Year 11 Mathematics Advanced

Topic: Probability and Data (1 of 5)

Review Questions (Worked Solutions): Sets and set notation

Term 3, 2026

Sets and Venn diagrams

1. Set notation and shading Venn regions

Q1 Fort St 2025 Trial Q5 · **1 mark**

Which Venn diagram best represents $A \cap \bar{B}$? (Options A–D are Venn diagrams.)

Criteria	Marks
Correct option (A)	1

Solution.

$A \cap \bar{B}$ is the set of elements that are in A but *not* in B. This is the part of circle A that does not overlap B (the "A only" crescent). Only the intersection with $\bar{B}$ survives, so the overlap and everything outside A are excluded.

$$A \cap \bar{B} = \{\, A \text{ only} \,\}.$$

The diagram with only the left crescent of A shaded is option **A**.

Q2 SCEGGS 2022 Prelim Q5 · **1 mark**

Which Venn diagram represents $A \cup \bar{B}$? (Options A–D are Venn diagrams.)

Criteria	Marks
Correct option (C)	1

Solution.

$\bar{B}$ is everything *outside* B: the "A only" region plus the region outside both circles. Taking the union with A (which is "A only" plus the overlap) gives everything except the "B only" region:

$$A \cup \bar{B} = \{\, A \text{ only} \,\} \cup \{\, \text{overlap} \,\} \cup \{\, \text{outside both} \,\}.$$

The only unshaded part is "B only". This is option **C**.

Q3 Shore 2023 Trial Q2 · **1 mark**

The shaded region is the part of B lying outside A (the "B only" crescent). Which set notation describes it?

Criteria	Marks
Correct option (D)	1

Solution.

The shaded "B only" region contains elements that are in B but *not* in A, i.e. in B and in A':

$$\{\, B \text{ only} \,\} = A' \cap B.$$

This is option **D**. (Option A, B, would also include the overlap; option B, $A \cap B$, is only the overlap; option C, A', would include the region outside both circles.)

Q4 Presbyterian 2023 Prelim Q12 · **1 mark**

Shade $\bar{A} \cap B$ on the Venn diagram.

Criteria	Marks
Shades the correct region (B only)	1

Solution.

$\bar{A} \cap B$ is the set of elements in B but *not* in A. On the diagram this is the part of circle B that lies *outside* circle A (the "B only" crescent). Shade only that crescent: not the overlap, not any part of A, and not the region outside both circles.

$$\bar{A} \cap B = \{\, B \text{ only} \,\}.$$

Q5 Hurlstone 2022 Prelim Q4 · **1 mark**

Which Venn diagram represents $A \cup \bar{B}$? (Options A–D are Venn diagrams.)

Criteria	Marks
Correct option (A)	1

Solution.

$\bar{B}$ is everything outside B: the "A only" region together with the region outside both circles. Its union with A ("A only" plus the overlap) shades everything except the "B only" region:

$$A \cup \bar{B} = \{\, A \text{ only} \,\} \cup \{\, \text{overlap} \,\} \cup \{\, \text{outside both} \,\}.$$

The diagram with the whole plane shaded except the "B only" crescent is option **A**.

Q6 Barker 2021 Prelim Q9 · **1 mark**

Both circles are left unshaded and only the region outside both circles is shaded. Which set notation describes this shaded area?

Criteria	Marks
Correct option (D)	1

Solution.

The shaded region is everything *outside* both A and B, i.e. the complement of $A \cup B$:

$$\overline{A \cup B}.$$

By De Morgan's law $\overline{A \cup B} = \bar{A} \cap \bar{B}$, which is option **D**.

Q7 Barker 2024 Prelim Q5 · **1 mark**

Everything is shaded except the "A only" crescent (the part of A outside B). Which set notation describes the shaded area?

Criteria	Marks
Correct option (D)	1

Solution.

The only unshaded region is "A only" $= A \cap B'$, so the shaded region is its complement, $\overline{A \cap B'} = A' \cup B$. Checking option D:

$$B \cup (A' \cap B') = (B \cup A') \cap (B \cup B') = (A' \cup B) \cap U = A' \cup B.$$

The shaded region equals $A' \cup B$, so the answer is option **D**.

Q8 Manly 2025 Trial Q13 · **2 marks**

(a) Shade $\bar{A} \cup B$ on the Venn diagram of two events A, B that are not mutually exclusive.
(b) Given $P(A) = 0.3$, $P(B) = 0.5$, $P(A \cap B) = 0.2$, find $P(\bar{A} \cup B)$.

Criteria	Marks
(a) Shades $\bar{A} \cup B$ (everything except "A only")	1
(b) $P(\bar{A} \cup B) = 0.9$	1

Solution.

(a) $\bar{A}$ is everything outside A ("B only" plus outside both circles). Its union with B ("B only" plus the overlap) shades everything *except* the "A only" crescent. Shade the overlap, the "B only" crescent, and the region outside both circles; leave only the "A only" crescent unshaded.

(b) Use De Morgan: $\bar{A} \cup B = \overline{A \cap \bar{B}}$, so

$$P(\bar{A} \cup B) = 1 - P(A \cap \bar{B}) = 1 - \big(P(A) - P(A \cap B)\big) = 1 - (0.3 - 0.2) = 0.9.$$

Check by inclusion–exclusion: $P(\bar{A}) + P(B) - P(\bar{A} \cap B) = 0.7 + 0.5 - (0.5 - 0.2) = 0.9$. Both give

$$P(\bar{A} \cup B) = \tfrac{9}{10} = 0.9.$$

2. Venn diagrams, two-way tables and the counting rule

Q9 Hurlstone 2021 Prelim Q20 · **1 mark**

Two events P and Q are mutually exclusive. Which Venn diagram illustrates this? (Options A–D are Venn diagrams.)

Criteria	Marks
Correct option (D)	1

Solution.

Mutually exclusive events cannot both occur, so $P \cap Q = \varnothing$. On a Venn diagram this means the two circles do *not* overlap:

$$P \cap Q = \varnothing.$$

The diagram showing two separate (disjoint) circles is option **D**.

Q10 Gosford 2023 Prelim Q8 · **1 mark**

For $A = \{3, 6, 9, 12, 15\}$ and $B = \{2, 4, 6, 8, 10, 12, 14\}$, which set is $A \cup B$?

Criteria	Marks
Correct option (B)	1

Solution.

The union $A \cup B$ lists every element in A *or* B (each written once):

$$A \cup B = \{2, 3, 4, 6, 8, 9, 10, 12, 14, 15\}.$$

This is option **B**.

Q11 2024 HSC Q2 · **1 mark**

In a group of 60 students, 38 play basketball, 35 play hockey and 5 play neither. How many play both?

Criteria	Marks
Correct option (B)	1

Solution.

Students who play at least one sport: $60 - 5 = 55$. By the inclusion–exclusion (addition) rule,

$$|B| + |H| - |B \cap H| = 55 \implies 38 + 35 - |B \cap H| = 55,$$

$$|B \cap H| = 73 - 55 = 18.$$

This is option **B**.

Q12 St George Girls 2024 Trial Q13 · **2 marks**

A class of 24 students: 12 go to the gym, 13 run, 4 neither. (a) Complete the two-way table. (b) Find the probability that a student who runs also goes to the gym.

Criteria	**Marks**
(a) Two-way table completed correctly	1
(b) $P(\text{gym} \mid \text{run}) = \frac{5}{13}$	1

Solution.

(a) Column and row totals must add to 24. "Do Not Gym" total = 24 − 12 = 12; "Do Not Run" total = 24 − 13 = 11. Since "Do Not Run ∩ Do Not Gym" = 4, the "Do Not Run ∩ Gym" cell = 11 − 4 = 7, so "Run ∩ Gym" = 12 − 7 = 5 and "Run ∩ Do Not Gym" = 13 − 5 = 8.

	Gym	Do Not Gym	Total
Run	5	8	13
Do Not Run	7	4	11
Total	12	12	24

(b) Of the 13 students who run, 5 also go to the gym:

$$P(\text{gym} \mid \text{run}) = \frac{5}{13}.$$

Q13 Hornsby Girls 2023 Trial Q26 · **3 marks**

A Venn diagram of television (T) and podcasts (P) has regions $11x$ (T only), 24 (both), $8x$ (P only) and $3x$ (neither). (a) With 244 in the survey, show $x = 10$. (b) Find $P(\text{watches television})$.

Criteria	**Marks**
(a) Sets up $11x + 24 + 8x + 3x = 244$	1
(a) Solves to $x = 10$	1
(b) $P(T) = \frac{67}{122}$	1

Solution.

(a) The four regions account for all 244 students:

$$11x + 24 + 8x + 3x = 244$$

$$22x + 24 = 244$$

$$22x = 220 \implies x = 10. \blacksquare$$

(b) The number who watch television is the whole T circle, $11x + 24 = 11(10) + 24 = 134$:

$$P(\text{watches television}) = \frac{134}{244} = \frac{67}{122}.$$

Q14 Barker 2021 Prelim Q13 · **4 marks**

In a class of 25: 18 play netball, 13 play soccer, 2 play neither. (a) Draw a Venn diagram. (b) Find (i) $P(\text{both soccer and netball})$ and (ii) $P(\text{do not play soccer})$.

Criteria	Marks
(a) Venn diagram: netball only 10, both 8, soccer only 5, neither 2	1
(a) All regions labelled correctly	1
(b)(i) $P(\text{both}) = \frac{8}{25}$	1
(b)(ii) $P(\text{not soccer}) = \frac{12}{25}$	1

Solution.

(a) Students playing at least one sport: $25 - 2 = 23$. By the addition rule, the number playing both is

$$|N \cap S| = |N| + |S| - |N \cup S| = 18 + 13 - 23 = 8.$$

So netball only $= 18 - 8 = 10$, soccer only $= 13 - 8 = 5$, both $= 8$, neither $= 2$ (check: $10 + 8 + 5 + 2 = 25$). The Venn diagram has two overlapping circles N and S: place 10 in "N only", 8 in the overlap, 5 in "S only", and 2 outside both circles.

(b)(i) $P(\text{both soccer and netball}) = \dfrac{8}{25}$.

(b)(ii) Students who do not play soccer number $25 - 13 = 12$, so

$$P(\text{do not play soccer}) = \frac{12}{25}.$$

Q15 James Ruse 2025 Trial Q15 · **3 marks**

A Venn diagram of Statistics (S) and Business (B) shows S only $= x$, both $= 0.24$, B only $= y$, neither $= 0.1$ (proportions). (a) Given the number taking Statistics is twice the number taking Business, find x and y. (b) Find $P(\text{not Statistics} \mid \text{Business})$.

Criteria	Marks
(a) Total equation $x + y + 0.24 + 0.1 = 1$	1
(a) $x = 0.52$, $y = 0.14$	1
(b) $P(\bar{S} \mid B) = \frac{7}{19}$	1

Solution.

(a) All four proportions sum to 1:

$$x + 0.24 + y + 0.1 = 1 \implies x + y = 0.66.$$

$P(S) = x + 0.24$ and $P(B) = y + 0.24$. The Statistics count is twice the Business count, so

$$x + 0.24 = 2(y + 0.24) \implies x = 2y + 0.24.$$

Substituting into $x + y = 0.66$: $3y + 0.24 = 0.66$, so $y = 0.14$ and $x = 0.52$.

(b) "Not Statistics" among Business students is the "B only" region, $y = 0.14$, and $P(B) = y + 0.24 = 0.38$:

$$P(\bar{S} \mid B) = \frac{P(\bar{S} \cap B)}{P(B)} = \frac{0.14}{0.38} = \frac{7}{19}.$$