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(I)GCSE Extended Level Mathematics (0580)

E1.2 Sets and Venn Diagrams

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Abstract

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Each full booklet comes with a companion Answer Booklet containing fully worked, exam-style model answers and explanations for every question.

Each worksheet and answer sheet has a Key Concepts and Formulas section with methods, pro-tips, galleries, deeper insights, cautionary notes, and in the answer sheets, reminders. These have been written with the student in mind in order to assist them in fully understanding the mathematics.

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E1 NUMBER FREE TASTER RESOURCE

Worksheet: E1.2 Sets and Venn Diagrams

Instructions

- Answer all questions.
- Show all your working clearly in the spaces provided.
- The number of marks for each question or part question is shown in brackets [ ].
- Use a ruler and pencil for drawing diagrams where instructed.

Key Concepts: Sets and Venn Diagrams

A **set** is simply a collection of distinct objects, which we call **elements**. Venn diagrams are the visual tool we use to see how different sets relate to each other.

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1. The Venn Diagram

The Structure of a Venn Diagram

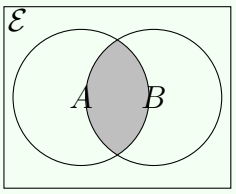
- The **rectangle** represents the **Universal Set**, denoted by the symbol $\mathcal{E}$. It contains every element being considered in the problem.
- The **circles** represent the individual sets (e.g., Set A, Set B).
- The **overlapping section** (or intersection) shows the elements that are in **both** sets.
- The area **outside the circles** but inside the rectangle shows the elements that are in **neither** set.

2. Key Operations and Regions

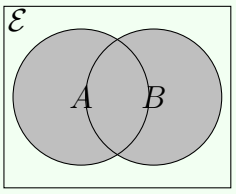
Understanding the notation for the different regions of a Venn diagram is essential.

The Four Key Set Operations

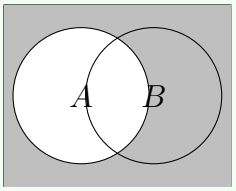
Intersection ($A \cap B$)
This means the elements that are in set A **AND** set B. It is the central overlapping region.



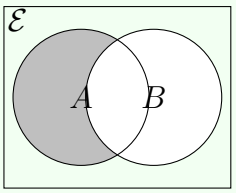
Union ($A \cup B$)
This means the elements that are in set A **OR** set B, or both. It includes everything inside both circles.



Complement (A')
This means the elements that are **NOT** in set A. It is everything outside of the circle for A.



Difference ($A \cap B'$)
This means the elements that are in set A **AND NOT** in set B. It is the part of circle A that does not overlap with B.



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3. Solving Problems

Method: Solving Venn Diagram Word Problems

When you are given information in a word problem, always work from the ”inside out”.

1. Draw the Venn diagram with the rectangle and circles.
2. Fill in the number for the **central intersection** first (the ”both” category).
3. Use this number to work outwards. For example, if 18 students play Football and 6 play both, then the number who play ”Football only” is $18-6=12$.
4. Once all the circles are filled, find the number for the ”neither” category by subtracting all the numbers in the circles from the total (the universal set, $\mathcal{E}$).

4. Glossary of Set Notation

Set Notation Reference

Symbol	Meaning
$\mathcal{E}$	Universal set (contains all elements being considered)
$A=\{1,2,3\}$	Set A contains the elements 1, 2, and 3
$x \in A$	x is an element of set A
$y \notin B$	y is not an element of set B
$n(A)$	The number of elements in set A
$\emptyset$ or $\{\}$	The empty set (contains no elements)
$A \subseteq B$	A is a subset of B (all elements of A are also in B)
$A \subset B$	A is a proper subset of B (A is a subset, but not equal to B)
A'	The complement of A (elements in $\mathcal{E}$ but not in A)
$A \cap B$	Intersection - elements in both A AND B
$A \cup B$	Union - elements in A OR B (or both)

1. Let $\mathcal{E} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{$Multiples of 2$\}$, $B = \{$Factors of 12$\}$.

   (a) List the elements of set A. [1]

   (b) List the elements of set B. [1]

   (c) Is $6 \in A$? (Yes/No) [1]

   (d) Is $5 \in B$? (Yes/No) [1]

   (e) Find $n(A)$. [1]

   (f) Is $B \subseteq A$? Explain your answer. [2]

Total: [7]

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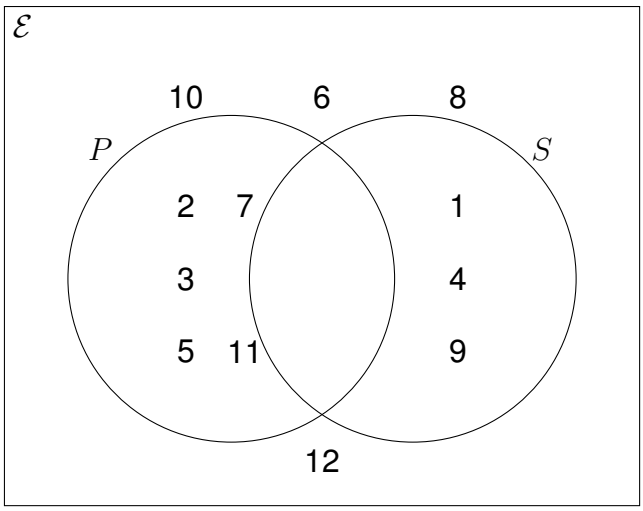
2. The Venn diagram shows information about the integers from 1 to 12. Set P = {Prime numbers}, Set S = {Square numbers}.



(a) List the elements of $P \cap S$. [1]

(b) List the elements of $P \cup S$. [1]

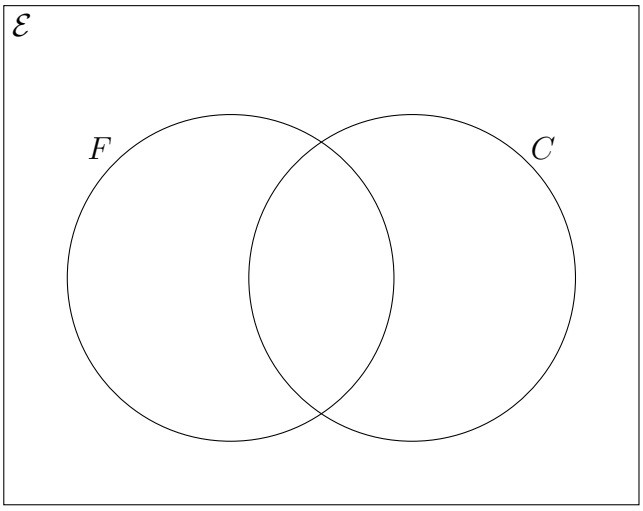
(c) List the elements of P'. [1]

(d) Find $n(S')$. [1]

Total: [4]

3. In a class of 30 students, 18 play Football (F) and 15 play Cricket (C). 6 students play both Football and Cricket.

   (a) Complete the Venn diagram below to show this information. [3]



   (b) Use your Venn diagram to find the number of students who play:

      (i) Football only. [1]

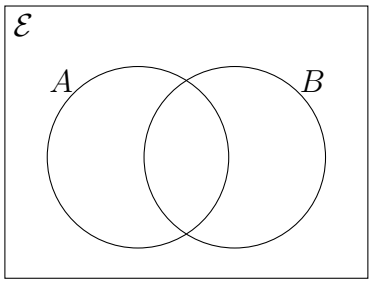
      (ii) Neither Football nor Cricket. [1]

   (c) A student is chosen at random from the class. Find the probability that the student plays Cricket but not Football. [1]

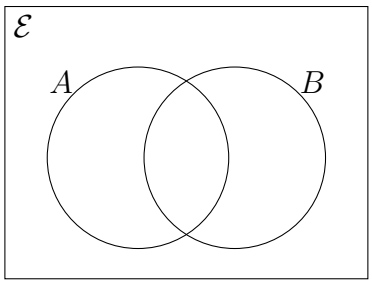
Total: [6]

4. On the Venn diagrams below, shade the region represented by the following sets:

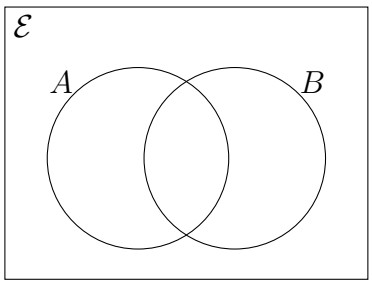
(a) $A \cap B$ [1]



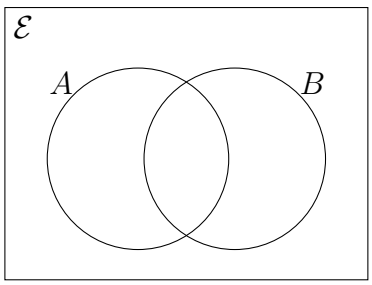
(b) $A \cup B$ [1]



(c) A' [1]



(d) $A \cap B'$ [1]



Total: [4]

5. $\mathcal{E} = \{\text{integers } x : 1 \leq x \leq 10\}$
   $P = \{\text{prime numbers}\}$
   $E = \{\text{even numbers}\}$

   (a) List the elements of $\mathcal{E}$. [1]

   (b) List the elements of P. [1]

   (c) List the elements of E. [1]

   (d) List the elements of $P \cap E$. [1]

   (e) List the elements of $(P \cup E)'$. [1]

   (f) Find $n(P' \cap E)$. [1]

Total: [6]

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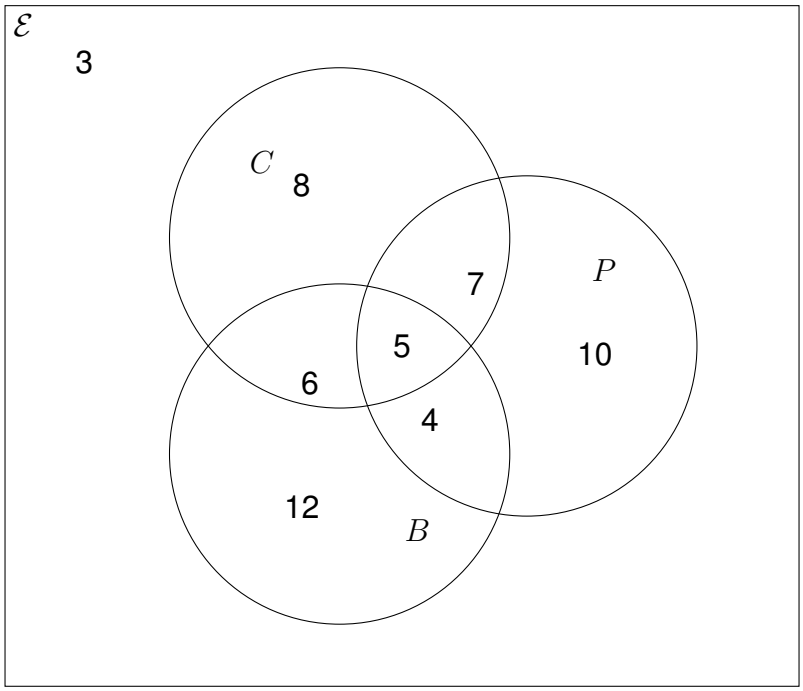
6. The Venn diagram shows information about students studying Physics (P), Chemistry (C) and Biology (B).



Find the number of students who study:

(a) Physics. ($n(P)$) [1]

(b) Chemistry and Biology but not Physics. ($n(C \cap B \cap P')$) [1]

(c) Physics or Chemistry. ($n(P \cup C)$) [2]

(d) Exactly two subjects. [2]

(e) None of these subjects. [1]

Total: [7]

End of Worksheet

Start of Answer Sheet

1) First, we list the elements of sets A and B based on the universal set $\mathcal{E} = \{1, 2, ..., 10\}$.

- Set A (Multiples of 2): $A = \{2, 4, 6, 8, 10\}$
- Set B (Factors of 12): $B = \{1, 2, 3, 4, 6\}$

Now we can answer the questions.

a) The elements of set A are $\{2, 4, 6, 8, 10\}$.

b) The elements of set B are $\{1, 2, 3, 4, 6\}$.

c) **Yes**. We can see from the list that $6 \in A$.

d) **No**. The number 5 is not a factor of 12, so $5 \notin B$.

e) n(A) represents the number of elements in set A. By counting the elements in A, we find that n(A) = 5.

f) **No**. For B to be a subset of A ($B \subseteq A$), every element of B must also be an element of A. We can see that $1 \in B$ but $1 \notin A$.

2) We are given the universal set $\mathcal{E} = \{1, ..., 12\}$. First, we define the sets P and S within this universal set.

- Set P (Prime numbers): $P = \{2, 3, 5, 7, 11\}$
- Set S (Square numbers): $S = \{1, 4, 9\}$

Reminder: Set Notation

- $\cap$ (Intersection): Elements in **both** sets.
- $\cup$ (Union): Elements in **either** set (or both).
- P' (Complement): Elements **not** in set P.

a) $P \cap S = \emptyset$ (the empty set), as there are no common elements.

b) $P \cup S = \{1, 2, 3, 4, 5, 7, 9, 11\}$.

c) $P' = \{1, 4, 6, 8, 9, 10, 12\}$.

d) n(S') is the number of elements not in S. $S' = \{2, 3, 5, 6, 7, 8, 10, 11, 12\}$, so n(S') = 9.

3) a)

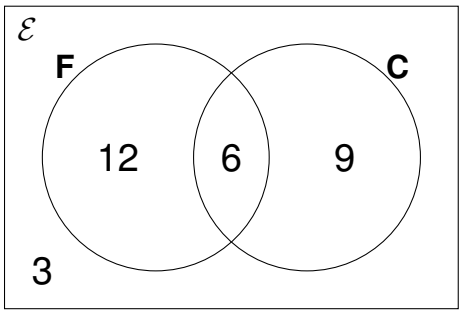
Method: Filling a Venn Diagram

Always start from the intersection and work outwards.

i. **Intersection:** Fill in the number of items in **both** sets first (e.g., $F \cap C$).

ii. **Outer regions:** For each set, subtract the intersection value from the total to find the "only" part.

iii. **Neither:** Add all numbers inside the circles and subtract this from the universal total.



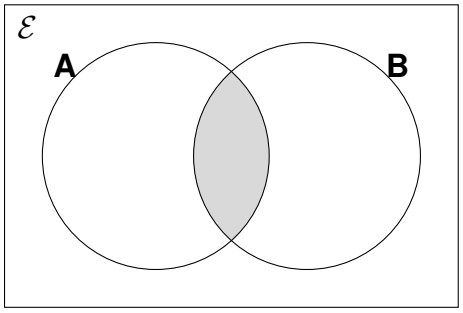
b) We can now read the answers directly from the completed Venn diagram.

i) The number of students who play Football only is 12.

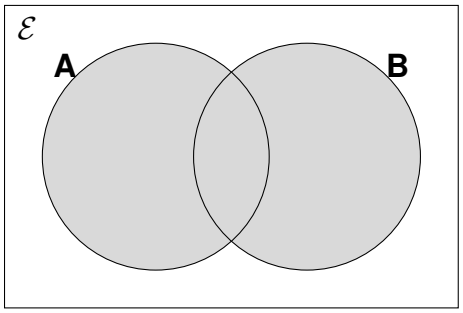
ii) The number of students who play neither Football nor Cricket is 3.

c) The probability is $\frac{\text{Cricket only}}{\text{Total}} = \frac{9}{30} = \mathbf{\frac{3}{10}}$.

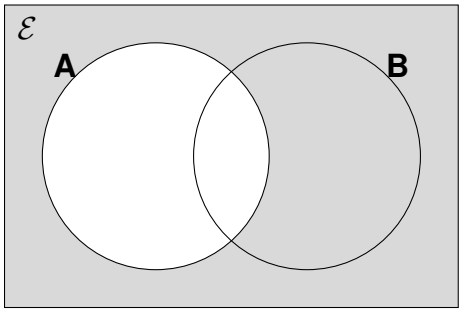
4) a) $A \cap B$



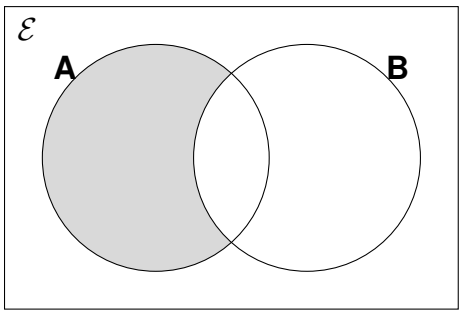
b) $A \cup B$



c) A'



d) $A \cap B'$



5) a) $\mathcal{E} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$.

b) $P = \{2, 3, 5, 7\}$.

c) $E = \{2, 4, 6, 8, 10\}$.

d) $P \cap E = \{2\}$.

e)

> **Caution: Order of Operations**
>
> Always calculate the operation inside the brackets **first**, before applying the complement symbol (').

First, find the union $P \cup E = \{2, 3, 4, 5, 6, 7, 8, 10\}$.
Then find the complement: $(P \cup E)' = \{\mathbf{1}, \mathbf{9}\}$.

e) First, find the complement $P' = \{1, 4, 6, 8, 9, 10\}$.
Then find the intersection $P' \cap E = \{4, 6, 8, 10\}$.
Finally, n($P' \cap E$) = **4**.

6) The answers are found by reading the values directly from the regions in the Venn diagram.

a) n(P) = $10 + 7 + 5 + 4 =$ **26**.

b) The value is **6**.

c) n(P $\cup$ C) = $10 + 8 + 7 + 6 + 5 + 4 =$ **40**.

d)

> **Caution: "Exactly Two" vs "At Least Two"**
>
> "Exactly two subjects" means the sum of the three 'lens' regions only. It does **not** include the central region where students study all three subjects.

(C and P only) + (C and B only) + (P and B only)
$7 + 6 + 4 =$ **17**.

d) The value is **3**.