THE MATH CIRCLE

O-LEVEL

Paper 1

Sets

WorkSheet

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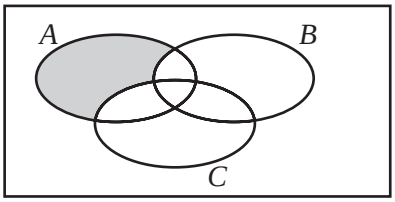
1 **(a)** Express in set notation, as simply as possible, the subset shaded in the Venn diagram.

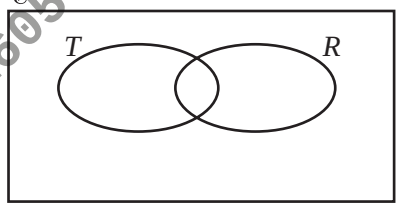


Answer (a) ..... [1]

(b) $\mathscr{E}$ = {all polygons},
T = {all triangles},
R = {all regular polygons},
Q = {all quadrilaterals}.

Add the set Q to the Venn diagram in the answer space.

Answer (b) $\mathscr{E}$



[1]

(c) $\mathscr{E}$ = { x : x is an integer and $3 \leqslant x \leqslant 11$},
F = { x : x is a factor of 12},
O = { x : x is an odd number}.

List the elements of the set $(F \cup O)'$.

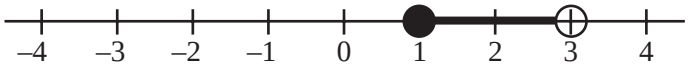
Answer (c) ..... [1]

(d) It is given that n($\mathscr{E}$) = 20.
P and S are sets such that n(P) = 7 and n(S) = 16.

Find the smallest possible value of n($P \cap S$) .

Answer (d) ..... [1]

2 (a)



The set $A = \{x : 1 \leqslant x < 3\}$ is shown on the number line above.

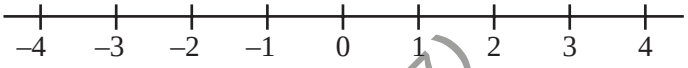
(i) Set B is shown on the number line below.

Complete the description in the answer space.

Answer (a)(i) $B = \{x :$ ..... x .....$\}$ [1]

(ii) The set $C = \{x : x \leqslant -3\}$.
Illustrate the set C' using the number line in the answer space.

Answer (a)(ii)



[1]

(b) $X = \{1, 3, 5\}$, $Y = \{3, 5\}$, $Z = \{(x, y) : x \in X, y \in Y, x \neq y\}$.
List the members of Z.

Answer (b) $Z = \{$ .....$\}$ [2]

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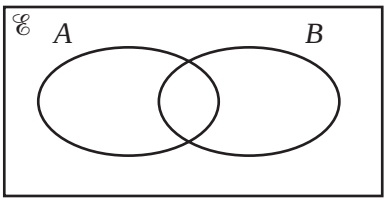
3 (a) On the Venn Diagram in the answer space, shade the region $A \cup B'$.

Answer (a)



[1]

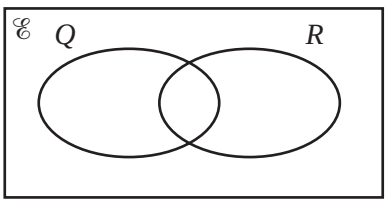
(b) $\mathscr{E} = \{$all polygons$\}$, $Q = \{$all quadrilaterals$\}$, $R = \{$all regular polygons$\}$.

(i) What is the special name of the polygons which belong to $Q \cap R$?

(ii) On the Venn Diagram in the answer space, show the set
$T = \{$all equilateral triangles$\}$.

Answer (b)(i) ..... [1]

(ii)



[1]

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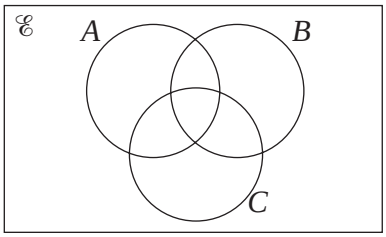
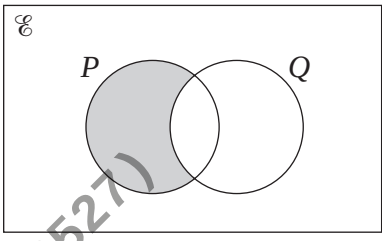
4 **(a)** On the Venn diagram in the answer space, shade the set $A \cup (B \cap C)$.

Answer (a)



(b) Express in set notation the subset shaded in the Venn diagram.

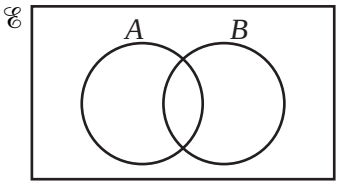


Answer (b) .....[1]

(c) In a class of 36 students, 25 study History, 20 study Geography and 4 study neither History nor Geography.
Find how many students study both History and Geography.

5 **(a)** The sets A and B are shown on the Venn Diagram in the answer space.
The element y is such that $y \in A$ and $y \notin B$.
On the diagram, write y in the correct region.

Answer (*a*)



[1]

(b) $\mathscr{E} = \{x : x \text{ is an integer and } 1 \leqslant x \leqslant 8\}$.
$P = \{x : x > 5\}$.
$Q = \{x : x \leqslant 3\}$.

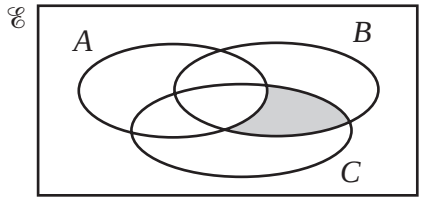
(i) Find the value of $n(P \cup Q)$.

(ii) List the elements of $P' \cap Q'$.

Answer (*b*)(i) .....[1]

(ii) { .....} [1]

6 **(a)** Express, in set notation, as simply as possible, the subset shaded in the Venn diagram.



Answer (*a*) .....[1]

(b) It is given that $n(\mathscr{E}) = 40$, $n(P) = 18$, $n(Q) = 20$ and $n(P \cap Q) = 7$.

Find

(i) $n(P \cup Q)$,

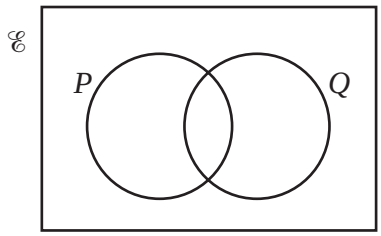
(ii) $n(P' \cap Q')$.

Answer (*b*)(i) .....[1]

(ii) .....[1]

7 **(a)** On the Venn diagram shown in the answer space, shade the set $P \cup Q'$.

Answer (*a*)



[1]

(b) There are 27 children in a class.
Of these children, 19 own a bicycle, 15 own a scooter and 3 own neither a bicycle nor a scooter.
Using a Venn diagram, or otherwise, find the number of children who own a bicycle but not a scooter.

Answer (*b*) .....[2]

8 **(a)** $\mathscr{E}$ = { 1, 2, 3, 4, 5 },
A = { 1, 2, 3 },
B = { 5 },
C = { 3, 4 }.

List the elements of

(i) $A \cup C$,

Answer (*a*)(i) .....[1]

(ii) $B' \cap C'$.

Answer (*a*)(ii) .....[1]

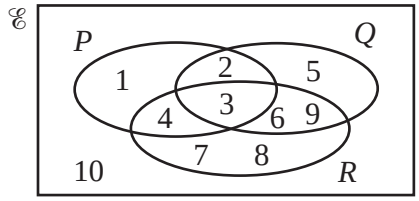
(b) A group of 60 children attend an after school club.
Of these, 35 children play football and 29 play hockey.
3 children do not play either football or hockey.

By drawing a Venn diagram, or otherwise, find the number of children who play only hockey.

Answer (*b*) .....[2]

9 The Venn diagram shows the sets $\mathscr{E}$, P, Q and R.

$\mathscr{E} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$



(a) Find the value of $n(Q \cup R)$.

Answer (*a*) .....[1]

(b) List the elements of the set $P' \cap (Q \cup R)$.

Answer (*b*) {.....} [1]

(c) One element is chosen at random from $\mathscr{E}$.
Write down the probability that this element belongs to $(P \cap Q) \cup (P \cap R)$.

Answer (*c*) .....[1]

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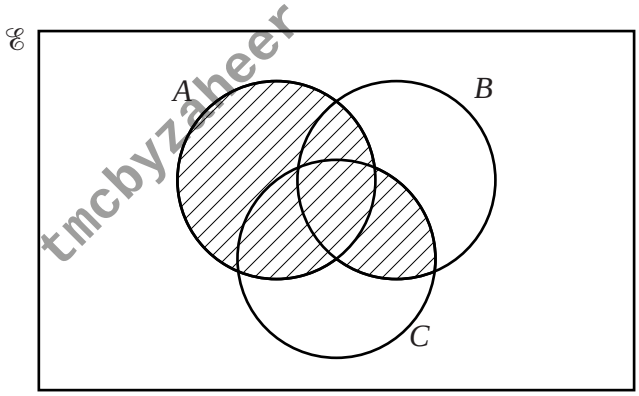
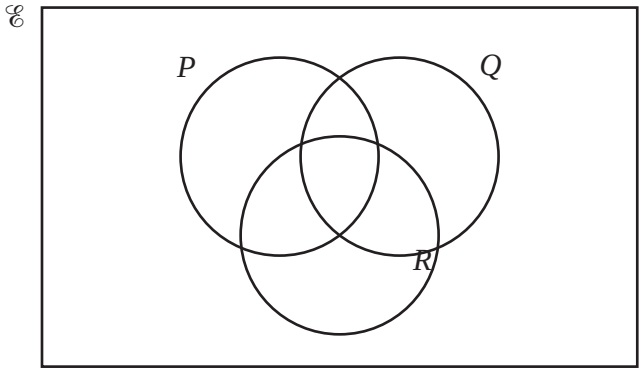
10 **(a)** Using set notation, describe the shaded region in the Venn diagram.



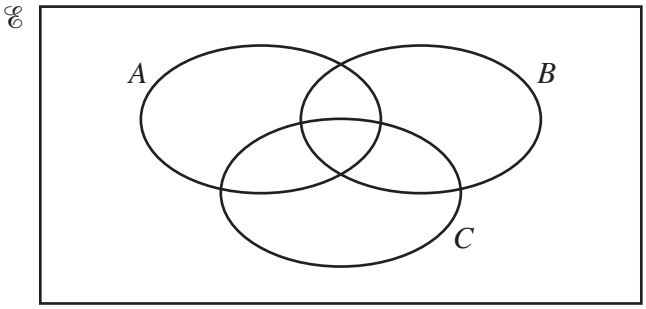
Answer ..... [1]

(b) In the Venn diagram, shade the region represented by $P' \cap (Q \cup R)$.



[1]

11 (a) On the Venn diagram, shade the set $A \cap B \cap C'$.



[1]

(b) $\mathscr{E} = \{2, 3, 4, 5, 6, 7, 8, 9, 10\}$
$P = \{x : x \text{ is a prime number}\}$
$Q = \{x : x \geqslant 5\}$

(i) Find the value of $\text{n}(P \cap Q)$.

Answer ..... [1]

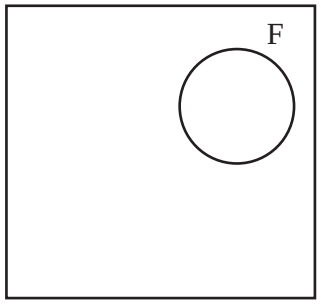
(ii) List the elements of $P \cup Q'$.

Answer ..... [1]

12 $\mathscr{E} = \{ x : x \text{ is an integer and } x > 5 \}$

$P = \{ x : x \text{ is a prime number} \}$
$F = \{ x : x \text{ is a multiple of } 4 \}$
$S = \{ x : x \text{ is a multiple of } 6 \}$

The Venn diagram shows the Universal set and the set F.



(a) Draw and label the two sets P and S to complete the Venn diagram. [2]

(b) Write down a possible element y such that y is an even number and $y \in (F \cup S)'$.

Answer $y =$ ..... [1]

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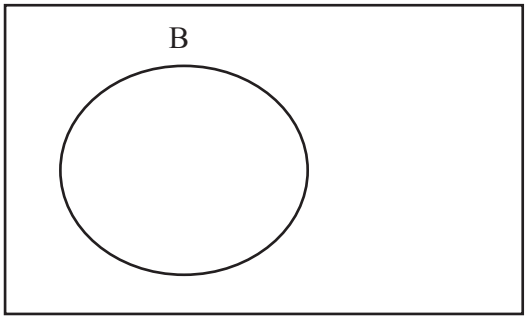
13 The Venn diagram shows the Universal set and the set B.
A and C are two sets such that

$$A \cup B = B, \quad A \cap B \neq B, \quad A \cap C = \varnothing \quad \text{and} \quad B \cap C \neq \varnothing.$$

Draw the sets A and C in the Venn diagram.



[2]

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14 **(a)** Given that $A = \{ 1, 2, 3, 4, 5 \}$ and $B = \{ 3, 4, 5, 6, 7 \}$, find $\text{n}(A \cup B)$.

Answer ..... [1]

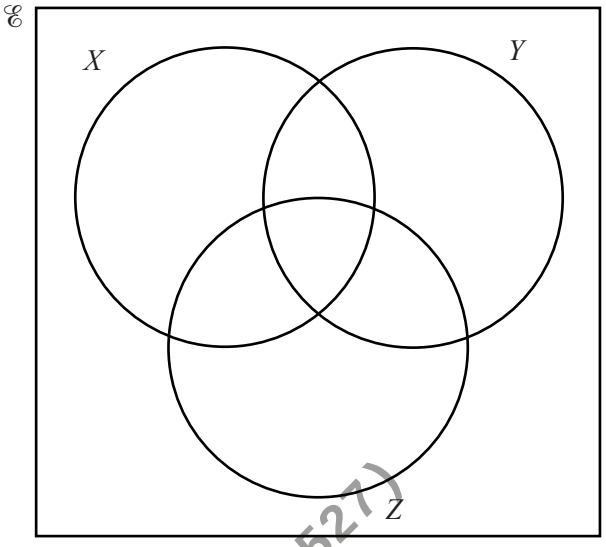
(b) $\mathscr{E} = \{ p, q, r, ... \}$

On the Venn diagram, write each of the letters p, q, and r in its appropriate subset, given that

$p \in X \cap Y \cap Z$,

$q \in X' \cap Y' \cap Z'$,

$r \in (X \cup Y)' \cap Z$.



[3]

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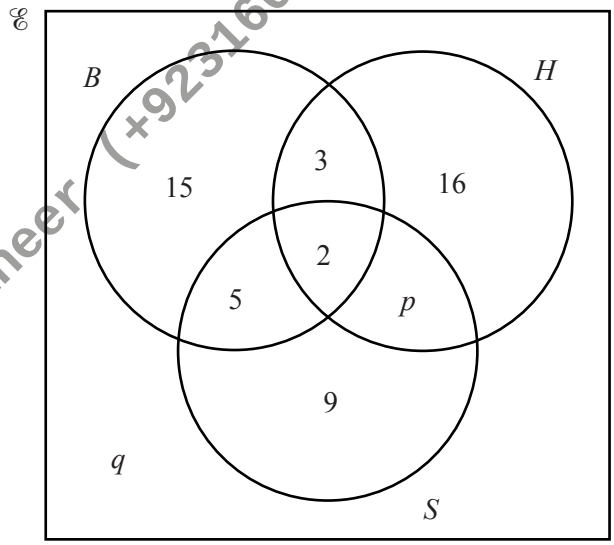
15 In a survey, 60 students are asked which of the subjects Biology (B), History (H) and Spanish (S) they are studying.

The Venn diagram shows the results.

27 students study History.



(a) Find the values of p and q.

Answer $p =$ .....

$q =$ ..... [1]

(b) Find $\text{n}(H')$.

Answer ..... [1]

(c) Find $\text{n}((B \cup H) \cap S')$.

Answer ..... [1]

16 **(a)** $A = \begin{pmatrix} 4 & 3 \\ 1 & 2 \end{pmatrix}$ $B = \begin{pmatrix} 2 & -3 \\ 1 & 1 \end{pmatrix}$

(i) Find $2A - B$.

Answer $\begin{pmatrix} & \\ & \end{pmatrix}$ [1]

(ii) Find B^{-1}.

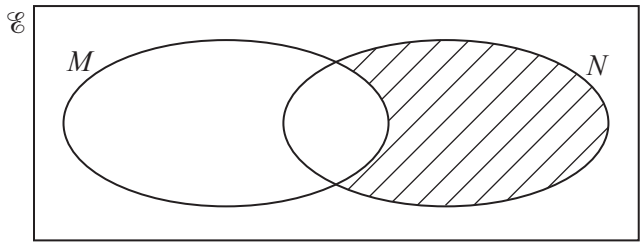
Answer $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

(b) $\mathscr{E}$ = {natural numbers}
P = {factors of 8}
Q = {factors of 12}

List the elements of the set $P \cup Q$.

Answer ..... [2]

(c)

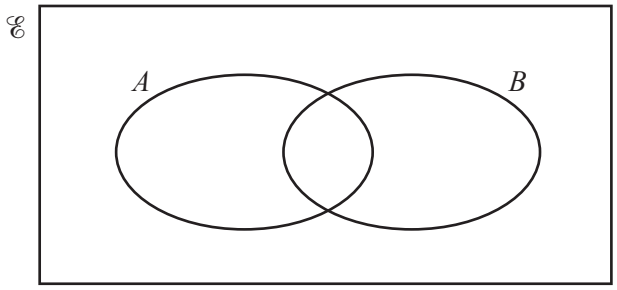


Use set notation to describe the shaded subset in the Venn diagram.

Answer ..... [1]

17 $\mathscr{E} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$
$A = \{\text{odd numbers}\}$
$B = \{\text{multiples of 3}\}$

(a) Complete the Venn diagram to illustrate this information.



[1]

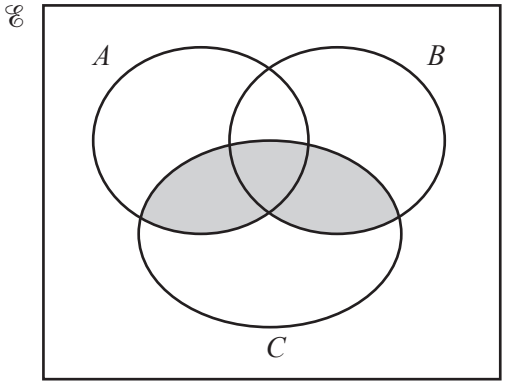
(b) Find the value of $\text{n}(A \cup B)$.

Answer .....[1]

(c) List the elements of the set $A \cap B'$.

Answer .....[1]

18 **(a)** Express, in set notation, the subset shaded in the diagram.



Answer .....[1]

(b) $\mathscr{E}$ = {a, b, c, d, e, f, g, h}

P = {a, b, c}

Q = {b, c, d, e, f}

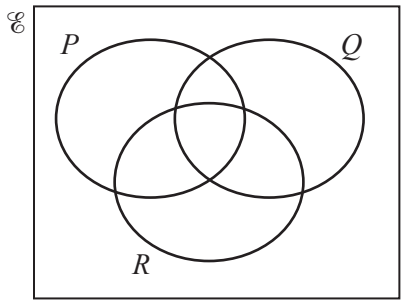
(i) Find n($P \cup Q$).

Answer .....[1]

(ii) List the members of the subset $P' \cap Q$.

Answer .....[1]

19 **(a)** On the Venn diagram, shade the set $P' \cap (Q \cup R)$.



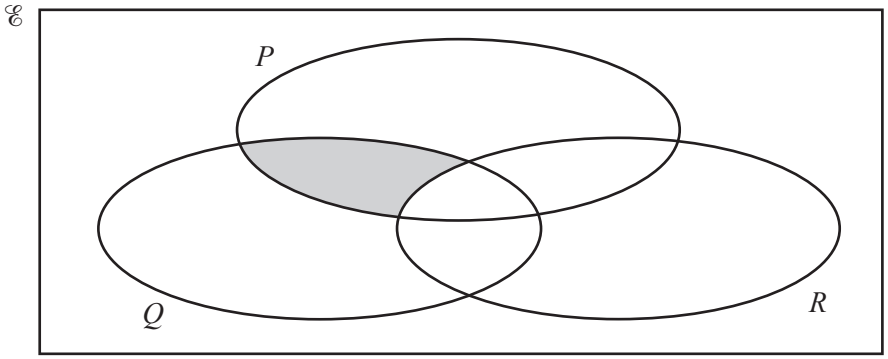
[1]

(b) A group of 40 children are asked what pets they own.
Of these children, 13 own a cat, 5 own both a cat and a dog and 15 own neither a cat nor a dog.

Using a Venn diagram, or otherwise, find the number of children who own a dog, but not a cat.

Answer ..... [2]

20 **(a)** Use set notation to describe the shaded subset in the Venn diagram.



Answer ..... [1]

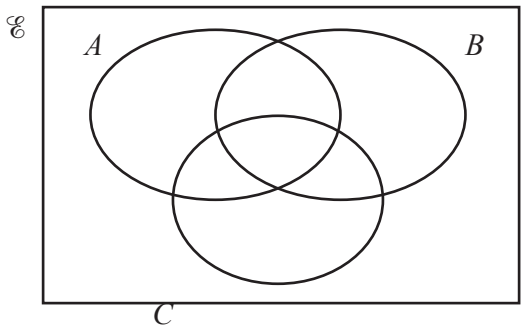
(b) In a group of students

30 play cricket,
38 play football and
9 play neither cricket nor football.

Find the lowest possible number of students in the group.

Answer ..... [2]

21 **(a)** On the Venn diagram, shade the set $C' \cap (A \cup B)$.



[1]

(b) $\mathscr{E} = \{ -1, 0, 1, 2, 3, 4, 5, 6 \}$

$P = \{ -1, 0, 1, 2 \}$

$Q = \{ x^2 : x \in P \}$

Find n(Q).

Answer ..... [1]

22 **(a)** $\mathscr{E} = \{ x : x \text{ is an integer, } 40 \leqslant x \leqslant 50 \}$

$P = \{ x : x \text{ is a prime number} \}$

$Q = \{ x : x \text{ is a multiple of 6} \}$

(i) Find $\text{n}(P)$.

Answer ..... [1]

(ii) List the members of Q.

Answer ..... [1]

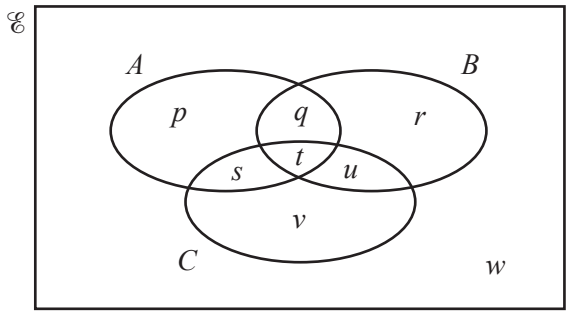
(b) In a group of 25 people,
11 people own both a bicycle and a skateboard,
6 people own neither a bicycle nor a skateboard,
n people own a bicycle.

Find the smallest and the largest possible values of n.

Answer smallest ..... [1]

largest ..... [1]

23 The Venn diagram shows the sets A, B and C.



List the elements of

(a) $A \cup B$,

Answer ..... [1]

(b) $B' \cap C$.

Answer ..... [1]

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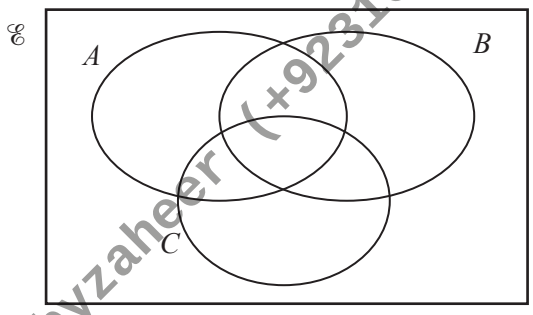
24 **(a)** On the Venn diagram, shade the set $B \cap (A \cup C)'$.



[1]

(b) $\mathscr{E} = \{ 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 \}$

$W = \{ x : x \text{ is a multiple of } 2 \}$

$H = \{ x : x \text{ is a multiple of } 3 \}$

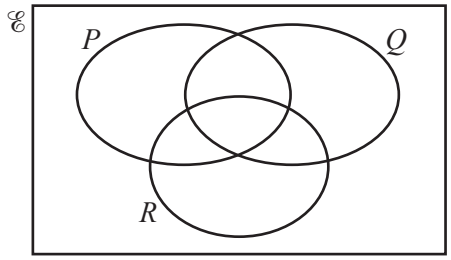
(i) Find $\text{n}(W \cup H)$.

Answer ..... [1]

(ii) List the members of $W \cap H'$.

Answer ..... [1]

25 **(a)** In the Venn diagram, shade the region which represents the subset $(P \cup Q)' \cap R$.



[1]

(b) $\mathscr{E} = \{ x : x \text{ is an integer and } 22 \leqslant x \leqslant 33 \}$
$E = \{ x : x \text{ is an even number} \}$
$T = \{ x : x \text{ is a multiple of 3} \}$
$F = \{ x : x \text{ is a multiple of 4} \}$

(i) List the members of $T \cap F$.

Answer ..... [1]

(ii) Find $\mathrm{n}(E \cup T)$.

Answer ..... [1]

(iii) Given that $y \in F' \cap E$, find one possible value of y.

Answer y = ... [1]

26 50 students are asked what type of movie they like to watch.
Of these students,

- 26 like comedy,
- 15 like both action and comedy and
- 8 like neither action nor comedy.

Using a Venn diagram, or otherwise, find the number of students who like action but not comedy.

Answer ..... [2]

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27 **(a)** $\mathscr{E} = \{ 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96 \}$

$P = \{ x : x \text{ is an even number} \}$

$Q = \{ x : x \text{ is a multiple of } 3 \}$

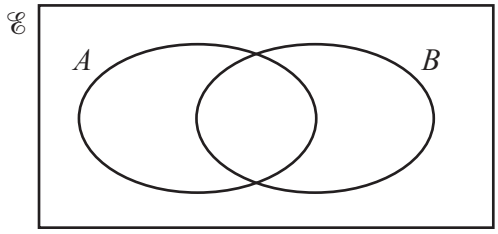
(i) Find $n(P \cup Q)$.

Answer ..... [1]

(ii) Given that $y \in \mathscr{E}$ and that y is a prime number, write down the value of y.

Answer $y =$ ..... [1]

(b) In the Venn diagram, shade the region represented by $A' \cap B$.



[1]

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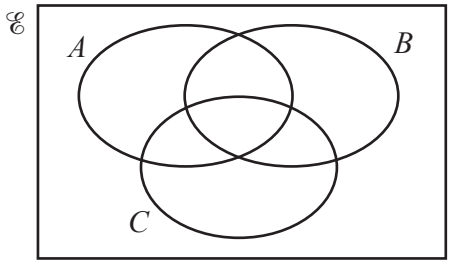
28 **(a)** In the Venn diagram, shade the region which represents the subset $(A \cap B') \cup C$.



[1]

(b) In a group of 36 students,

23 study Spanish,
17 study French,
4 study neither Spanish nor French.

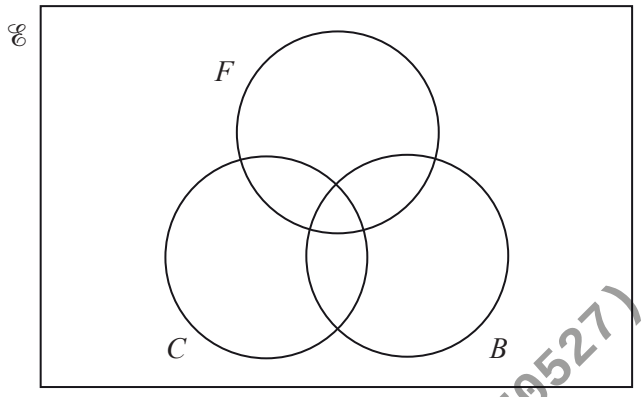
By drawing a Venn diagram, or otherwise, find the number of students who study both Spanish and French.

Answer ..... [2]

29 **(a)** In a sports club 24 members play basketball (B),
28 play cricket (C),
16 play football (F),
9 play basketball and cricket,
11 play cricket and football and
6 play basketball and football.

Five members play all three games and **eight** members play none of these games.

(i) Complete the Venn diagram to show this information.

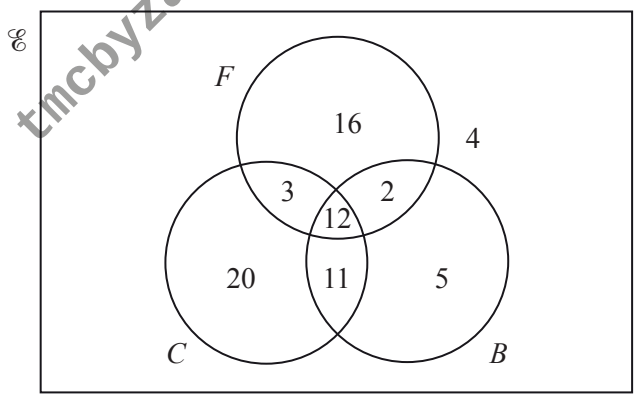


[2]

(ii) Hence work out the **total** number of members in the club.

Answer ..... [1]

(b) In another sports club, the number of members playing basketball (B), cricket (C) and football (F) are shown in the Venn diagram below.



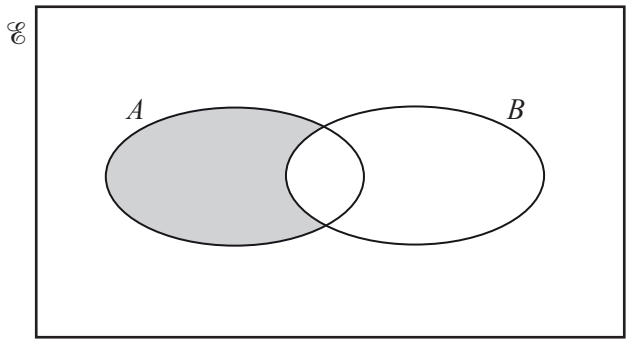
(i) Find n(F').

Answer ..... [1]

(ii) Find n$\big((F \cup C) \cap B' \big)$.

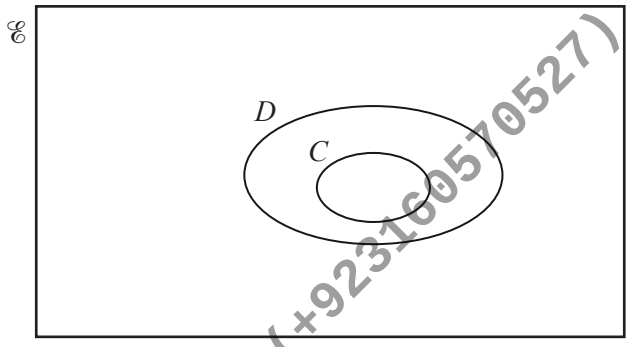
Answer ..... [1]

30 **(a)** Use set notation to describe the shaded set in the Venn diagram.



Answer ..... [1]

(b) Use set notation to complete the statement about sets C and D.



Answer C ..... D [1]