$
 (c) $(M \cap N)'$
 (d) $(L \cap M \cap N)'$

How do you solve problems involving the intersection of sets?



Learning Standard

Solve problems involving the intersection of sets.

Example 6

A total of 140 Form 5 pupils are given the opportunity to attend the intensive classes for History and Bahasa Melayu subjects. 65 pupils choose Bahasa Melayu, 70 pupils choose History while 50 pupils choose both Bahasa Melayu and History. Calculate

- the total number of pupils who attend the intensive classes.
- the total number of pupils who do not attend any intensive classes.

Understanding the problem

Total number of pupils = 140

History = 70

Calculate

- the total number of pupils who attend the intensive classes.
- the total number of pupils who do not attend any intensive classes.

Bahasa Melayu = 65

Bahasa Melayu and History = 50

Planning a strategy

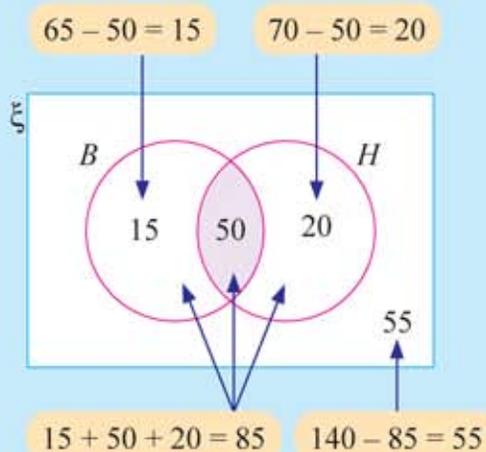
ξ = {total number of pupils}

B = {pupils who attend Bahasa Melayu class}

H = {pupils who attend History class}

Draw a Venn diagram that represents all the given information.

Implementing the strategy



Steps:

- Fill in $n(B \cap H) = 50$.
- Fill in the number of pupils who attend Bahasa Melayu class only.
 $65 - 50 = 15$
- Fill in the number of pupils who attend History class only.
 $70 - 50 = 20$
- Pupils who attend the intensive classes
 $15 + 50 + 20 = 85$
- Pupils who do not attend any intensive classes
 $140 - 85 = 55$

Conclusion

- 85 pupils attend the intensive classes.
- 55 pupils do not attend any intensive classes.

Example 7

A total of 200 university students take part in a survey on the use of technological devices. The result of the survey shows that 155 students have mobile phones, 90 students have laptops, 37 students have tablets, 4 students have both laptops and tablets only, 50 students have both mobile phones and laptops only, 5 students have both mobile phones and tablets only, and 83 students have mobile phones only. Calculate

- the total number of students who have all three technological devices.
- the total number of students who do not have any of the technological devices.

Understanding the problem

Total number of students = 200 Mobile phones = 155 Laptops = 90 Tablets = 37
 Mobile phones and laptops only = 50 Laptops and tablets only = 4
 Mobile phones only = 83 Mobile phones and tablets only = 5

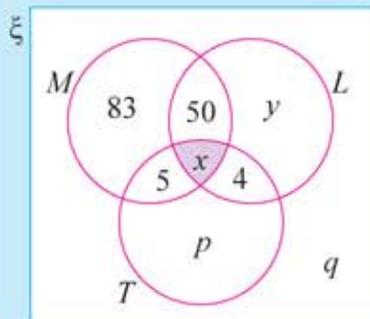
Calculate

- the total number of students who have all three technological devices.
- the total number of students who do not have any of the technological devices.

Planning a strategy

$\xi = \{200 \text{ students}\}$
 $M = \{\text{students who have mobile phones}\}$
 $L = \{\text{students who have laptops}\}$
 $T = \{\text{students who have tablets}\}$

Draw a Venn diagram to represent all the given information.

Implementing the strategy**Steps:**

- Draw the Venn diagram as shown on the left based on the given information.

- Calculate the values of x , y , p and q .

$$x = 155 - 83 - 50 - 5$$

$$= 17$$

$$y = 90 - 50 - 4 - 17$$

$$= 19$$

$$p = 37 - 5 - 17 - 4$$

$$= 11$$

$$q = 200 - 83 - 50 - 5 - 4 - x - y - p$$

$$= 200 - 83 - 50 - 5 - 4 - 17 - 19 - 11$$

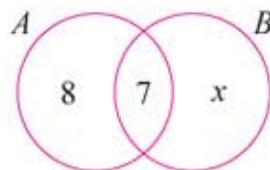
$$= 11$$

Conclusion

- 17 students have all three technological devices.
- 11 students do not have any of the technological devices.

Self Practice 4.1c

1. The Venn diagram shows set $A = \{\text{members of Art Club}\}$ and set $B = \{\text{members of Science Club}\}$. If $n(A) = 15$ and $n(B) = 22$, calculate



- (a) the value of x .
 (b) the total number of members of Art Club and Science Club.

2. A total of 150 pupils take part in a diagnostic test for two subjects, Science and Mathematics. The results show that 40% of the pupils passed Science and 30% of the pupils passed both subjects. If 8% of the pupils failed both subjects, calculate

- (a) the number of pupils who passed Mathematics.
 (b) the number of pupils who passed Science only.
 (c) the number of pupils who passed Mathematics only.

3. A textile shop is holding a clearance sale. The sales shows that a total of 210 customers buy batik clothes. 70 customers buy green batik clothes only, 13 customers buy both green and blue batik clothes, 50 customers buy blue batik clothes only, 15 customers buy both green and red batik clothes and no customer buys all three colours. How many customers buy red batik clothes only?

4. It is given that $\xi = \{\text{Form 4 pupils}\}$, set $K = \{\text{pupils who like to play piano}\}$ and set $L = \{\text{pupils who like to play violin}\}$. If $n(\xi) = 35$, $n(K) = 15$, $n(L) = 9$ and $n(K \cap L) = 5$, calculate the number of pupils who do not like to play both musical instruments.



5. A Badminton Club organises a competition among its members. A total of 38 members are involved in this competition. 20 members play in the double event and 26 members play in the single event. Calculate the number of members who play in both events.



4.2 Union of Sets

How do you determine and describe the union of sets using various representations?

The union of sets P and Q is written using the symbol \cup . $P \cup Q$ represents all the elements in set P or set Q or in both sets P and Q .



Malaysia consists of different races.
The various races are united as
citizens of Malaysia.



Learning Standard

Determine and describe the union of sets using various representations.

Mind Stimulation 2

Aim: To determine and describe the union of sets using various representations.

A group of pupils choose their favorite leisure activities from reading, surfing the Internet and playing sport.

Amirah likes reading.

Kiran likes surfing the Internet.

Adeline likes surfing the Internet.

Karim likes playing sport and surfing the Internet.

Mee Yee likes reading.

Sofie likes surfing the Internet.

Habibah likes reading.

Ranjit likes playing sport.

Kamal likes reading and playing sport.

Farhan likes playing sport.

Steps:

1. Divide the class into groups.
2. Each group is given A3 paper, sticky note, traffic light card and marker pens.
3. Each group reads the given situation above and complete the task.
4. Each group presents their work through Gallery Walk activity.

Task:

(a) Prepare a table as follows.

Names of pupils who like reading	Names of pupils who like surfing the Internet	Names of pupils who like playing sport
<ul style="list-style-type: none"> • Amirah • Mei Yee • Habibah • Kamal 		

Example 8

It is given that set $P = \{\text{factors of } 24\}$, set $Q = \{\text{multiples of } 3 \text{ which are less than } 20\}$ and set $R = \{\text{multiples of } 4 \text{ which are less than } 20\}$.

(a) List all the elements of the following unions of sets.

(i) $P \cup Q$

(ii) $P \cup R$

(iii) $Q \cup R$

(iv) $P \cup Q \cup R$

(b) Draw a Venn diagram to represent sets P , Q and R , and shade the regions that represent the following unions of sets.

(i) $P \cup Q$

(ii) $P \cup Q \cup R$

Solution:

(a) (i) $P = \{1, 2, 3, 4, 6, 8, 12, 24\}$

$Q = \{3, 6, 9, 12, 15, 18\}$

$P \cup Q = \{1, 2, 3, 4, 6, 8, 9, 12, 15, 18, 24\}$

(ii) $P = \{1, 2, 3, 4, 6, 8, 12, 24\}$

$R = \{4, 8, 12, 16\}$

$P \cup R = \{1, 2, 3, 4, 6, 8, 12, 16, 24\}$

(iii) $Q = \{3, 6, 9, 12, 15, 18\}$

$R = \{4, 8, 12, 16\}$

$Q \cup R = \{3, 4, 6, 8, 9, 12, 15, 16, 18\}$

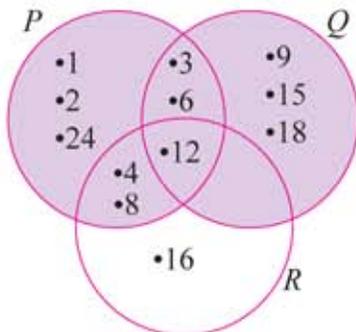
(iv) $P = \{1, 2, 3, 4, 6, 8, 12, 24\}$

$Q = \{3, 6, 9, 12, 15, 18\}$

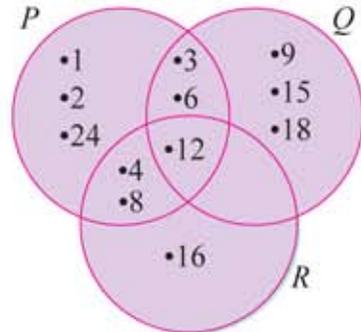
$R = \{4, 8, 12, 16\}$

$P \cup Q \cup R = \{1, 2, 3, 4, 6, 8, 9, 12, 15, 16, 18, 24\}$

(b) (i)



(ii)



(b) Write the names of pupils representing each of the given sets using set notations.

$A = \{\text{pupils who like reading}\}$

$A = \{\text{Amirah, Mei Yee, Habibah, Kamal}\}$

$B = \{\text{pupils who like surfing the Internet}\}$

$B = \{\text{[] , [] , [] , []}\}$

$C = \{\text{pupils who like playing sport}\}$

$C = \{\text{[] , [] , [] , []}\}$

$A \cup B = \{\text{all pupils who like reading or surfing the Internet}\}$

$A \cup B = \{\text{Amirah, Mei Yee, Habibah, Kamal, Kiran, Adeline, Karim, Sofie}\}$

$B \cup C = \{\text{all pupils who like surfing the Internet or playing sport}\}$

$B \cup C = \{\text{[] , [] , [] , [] , [] , [] , []}\}$

$A \cup C = \{\text{all pupils who like reading or playing sport}\}$

$A \cup C = \{\text{[] , [] , [] , [] , [] , [] , []}\}$

$A \cup B \cup C = \{\text{all pupils who like reading, surfing the Internet or playing sport}\}$

$A \cup B \cup C = \{\text{[] , [] , [] , [] , [] , [] , [] , [] , [] , [] , []}\}$

(c) Draw the following unions of sets using the Venn diagram.

(i) set $A \cup B$

(ii) set $B \cup C$

(iii) set $A \cup B \cup C$

Discussion:

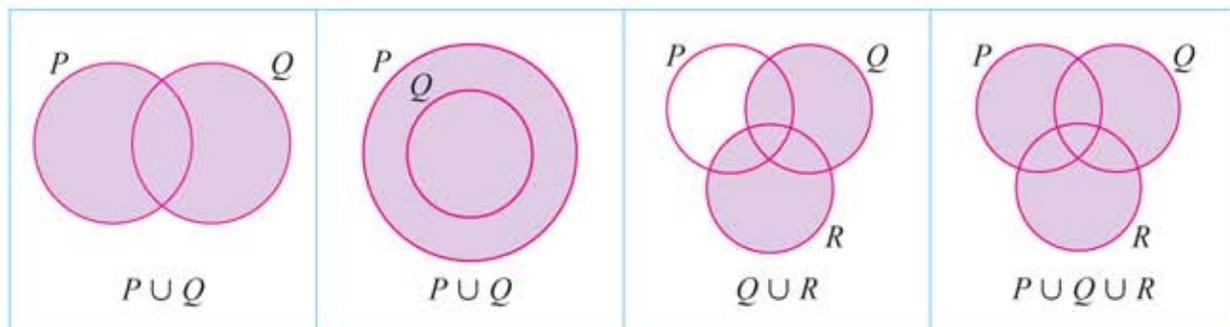
How can you determine the union of sets based on the above activity?

From the activity in Mind Stimulation 2, it is found that:

$A \cup B \cup C$ consists of all pupils in set A , set B or set C , who are Amirah, Mei Yee, Habibah, Kamal, Karim, Kiran, Adeline, Sofie, Ranjit and Farhan.

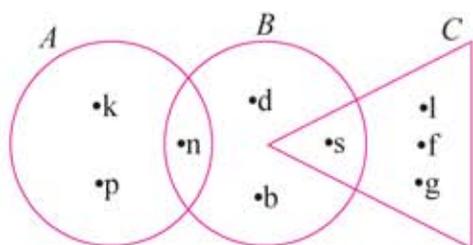
How do you determine the union of two or more sets using the Venn diagram?

The union of two or more sets can be represented by the shaded regions in the Venn diagrams below.



Self Practice 4.2a

1. The Venn diagram shows set A , set B and set C such that the universal set, $\xi = A \cup B \cup C$.



List all the elements of the following sets.

- (a) $A \cup B$ (b) $A \cup C$ (c) $B \cup C$ (d) $A \cup B \cup C$

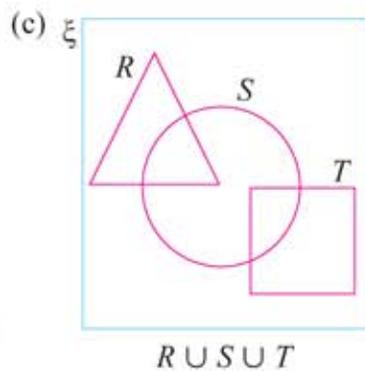
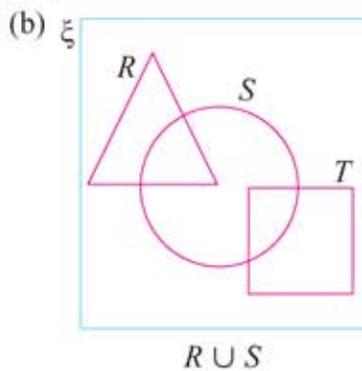
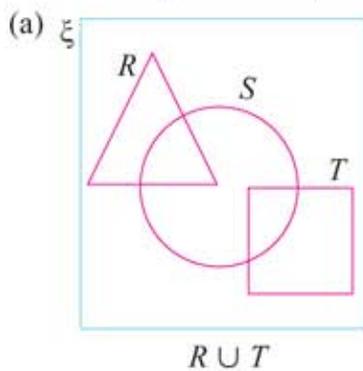
2. It is given that $\xi = \{x : x \text{ is an integer, } 50 \leq x \leq 60\}$, set $P = \{x : x \text{ is a multiple of } 3\}$, set $Q = \{x : x \text{ is an odd number}\}$ and set $R = \{x : x \text{ is a prime number}\}$.

(a) Draw a Venn diagram to represent the universal set ξ , set P , set Q and set R .

(b) List all the elements of the following sets.

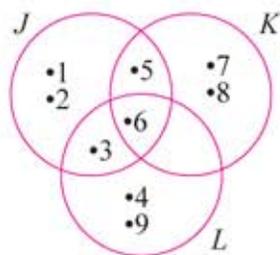
- (i) $P \cup Q$ (ii) $P \cup R$ (iii) $Q \cup R$ (iv) $P \cup Q \cup R$

3. Shade the regions that represent the given sets.



4. The Venn diagram shows set J , set K and set L such that the universal set, $\xi = J \cup K \cup L$. List all the elements of the following sets.

- (a) $J \cup K$
 (b) $J \cup L$
 (c) $J \cup K \cup L$



Q How do you determine the complement of the union of sets?

The complement of the union of sets is written as $(A \cup B)'$, and is read as “the complement of the union of sets A and B ”.

The complement of the union of sets A and B refers to all the elements not in set A and set B .



Learning Standard

Determine the complement of the union of sets.

Example 9

Given the universal set, $\xi = \{x : x \text{ is an integer, } 50 \leq x \leq 60\}$, set $G = \{x : x \text{ is a prime number}\}$, set $H = \{x : x \text{ is a multiple of } 4\}$ and set $I = \{x : x \text{ is a multiple of } 5\}$, list all the elements and state the number of elements of the following sets.

- (a) $(G \cup H)'$ (b) $(G \cup I)'$ (c) $(H \cup I)'$ (d) $(G \cup H \cup I)'$

Solution:

$$\xi = \{50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60\}$$

$$G = \{53, 59\}$$

$$H = \{52, 56, 60\}$$

$$I = \{50, 55, 60\}$$

(a) $G \cup H = \{52, 53, 56, 59, 60\}$

$$(G \cup H)' = \{50, 51, 54, 55, 57, 58\}$$

$$n(G \cup H)' = 6$$

(b) $G \cup I = \{50, 53, 55, 59, 60\}$

$$(G \cup I)' = \{51, 52, 54, 56, 57, 58\}$$

$$n(G \cup I)' = 6$$

(c) $H \cup I = \{50, 52, 55, 56, 60\}$

$$(H \cup I)' = \{51, 53, 54, 57, 58, 59\}$$

$$n(H \cup I)' = 6$$

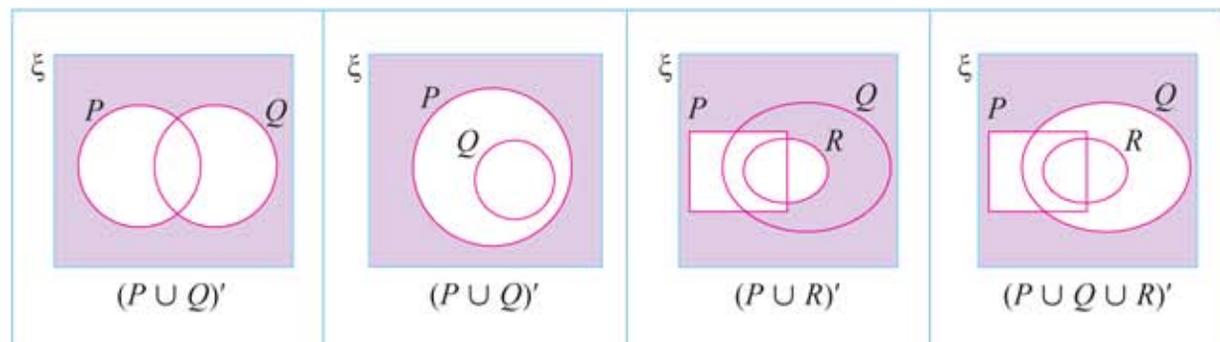
(d) $G \cup H \cup I = \{50, 52, 53, 55, 56, 59, 60\}$

$$(G \cup H \cup I)' = \{51, 54, 57, 58\}$$

$$n(G \cup H \cup I)' = 4$$

How do you determine the complements of the unions of two or more sets using Venn diagrams?

The complements of the unions of two or more sets can be represented by the shaded regions in the Venn diagrams below.



Example 10

Three private travel agencies, A , B and C , are chosen to organise the tourism exhibitions 2020 in Sarawak. Several divisions in Sarawak are chosen to hold the exhibitions as follows.

$$\xi = \{\text{Kapit, Miri, Bintulu, Sibul, Limbang, Mukah, Kuching, Betong}\}$$

$$A = \{\text{Miri, Sibul, Kuching, Betong}\}$$

$$B = \{\text{Miri, Sibul, Kapit, Limbang}\}$$

$$C = \{\text{Miri, Betong, Kapit, Mukah}\}$$

(a) List all the elements of the following sets.

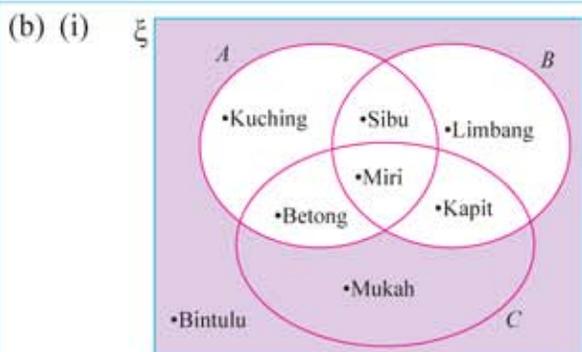
(i) $(A \cup B)'$ (ii) $(B \cup C)'$ (iii) $(A \cup B \cup C)'$

(b) Draw a Venn diagram to represent sets A , B and C , and shade the region that represents each of the following complements of unions of sets.

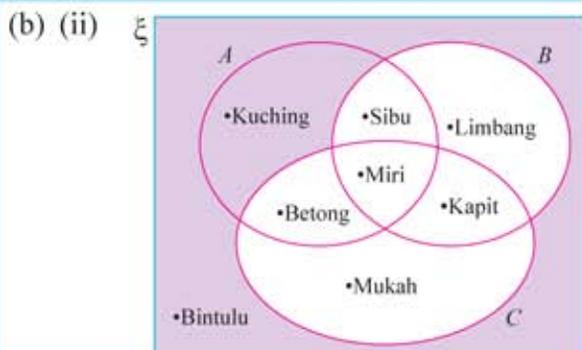
(i) $(A \cup B)'$ (ii) $(B \cup C)'$ (iii) $(A \cup B \cup C)'$

Solution:

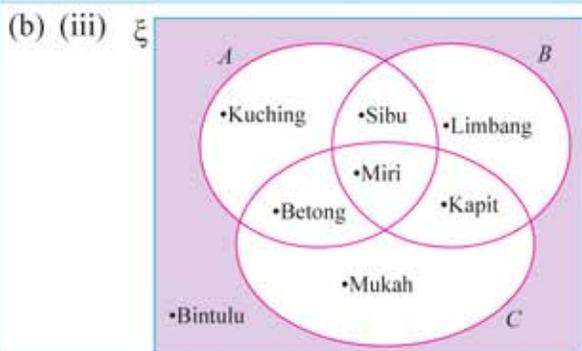
(a) (i) $A \cup B = \{\text{Kapit, Miri, Sibul, Limbang, Kuching, Betong}\}$
 $(A \cup B)' = \{\text{Mukah, Bintulu}\}$



(a) (ii) $B \cup C = \{\text{Kapit, Miri, Sibul, Limbang, Betong, Mukah}\}$
 $(B \cup C)' = \{\text{Kuching, Bintulu}\}$



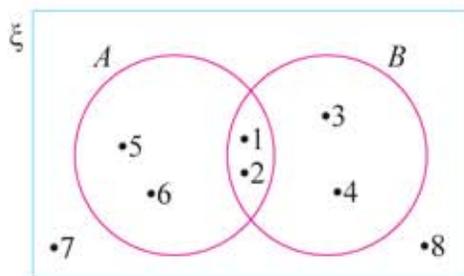
(a) (iii) $A \cup B \cup C = \{\text{Kapit, Miri, Sibul, Limbang, Mukah, Betong, Kuching}\}$
 $(A \cup B \cup C)' = \{\text{Bintulu}\}$





Self Practice 4.2b

1. The Venn diagram shows the universal set ξ , set A and set B .



List all the elements of the following sets.

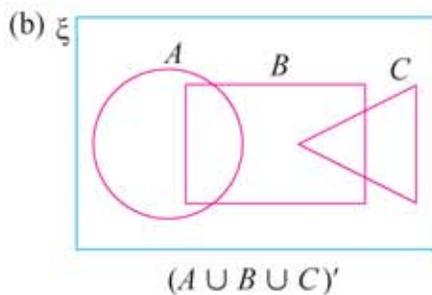
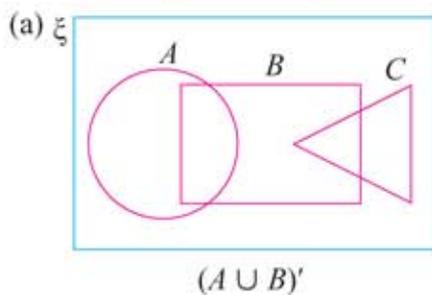
- (a) A' (b) B' (c) $(A \cup B)'$
2. It is given that $\xi = \{x : x \text{ is an integer, } 10 \leq x \leq 30\}$, set $G = \{x : x \text{ is a prime number}\}$, set $H = \{x : x \text{ is a number such that the sum of its two digits is odd}\}$ and set $I = \{x : x \text{ is a multiple of } 6\}$.

(a) Draw a Venn diagram to represent the universal set ξ , set G , set H and set I .

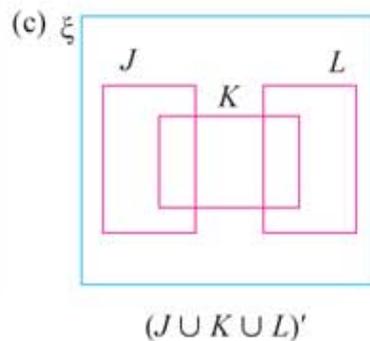
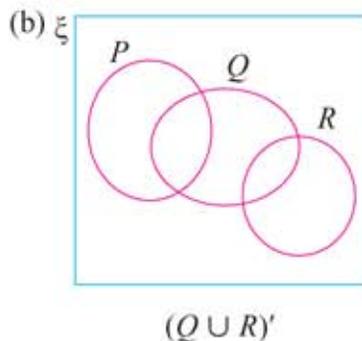
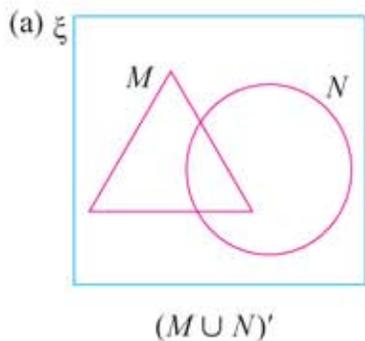
(b) List all the elements of the following sets.

- (i) $(G \cup H)'$ (ii) $(H \cup I)'$ (iii) $(G \cup H \cup I)'$

3. Shade the regions that represent the given sets.



4. Shade the regions that represent the given sets.



How do you solve problems involving the union of sets?

Example 11

A total of 26 pupils participate in a scouting programme at the river bank. The activities of the programme are kayaking and fishing. 18 pupils participate in kayaking and 15 pupils participate in fishing while 9 pupils participate in both kayaking and fishing. What is the total number of pupils who participate in the activities of the programme?



Learning Standard

Solve problems involving the union of sets.

Understanding the problem

Total number of pupils = 26

Kayaking = 18

Fishing = 15

Kayaking and fishing = 9

Calculate the total number of pupils who participate in the activities of the programme.

Planning a strategy

ξ = {total number of pupils}

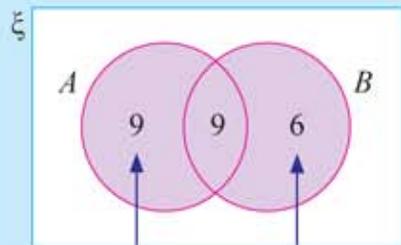
A = {pupils who participate in kayaking}

B = {pupils who participate in fishing}

Draw a Venn diagram to represent all the given information. Calculate

- the total number of pupils who participate in kayaking only.
- the total number of pupils who participate in fishing only.
- the total number of pupils who do not participate in the activities of the programme.
- the total number of pupils who participate in the activities of the programme, $n(A \cup B)$.

Implementing the strategy



$$18 - 9 = 9$$

$$15 - 9 = 6$$

- Kayaking only = $18 - 9$
= 9
- Fishing only = $15 - 9$
= 6
- Total number of pupils who do not participate in the activities of the programme
= $26 - 9 - 9 - 6$
= 2
- Total number of pupils who participate in the activities of the programme,
 $n(A \cup B)$ (Shaded region)
= $26 - 2 = 24$

Checking Answer

$$9 + 9 + 6 = 24$$

Conclusion

24 pupils participate in the activities of the programme, $n(A \cup B) = 24$

Example 12

A total of 100 adults are involved in a survey on their top choices of reading materials. 40 people choose newspapers, 25 people choose magazines, 18 people choose storybooks, 8 people choose both newspapers and magazines, 7 people choose both magazines and storybooks, 5 people choose both newspapers and storybooks, and 3 people choose all three types of reading materials. How many people do not choose any of the reading materials?

Understanding the problem

Total number of adults = 100 Newspapers = 40 Magazines = 25 Storybooks = 18
 Newspapers and magazines = 8
 Magazines and storybooks = 7
 Newspapers and storybooks = 5
 Newspapers, magazines and storybooks = 3
 Calculate the number of people who do not choose any of the reading materials.

Planning a strategy

ξ = {total number of adults}

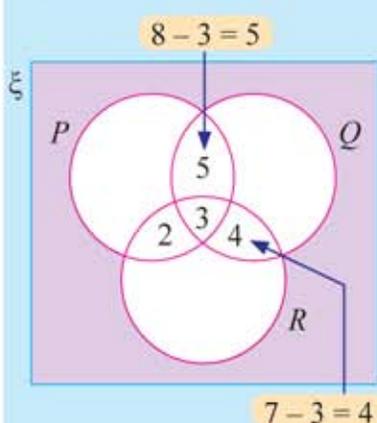
P = {newspapers}

Q = {magazines}

R = {storybooks}

Draw a Venn diagram to represent all the given information and calculate

- the total number of people who choose newspapers only.
- the total number of people who choose magazines only.
- the total number of people who choose storybooks only.
- the total number of people who do not choose any of the reading materials, $n(A \cup B \cup C)'$

Implementing the strategy

(a) Newspapers only
 $= 40 - 5 - 3 - 2$
 $= 30$

(b) Magazines only
 $= 25 - 5 - 3 - 4$
 $= 13$

(c) Storybooks only
 $= 18 - 3 - 4 - 2$
 $= 9$

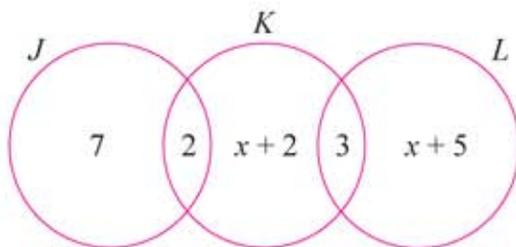
(d) Total number of people who do not choose any of the reading materials,
 $n(A \cup B \cup C)' = 100 - 5 - 3 - 4 - 2 - 30 - 13 - 9$
 $= 34$

Conclusion

34 people do not choose any of the reading materials.
 $n(A \cup B \cup C)' = 34$

Self Practice 4.2c

1. The Venn diagram shows the number of elements in set J , set K and set L . Given $\xi = J \cup K \cup L$ and $n(\xi) = 25$, calculate the value of x .



2. It is given that set $B = \{\text{pupils from Sabah}\}$ and set $T = \{\text{pupils from Sarawak}\}$. If there are 40 pupils in a class and $n(B \cup T) = 32$, calculate the number of pupils who are not from any of the states.
3. During the Independence Month celebration, the school organises a drama activity, a patriotic song singing activity and a History quiz. 40 pupils are involved in the activities. $\frac{1}{2}$ of the pupils participate in drama, $\frac{1}{4}$ of the pupils participate in singing, 6 pupils participate in drama and quiz and one pupil participates in all three activities. There is no pupil who participates in drama and singing only, and also no pupil participates in singing and quiz only. How many pupils participate in the History quiz only?
4. A bookstore conducts a survey for 200 customers on whether they buy fiction or non-fiction books. The survey shows that 114 customers buy non-fiction books, 52 customers buy fiction books and 27 customers buy both fiction and non-fiction books. Calculate
- the number of customers who buy fiction books only.
 - the number of customers who buy non-fiction books only.
 - the number of customers who do not buy any types of books.
5. The Form 4 pupils who are involved in Recycling Programme manage to collect old newspapers, plastic bottles and tins. 72 pupils collect plastic bottles, 36 pupils collect old newspapers, 25 pupils collect tins, 20 pupils collect old newspapers and plastic bottles, 8 pupils collect old newspapers and tins, 18 pupils collect plastic bottles and tins, and 7 pupils collect all the three types of materials. Calculate the total number of pupils who are involved in the programme.



4.3 Combined Operations on Sets

Q How do you determine and describe combined operations on sets using various representations?



Learning Standard

Determine and describe the combined operations on sets using various representations.

Combined operations on sets involve both intersection of sets (\cap) and union of sets (\cup) at the same time. Combined operations of sets are solved from left to right. However, if there are operations in brackets, the operations in brackets must be carried out first.

Example 13

The table below shows the hobbies of a group of pupils.

Arif likes singing.	Iris likes drawing, singing and dancing.
Zarif likes drawing.	Alan likes singing and dancing.
Lily likes dancing.	May likes dancing and drawing.
Emy likes dancing and singing.	Jay likes singing and drawing.
Getha likes drawing.	Nani likes dancing.

$P = \{\text{pupils who like singing}\}$, $Q = \{\text{pupils who like dancing}\}$ and $R = \{\text{pupils who like drawing}\}$.

Based on the above table,

(a) list all the elements of the following sets.

(i) $(P \cup Q) \cap R$

(ii) $Q \cup (P \cap R)$

(b) draw a Venn diagram and shade the region that represents each of the following sets.

(i) $(P \cup Q) \cap R$

(ii) $Q \cup (P \cap R)$

Solution:

$$P = \{\text{Arif, Emy, Iris, Alan, Jay}\}$$

$$Q = \{\text{Lily, Emy, Iris, Alan, May, Nani}\}$$

$$R = \{\text{Zarif, Getha, Iris, May, Jay}\}$$

(a) (i) $(P \cup Q) = \{\text{Arif, Emy, Iris, Alan, Jay, Lily, May, Nani}\}$

$$R = \{\text{Zarif, Getha, Iris, May, Jay}\}$$

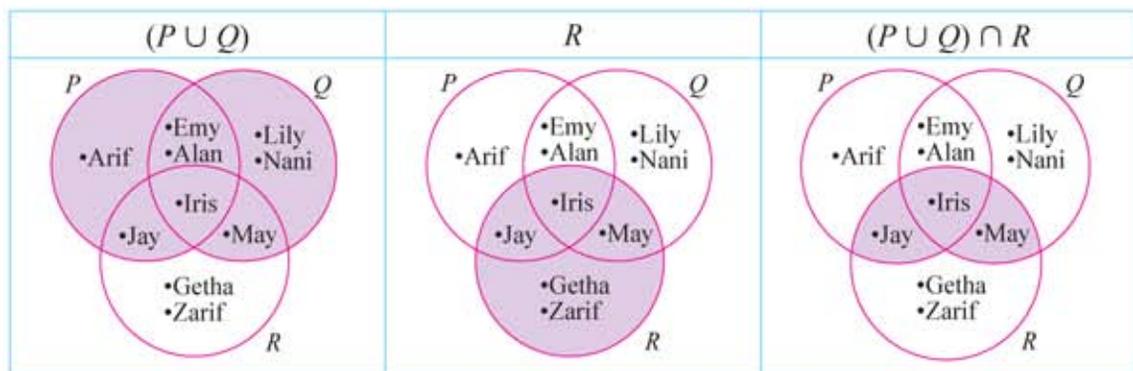
$$(P \cup Q) \cap R = \{\text{Jay, Iris, May}\}$$

(ii) $Q = \{\text{Lily, Emy, Iris, Alan, May, Nani}\}$

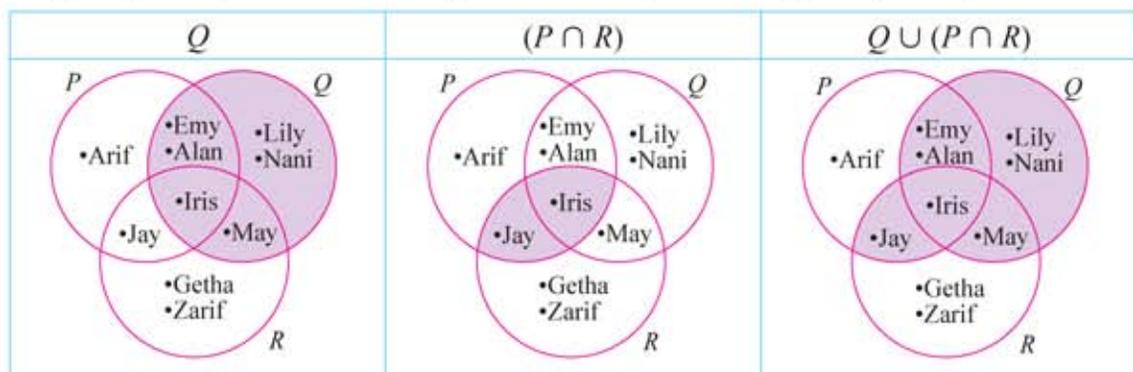
$$(P \cap R) = \{\text{Iris, Jay}\}$$

$$Q \cup (P \cap R) = \{\text{Lily, Emy, Iris, Alan, May, Nani, Jay}\}$$

- (b) (i) Shade the region for set
- $(P \cup Q)$
- .

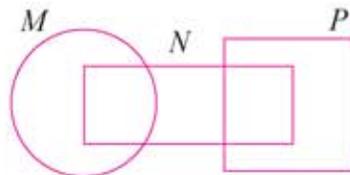
Shade the region for set R .Set $(P \cup Q) \cap R$ refers to the common region for both sets $(P \cup Q)$ and R .

- (ii) Shade the region for set
- Q
- .

Shade the region for set $(P \cap R)$.Set $Q \cup (P \cap R)$ refers to all the regions covered by both sets Q and $(P \cap R)$.

Self Practice 4.3a

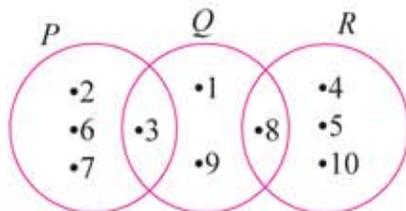
1. The Venn diagram shows sets M , N and P such that the universal set, $\xi = M \cup N \cup P$. Shade set $(M \cup P) \cap N$.



2. Given the universal set, $\xi = \{x : x \text{ is an integer, } 1 \leq x \leq 15\}$, set $S = \{x : x \text{ is an odd number}\}$, set $R = \{x : x \text{ is a prime number}\}$ and set $T = \{1, 4, 7, 10, 13\}$, list all the elements of set $(S \cup T) \cap R$.

3. The Venn diagram shows sets P , Q and R such that the universal set, $\xi = P \cup Q \cup R$. List all the elements of the following sets.

- (a) $P \cap (Q \cup R)$
 (b) $Q \cap (P \cup R)$
 (c) $(Q \cap R) \cup P$



Q How do you determine the complement of combined operations on sets?

The complement of combined operations on sets involves the complement of either intersection of sets (\cap) or union of sets (\cup) or both intersections. The complement of combined operations on sets is solved from left to right. However, if there are operations in brackets, the operations in brackets must be carried out first.



Learning Standard

Determine the complement of combined operations on sets.

Example 14

It is given that $\xi = \{x : x \text{ is an integer, } 30 \leq x \leq 40\}$, set $A = \{x : x \text{ is a multiple of } 3\}$, set $B = \{x : x \text{ is a number such that the sum of its two digits is odd}\}$ and set $C = \{30, 32, 35, 39, 40\}$.

(a) List all the elements of the following sets.

(i) $(A \cup B)' \cap C$

(ii) $A' \cap (B \cup C)$

(iii) $(A \cap C)' \cup (B \cap C)$

(b) Draw a Venn diagram and shade the region that represents each of the following sets.

(i) $(A \cup B)' \cap C$

(ii) $A' \cap (B \cup C)$

(iii) $(A \cap C)' \cup (B \cap C)$

Solution:

$$\xi = \{30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40\}$$

$$A = \{30, 33, 36, 39\}$$

$$B = \{30, 32, 34, 36, 38\}$$

$$C = \{30, 32, 35, 39, 40\}$$

(a) (i) $(A \cup B)' = \{31, 35, 37, 40\}$
 $C = \{30, 32, 35, 39, 40\}$
 $(A \cup B)' \cap C = \{35, 40\}$

(ii) $A' = \{31, 32, 34, 35, 37, 38, 40\}$
 $(B \cup C) = \{30, 32, 34, 35, 36, 38, 39, 40\}$
 $A' \cap (B \cup C) = \{32, 34, 35, 38, 40\}$

(iii) $(A \cap C)' = \{31, 32, 33, 34, 35, 36, 37, 38, 40\}$
 $(B \cap C) = \{30, 32\}$
 $(A \cap C)' \cup (B \cap C) = \{30, 31, 32, 33, 34, 35, 36, 37, 38, 40\}$



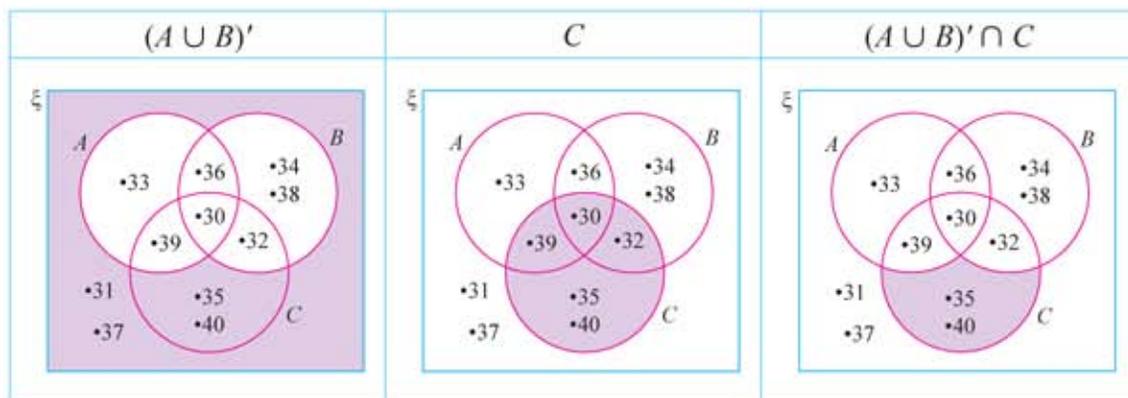
MY MEMORY

For a set A in the universal set, the complement of set A , is written as A' , meaning all the elements that are not in set A .

(b) (i) Shade the region for set $(A \cup B)'$.

Shade the region for set C .

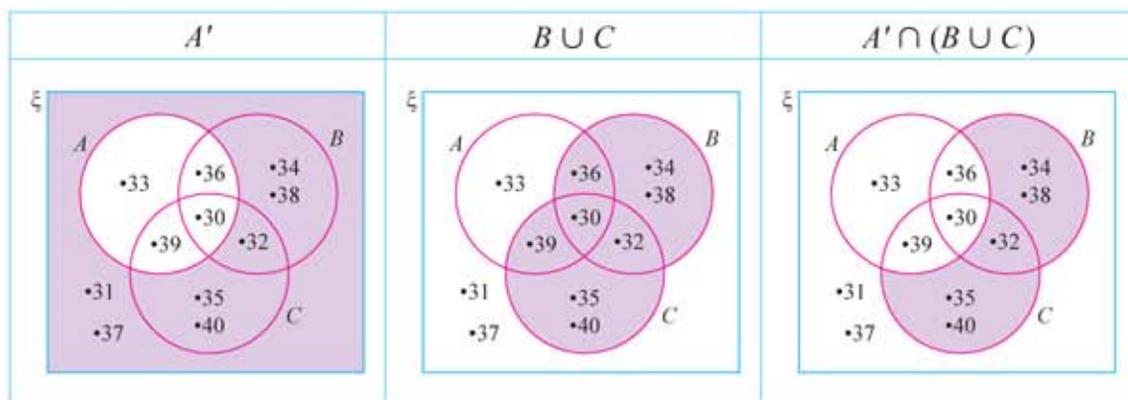
Set $(A \cup B)' \cap C$ refers to the common region for both sets $(A \cup B)'$ and C .



(ii) Shade the region for set A' .

Shade the region for set $(B \cup C)$.

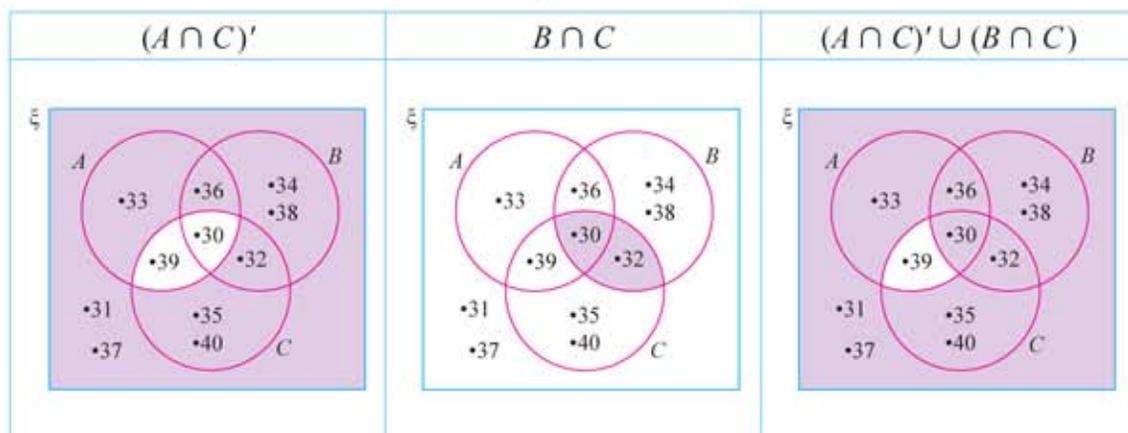
Set $A' \cap (B \cup C)$ refers to the common region for both sets A' and $(B \cup C)$.



(iii) Shade the region for set $(A \cap C)'$.

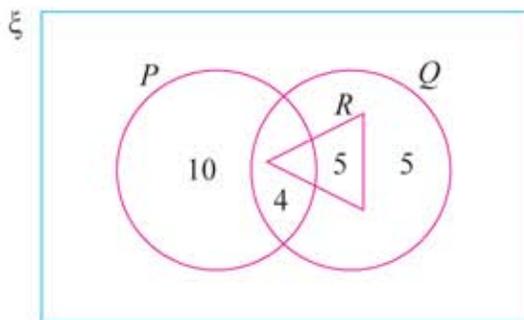
Shade the region for set $(B \cap C)$.

Set $(A \cap C)' \cup (B \cap C)$ refers to all the regions covered by both sets $(A \cap C)'$ and $(B \cap C)$.

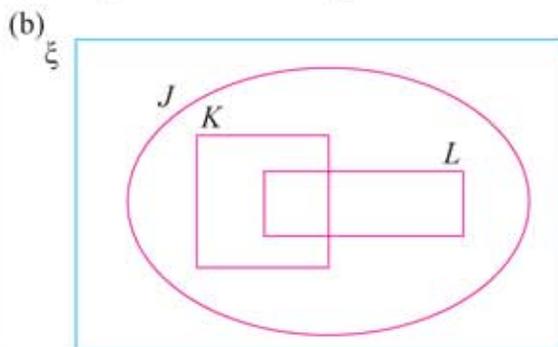
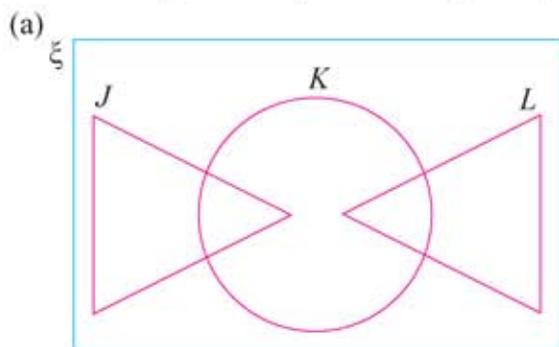


Self Practice 4.3b

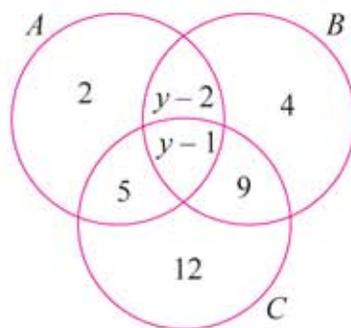
- Given $\xi = \{x : x \text{ is an integer, } 10 \leq x \leq 20\}$, set $L = \{x : x \text{ is a multiple of } 2\}$, set $M = \{13, 16, 19\}$ and set $N = \{x : x \text{ is a multiple of } 5\}$, list all the elements of the following sets.
 - $L' \cap (M \cup N)$
 - $(M \cup N)' \cap L$
- The incomplete Venn diagram shows the number of elements in sets P , Q and R . It is given that $n(P \cap Q) = n(P \cup Q)'$ and $n(\xi) = 50$. Determine $n(P)$.



- Shade the region that represents set $(J \cap K)' \cap (K \cup L)$ on each Venn diagram below.



- The Venn diagram shows the universal set, $\xi = A \cup B \cup C$ and $n(B') = n(B \cap C)$. Determine
 - the value of y .
 - $n(A \cup B \cup C)$.



Q How do you solve problems involving combined operations on sets?



Learning Standard

Solve problems involving combined operations on sets.

Example 15

The Residents' Association of Happy Garden organises various sports competitions to instil health awareness among residents. A total of 35 participants join the football competition, 24 participants join the table tennis competition and 13 participants join the badminton competition. There are 4 participants who join both the football and table tennis competitions, 8 participants who join both the table tennis and badminton competitions, and 2 participants join all three competitions. There is no participant joining the badminton and football competitions only. Calculate the total number of participants who join one competition only.

Understanding the problem

Total number of participants = ?

Football = 35

Table tennis = 24

Badminton = 13

Football and table tennis only = 4

Badminton and football only = 0

Table tennis and badminton only = 8

Football, table tennis and badminton = 2

Calculate the total number of participants who join one competition only.

Planning a strategy

$\xi = \{\text{all participants}\}$

$A = \{\text{participants who join the football competition}\}$

$B = \{\text{participants who join the table tennis competition}\}$

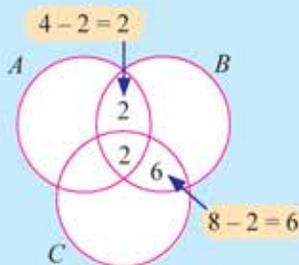
$C = \{\text{participants who join the badminton competition}\}$

Draw a Venn diagram to represent all the given information.

Calculate

- the total number of participants who join the football competition only.
- the total number of participants who join the badminton competition only.
- the total number of participants who join the table tennis competition only.
- the total number of participants who join one competition only.

Implementing the strategy



- (a) Football only

$$= 35 - 4$$

$$= 31$$

- (b) Badminton only

$$= 13 - 6 - 2$$

$$= 5$$

- (c) Table tennis only

$$= 24 - 6 - 2 - 2$$

$$= 14$$

- (d) Total number of participants who join one competition only

$$= 31 + 14 + 5$$

$$= 50$$

Conclusion

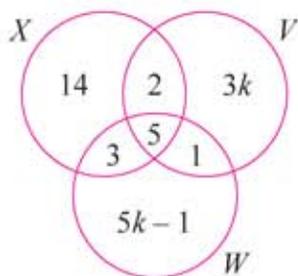
50 participants join one competition only.

Self Practice 4.3c

1. A supermarket initiates a campaign “No Plastic Bag Day”. Customers need to buy plastic bags or recycle bags to pack the items bought. Among a total of 90 customers, 51 customers buy plastic bags, 48 customers buy recycle bags, and 9 customers buy both plastic and recycle bags. Calculate the number of customers who do not use plastic bags.



2. The Venn diagram shows the number of elements in sets X , V and W . It is given that $\xi = X \cup V \cup W$ and $n(\xi) = 56$. Determine the value of k .



3. A total of 100 children need to choose their favourite food from burger, salad and *nasi lemak*. 50 children choose burger, 60 children choose *nasi lemak*, 5 children choose burger and salad, 3 children choose *nasi lemak* and salad, and 22 children choose burger and *nasi lemak*. If only one child chooses all the three types of food, calculate the number of children who choose salad only.



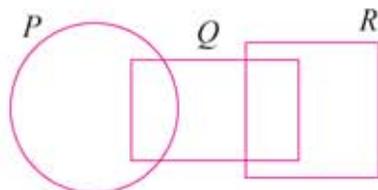
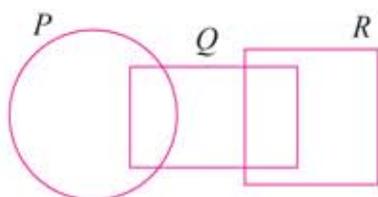
4. Based on a survey among 100 adults, 68 of them own national cars while 52 of them own imported cars. If 27 adults own both the imported and national cars, calculate the number of adults who

- (a) own national cars only.
 (b) own imported cars only.
 (c) do not own any cars.

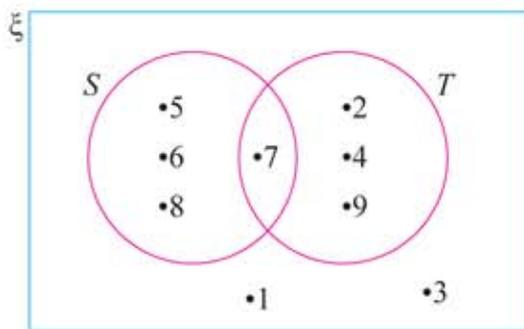


Comprehensive Practice

- It is given that the universal set, $\xi = \{2, 3, 5, 6\}$, set $P = \{3, 5\}$, set $Q = \{2, 3, 5\}$ and set $R = \{3, 6\}$. List all the elements of the following sets.
 - $P \cap Q$
 - $P \cap R$
 - $P \cap Q \cap R$
 - $(P \cap Q \cap R)'$
- Given set $M = \{b, a, i, k\}$, set $N = \{b, u, d, i\}$ and set $P = \{b, e, r, a, n, i\}$, list all the elements of the following sets.
 - $M \cup N$
 - $M \cup P$
 - $M \cup N \cup P$
- Shade the regions that represent the given sets, such that the universal set, $\xi = P \cup Q \cup R$.
 - $P \cap Q$
 - $P \cup R$

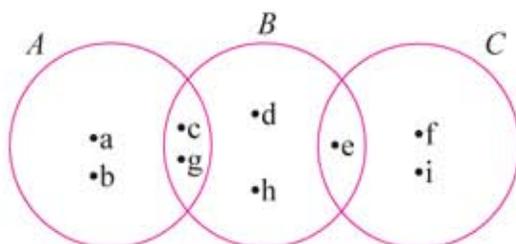


- The Venn diagram shows the universal set ξ , set S and set T .



List all the elements of the following sets.

- T'
 - $S \cup T$
 - $S' \cap T$
 - $(S \cap T)'$
- The Venn diagram shows the elements of sets A , B and C . Given the universal set, $\xi = A \cup B \cup C$, list all the elements of set A' .



6. It is given that $\xi = \{x : x \text{ is an integer, } 10 \leq x \leq 30\}$, set $P = \{x : x \text{ is a prime number}\}$, set $Q = \{x : x \text{ is a multiple of } 5\}$ and set $R = \{x : x \text{ is a factor of } 24\}$. List all the elements of the following sets.

(a) Q'

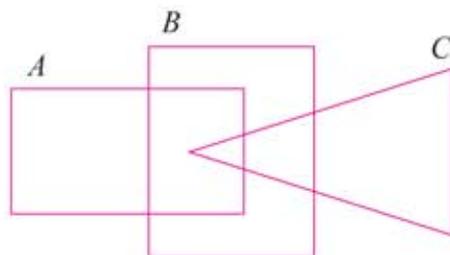
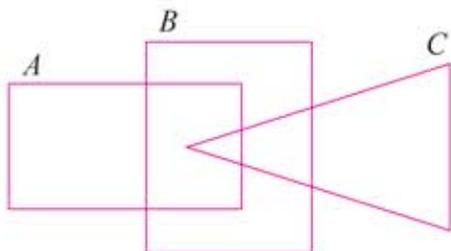
(b) $P \cup R'$

(c) $(P \cup R)' \cap Q$

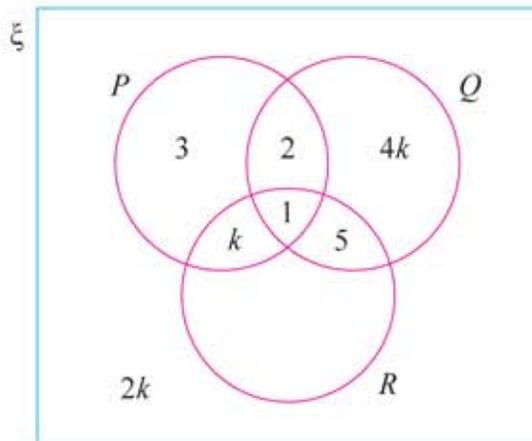
7. Shade the regions to represent the following sets, such that the universal set, $\xi = A \cup B \cup C$.

(a) $A \cap (B \cup C)$

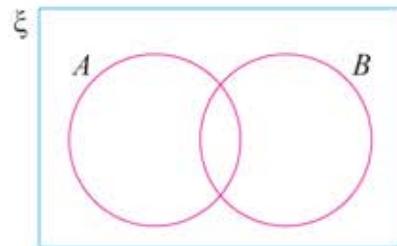
(b) $C \cup (A \cap B)'$



8. The Venn diagram shows the universal set ξ , set P , set Q and set R . Given $n(Q) = n(P \cup R)'$, determine $n(\xi)$.



9. The Venn diagram on the right shows the universal set, $\xi = \{\text{Form 4 pupils}\}$, set $A = \{\text{members of Music Club}\}$ and set $B = \{\text{members of Robotic Club}\}$. Given $n(\xi) = 58$, $n(A) = 20$, $n(B) = 16$ and $n(A \cap B) = 9$, determine the number of pupils who are not members of both clubs.



10. A total of 55 pupils are required to choose between two activities during school holidays. 28 pupils choose sports activities while 21 pupils choose community service activities. If 12 pupils do not choose any of the activities, how many pupils choose both activities?



11. The thrifty habit among teenagers is influenced by their families, society and mass media. 80 teenagers participate in a survey. It is found that 30 teenagers are influenced by their families, 15 teenagers are influenced by their families and society, 9 teenagers are influenced by society and mass media, 7 teenagers are only influenced by their families, and 3 teenagers are influenced by all the three factors. The ratio of the teenagers who are influenced by society only to the teenagers influenced by mass media only is 3 : 1. Calculate the number of teenagers who are influenced by

- two factors, which are their families and mass media only.
- mass media only.
- society.

12. The History Society introduces traditional games to its 40 members. 17 members play *ceper*, 25 members play *batu seremban*, 18 members play *congkak*, 8 members play *ceper* and *batu seremban*, 12 members play *batu seremban* and *congkak*, and 3 members play *ceper*, *batu seremban* and *congkak*.



If the number of members who play *batu seremban* only is twice the number of members who play *congkak* only, calculate the number of members who

- play *batu seremban* only.
 - play both *ceper* and *congkak*.
 - play *ceper* only.
 - are not involved in these traditional games.
13. A study of 80 pupils was conducted on the modes of transportation when they travel back to their hometowns. 25 pupils travel by train and 48 pupils travel by train or car. If 7 pupils travel by train and car, 5 pupils travel by bus and train, and 2 pupils travel by all three modes of transportation, how many pupils do travel by bus or train but not by car?

PROJECT

Discuss three fields of careers that will be your choice in the future.

- List the three fields of careers.
- Give examples of jobs in the fields of careers.
- What are the subjects that are important in the above fields of careers? Explain your answers with the help of Venn diagrams.

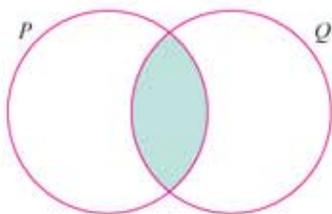


CONCEPT MAP

Operations on Sets

Intersection of Sets

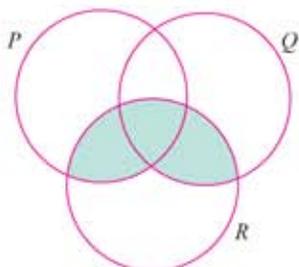
The intersection of set P and set Q is written using the symbol \cap . $P \cap Q$ refers to both sets P and Q have common elements.



$$P \cap Q$$

Combined Operations on Sets

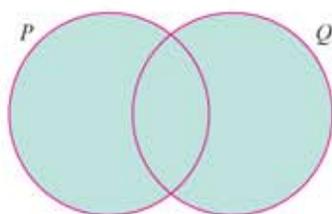
Combined operations on sets involve both the intersection of sets (\cap) and union of sets (\cup) at the same time.



$$(P \cup Q) \cap R$$

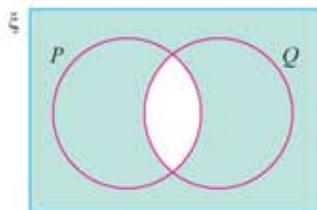
Union of Sets

$P \cup Q$ represents all the elements in set P , set Q or both sets P and Q .



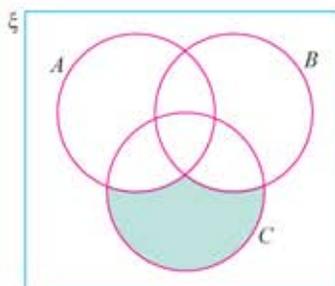
$$P \cup Q$$

The complement of the intersection of sets P and Q refers to all the elements which are not in the intersection of sets P and Q .



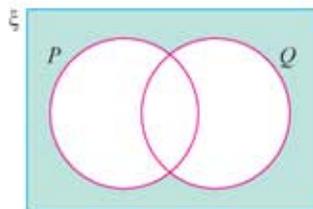
$$(P \cap Q)'$$

The complement of combined operations on sets involves the complements of either intersection of sets (\cap) or union of sets (\cup) or both intersection of sets (\cap) and union of sets (\cup) at the same time.



$$(A \cup B)' \cap C$$

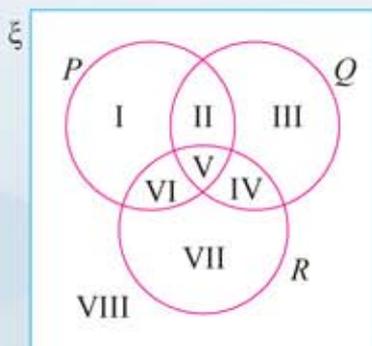
The complement of the union of set P or set Q refers to all the elements which are not in set P or set Q .



$$(P \cup Q)'$$

Self Reflection

The Venn diagram shows the universal set ξ , set P , set Q and set R with labelled regions. Answer all the questions by stating the regions that represent the following sets.



1. P : Regions I, II, V, VI
2. Q'
3. R
4. $P \cap Q$
5. $Q \cap R$
6. $P \cap Q \cap R$
7. $(P \cap Q \cap R)'$
8. $P \cap (Q \cup R)$
9. $Q \cap (P \cup R)$
10. $P \cup (Q \cap R)$
11. $P \cup (Q \cap R)'$
12. $Q \cup (P \cap R)'$
13. $P \cup Q \cup R$
14. $(P \cup Q \cup R)'$
15. $P' \cap (Q \cup R)$
16. $Q' \cap (P \cap R)'$
17. $R' \cup (P \cap Q)'$
18. $(P \cap Q) \cup (Q \cap R)$
19. $(P \cap Q)' \cup (Q \cap R)$
20. $(P \cap Q)' \cup (Q \cup R)'$



Mathematics Exploration

Based on the given food pyramid, draw two Venn diagrams to show the balanced diet for breakfast, lunch and dinner.

Steps

1. Divide the class into groups.
2. Choose the food needed for breakfast, lunch and dinner.
3. Draw Venn diagrams based on the food chosen from the food pyramid. It is given that
 $K = \{\text{breakfast}\}$,
 $L = \{\text{lunch}\}$ and
 $M = \{\text{dinner}\}$.
4. Present your group's findings using Three Stray, One Stay activity.
5. Give your opinions on the appropriateness of the other groups' food options for breakfast, lunch and dinner.



Food Pyramid