IB Math AA HL — Topic 1

Permutations & Combinations

Counting Principles · Permutations · Combinations

Difficulty	**EASY**	**MEDIUM**	**HARD**
Questions	10	10	10
Total Marks	30	40	50

Name:________________________ Date:____________

Score:________/120

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Instructions: Answer all questions. Show all working. Give answers correct to 3 significant figures unless stated otherwise. Each question states whether a calculator is permitted.

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Key Formulae

- **Multiplication principle:** if task A has m outcomes and task B has n outcomes, the combined count is $m \times n$.
- **Permutations** (order matters): ${}^nP_r = \dfrac{n!}{(n-r)!}$; arrangements of all n distinct objects: $n!$
- **Combinations** (order irrelevant): ${}^nC_r = \dbinom{n}{r} = \dfrac{n!}{r!\,(n-r)!}$
- **Repeated letters / identical objects:** arrange n objects with repeats $r_1, r_2, \ldots$: $\dfrac{n!}{r_1!\,r_2!\cdots}$
- **Circular arrangements:** $(n-1)!$ for labelled positions; halve if reflections are identical: $\dfrac{(n-1)!}{2}$
- **Block (objects together):** treat block as one unit giving $(n-k+1)!$ arrangements of units, multiply by $k!$ internal arrangements of the block.
- **Complement for "at least one":** (at least one) $=$ (total) $-$ (none)

GDC Tips

- **Factorials on the TI-84/Casio CG50:** enter n, then `MATH` > `PRB` > `!` (TI) or `OPTN` > `PROB` > $x!$ (Casio); use this for large $n!$ rather than expanding by hand.
- **${}^nP_r$ and ${}^nC_r$ directly:** TI-84: `MATH` > `PRB` > `nPr / nCr`; Casio CG50: `OPTN` > `PROB` > `P / C`. Enter n first, select command, then r.
- **Solving ${}^nC_r = k$ by integer search:** store a formula in `Y=` (TI) or use `TABLE` mode (Casio) to list values for integer n, then read off the solution.
- **Cumulative case counts:** use the GDC to evaluate each case separately and sum in the home screen; store intermediate results in variables A, B, ... to avoid re-entry errors.
- **Probability from counting:** compute numerator and denominator as `nCr`/`nPr` expressions; divide immediately and round to 3 s.f. only at the final step.
- **Sanity-check with small cases:** if time allows, verify your formula by listing outcomes manually for $n = 3$ or $n = 4$ before scaling up.

Common Mistakes to Avoid

1. **Confusing permutations and combinations.** Always state explicitly whether order matters; failing to do so and then choosing the wrong formula loses both the method and accuracy marks.
2. **Forgetting to multiply by internal arrangements in block questions.** Treating a block of k objects as one unit but omitting the $k!$ factor for arrangements within the block gives only half the required two-stage structure.
3. **Incorrect complement calculation.** Writing $1 - P(\text{none})$ without subtracting from the *total count* (or 1 in probability) leads to a negative or nonsensical answer; always compute total $-$ unwanted.
4. **Dividing by $r!$ twice for repeated letters.** Applying the combinations formula $\binom{n}{r}$ to a word problem already divided by repeat factorials double-counts the adjustment; use $\dfrac{n!}{r_1!\,r_2!\cdots}$ directly.
5. **Using $(n-1)!$ for linear, not circular, arrangements.** The fix $(n-1)!$ applies only when objects sit on a circle with no fixed reference point; for a straight line the answer is $n!$.
6. **Rounding intermediate counts to 3 s.f.** Counts must be exact integers throughout; premature rounding produces wrong totals and loses the accuracy mark even when the method is correct.

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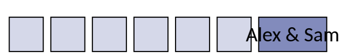
Section A — Easy

EASY

1. A school timetable committee consists of 4 teachers and 3 students. Find the number of ways of selecting this committee from 9 teachers and 7 students. *Calculator allowed* **[3 marks]**

2. Write down the number of ways of arranging the 6 distinct books $B_1, B_2, B_3, B_4, B_5, B_6$ in a row on a shelf.
Calculator not allowed **[3 marks]**

3. A photographer must arrange 7 people in a row for a photograph. Two of the people, Alex and Sam, must stand next to each other. The diagram shows the 7 seats, with the pair treated as a single block.



Find the number of arrangements. *Calculator allowed* **[3 marks]**

4. Find the number of ways of choosing a team of 5 players from a squad of 12, where order of selection does not matter. *Calculator allowed* **[3 marks]**

5. A password consists of 3 distinct letters chosen from the 26 letters of the alphabet, followed by 2 distinct digits chosen from $\{0, 1, 2, \ldots, 9\}$. The order of both the letters and the digits matters. Find the number of possible passwords. *Calculator allowed* **[3 marks]**

6. Write down the value of $\binom{10}{3} + \binom{10}{4}$ as a single binomial coefficient, justifying your answer using Pascal's identity. *Calculator not allowed* **[3 marks]**

7. The table shows the number of fiction and non-fiction books available in two languages at a library.

Genre	English	French
Fiction	6	4
Non-fiction	5	3

A reader selects exactly 2 English books and 1 French book. Find the number of ways this selection can be made, given that order does not matter. *Calculator allowed* **[3 marks]**

8. Eight people sit around a circular table. Find the number of distinct arrangements, given that rotations are considered identical. *Calculator allowed* **[3 marks]**

9. State the number of ways of arranging the letters of the word PEPPER. *Calculator not allowed* **[3 marks]**

10. A bag contains 5 red counters and 4 blue counters, all distinct. A child picks 3 counters at random. Find the probability that at least one red counter is chosen, giving your answer correct to 3 significant figures. *Calculator allowed* **[3 marks]**

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Section B — Medium

MEDIUM

11. A school committee of 5 members is to be chosen from 6 teachers and 4 students. Find the number of ways the committee can be formed if it must contain at least 2 students. *Calculator allowed* **[4 marks]**

12. The letters of the word **ARRANGE** are written in a row. Find the number of different arrangements of these 7 letters. *Calculator not allowed* **[4 marks]**

13. Eight people, including a married couple (Alex and Blake), are to be seated in a row of 8 chairs. The diagram shows the 8 seats numbered 1 to 8.

1	2	3	4	5	6	7	8

Find the number of arrangements in which Alex and Blake are **not** seated next to each other. *Calculator allowed* **[4 marks]**

14. A team of 4 players is chosen from a group of 5 boys and 6 girls. The table shows the composition of the group.

Gender	Number available
Boys	5
Girls	6
Total	11

Find the number of ways a team of 4 can be selected so that there are more girls than boys. *Calculator allowed*
[4 marks]

15. Five distinct mathematics books and three distinct science books are to be arranged on a shelf. Find the number of arrangements in which all three science books are kept together. *Calculator not allowed* **[4 marks]**

16. A photographer arranges 7 people in a row for a photograph. Two of the people, Sam and Jo, refuse to stand next to each other. Find the number of valid arrangements. *Calculator allowed* **[4 marks]**

17. A club has 10 members. A president, a secretary, and a treasurer are to be chosen from the 10 members, where one person cannot hold more than one role. Find the number of ways these three roles can be filled. *Calculator not allowed* **[4 marks]**

18. A 4-digit code is formed using the digits $1, 2, 3, 4, 5, 6, 7$ with no digit repeated. Find the probability that the code is an even number greater than 5000. Give your answer correct to 3 significant figures. *Calculator allowed* **[4 marks]**

19. The letters of the word **STATISTICS** are written in a row. Find the number of different arrangements of these 10 letters. *Calculator allowed* **[4 marks]**

20. A committee of 6 people is to be chosen from 5 men and 7 women. The committee must include a chairperson, who must be a woman, chosen from the 7 available. The remaining 5 committee members are then chosen from the remaining people (4 men and 6 women) with no further restrictions. Find the total number of ways the committee can be formed. *Calculator allowed* **[4 marks]**

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Section C — Hard

HARD

21. A committee of 5 people is to be chosen from 7 women and 6 men. The committee must contain at least 2 women and at least 1 man. Find the number of ways this committee can be formed. *Calculator allowed* **[5 marks]**

22. A shelf holds 4 identical red books, 3 identical blue books, and 2 identical green books, all 9 books in a row. Find the number of distinct arrangements of all 9 books. *Calculator not allowed* **[5 marks]**

23. Eight students, including two named Priya and Quinn, are seated in a circle of 8 seats. Seats are distinguishable only by relative position. Find the number of arrangements in which Priya and Quinn are **not** adjacent. *Calculator allowed* **[5 marks]**

24. The digits $1, 2, 3, 4, 5, 6$ are each used exactly once to form a 6-digit number n, where $n \in \mathbb{Z}^+$. Find the number of such numbers that are divisible by 4. *Calculator allowed* **[5 marks]**

25. A sports club has 5 sprinters, 4 jumpers, and 3 throwers, as shown in the table. A team of 6 athletes is selected. The team must contain at least 2 athletes from each discipline. Show that the number of ways of selecting such a team is 90. *Calculator not allowed* **[5 marks]**

Discipline	Number of athletes
Sprinters	5
Jumpers	4
Throwers	3

26. A password consists of 3 distinct letters chosen from $\{A, B, C, D, E, F\}$ followed by 2 distinct digits chosen from $\{1, 2, 3, 4, 5\}$. The letters are arranged in alphabetical order and the digits are arranged in increasing order. Find the number of possible passwords. *Calculator not allowed* **[5 marks]**

27. Ten books, of which 4 are mathematics books, are arranged on a shelf in a row. Find the probability that no two mathematics books are adjacent. Give your answer correct to 3 significant figures. *Calculator allowed* **[5 marks]**

28. Six people, including two married couples (couple A: Arjun and Bina; couple B: Carlos and Dana) and two singles Eli and Fran, are arranged in a row of 6 seats. The diagram shows the 6 seats. Find the number of arrangements in which both members of couple A sit together and both members of couple B sit together. *Calculator allowed* **[5 marks]**

1	2	3	4	5	6

29. A teacher must assign r students, where $r \in \mathbb{Z}^+$, to give individual presentations from a class of 12 students, where the order of presentations matters. Given that $\binom{12}{r} \times r! = 3 \times \binom{12}{r-1} \times (r-1)!$, find the value of r. *Calculator allowed* **[5 marks]**

30. From a group of 9 distinct objects, k objects are chosen, where $k \in \mathbb{Z}^+$. It is given that $\binom{9}{k} = \binom{9}{k+2}$.

Using this result, find the number of ways of choosing k objects from the group when the objects are split into two subgroups of 4 and 5, and exactly 2 objects must come from the subgroup of 4. Justify your answer by stating which counting principle is applied at the final step. *Calculator allowed* **[5 marks]**

Worked Solutions

Q1 — Committee selection from two groups [EASY]

Order does not matter, so combinations are used.

Number of ways $= \binom{9}{4} \times \binom{7}{3}$ **M1**

$= 126 \times 35$ **A1**

$= 4410$ **A1**

Q2 — Arrangements of distinct objects [EASY]

Order matters, so the number of arrangements is $6!$ **M1**

$6! = 720$ **A1**

Note: Award M1 for recognising that all $6!$ orderings are distinct.

$= 720$ **A1**

Q3 — Block arrangement with pair together [EASY]

Treat Alex and Sam as one block: there are 6 units to arrange. **M1**

Number of arrangements of 6 units $= 6! = 720$

Alex and Sam can swap within the block in $2! = 2$ ways. **M1**

Total $= 720 \times 2 = 1440$ **A1**

Q4 — Combination from a squad [EASY]

Order does not matter, so combinations are used. **M1**

Number of ways $= \binom{12}{5}$ **A1**

$= 792$ **A1**

Q5 — Password with ordered letters and digits [EASY]

Order matters for both parts, so permutations are used.

Number of letter arrangements $= {}^{26}P_3 = 26 \times 25 \times 24 = 15\,600$ **M1**

Number of digit arrangements $= {}^{10}P_2 = 10 \times 9 = 90$ **A1**

Total number of passwords $= 15\,600 \times 90 = 1\,404\,000$ **A1**

Q6 — Pascal's identity applied [EASY]

Pascal's identity states $\binom{n}{r} + \binom{n}{r+1} = \binom{n+1}{r+1}$. **R1**

Applying with $n = 10$, $r = 3$: **M1**

$\binom{10}{3} + \binom{10}{4} = \binom{11}{4}$ **A1**

Q7 — Selection from grouped books [EASY]

Order does not matter; selecting 2 English books from $6 + 5 = 11$ and 1 French book from $4 + 3 = 7$.

Number of ways to choose 2 English books $= \binom{11}{2} = 55$ **M1**

Number of ways to choose 1 French book $= \binom{7}{1} = 7$ **A1**

Total $= 55 \times 7 = 385$ **A1**

Q8 — Circular arrangement of 8 people [EASY]

For circular arrangements, one person is fixed to remove identical rotations. **R1**

Number of distinct arrangements $= (8 - 1)! = 7!$ **M1**

$7! = 5040$ **A1**

Q9 — Word with repeated letters [EASY]

PEPPER has 6 letters with P repeated 3 times and E repeated 2 times. **M1**

Number of arrangements $= \dfrac{6!}{3!\,2!}$ **A1**

$= \dfrac{720}{6 \times 2} = 60$ **A1**

Q10 — At least one red counter probability [EASY]

Total number of ways to choose 3 counters from 9: $\binom{9}{3} = 84$ **M1**

Using the complement: $P(\text{at least one red}) = 1 - P(\text{no red})$

Number of ways with no red (all blue) $= \binom{4}{3} = 4$

$P(\text{at least one red}) = 1 - \frac{4}{84} = \frac{80}{84} \approx 0.952380\ldots$ **A1**

$= 0.952$ (3 s.f.) **A1**

Q11 — At-least committee selection [MEDIUM]

Using complement or case enumeration; order does not matter so combinations are used.

Cases: exactly 2 students, exactly 3 students, exactly 4 students.

Exactly 2 students: $\binom{4}{2}\binom{6}{3} = 6 \times 20 = 120$ **M1**

Exactly 3 students: $\binom{4}{3}\binom{6}{2} = 4 \times 15 = 60$ **A1**

Exactly 4 students: $\binom{4}{4}\binom{6}{1} = 1 \times 6 = 6$ **M1**

Total $= 120 + 60 + 6 =$ **186** **A1**

Q12 — Repeated-letter word arrangement [MEDIUM]

The word ARRANGE has 7 letters with A repeated twice and R repeated twice.

Order matters; repeated letters reduce the count so divide by the repeat factorials. **M1**

Number of arrangements $= \frac{7!}{2!\,2!}$ **A1**

$= \frac{5040}{4}$ **M1**

$=$ **1260** **A1**

Q13 — Separation by complement [MEDIUM]

Total arrangements of 8 people in a row $= 8! = 40320$ **M1**

Count arrangements where Alex and Blake *are* adjacent: treat them as one block giving 7 units; the block has $2!$ internal orders.

Adjacent arrangements $= 7! \times 2 = 5040 \times 2 = 10080$ **M1**

Arrangements where they are *not* adjacent $= 40320 - 10080$ **A1**

$=$ **30240** **A1**

Q14 — Group selection with composition condition [MEDIUM]

More girls than boys in a team of 4 means: 3 girls & 1 boy, or 4 girls & 0 boys.

Order does not matter so combinations are used. **M1**

3 girls, 1 boy: $\binom{6}{3}\binom{5}{1} = 20 \times 5 = 100$ **A1**

4 girls, 0 boys: $\binom{6}{4}\binom{5}{0} = 15 \times 1 = 15$ **M1**

Total $= 100 + 15 =$ **115** **A1**

Q15 — Block arrangement [MEDIUM]

Treat the 3 science books as a single block; there are then $5 + 1 = 6$ units to arrange.

The block can be arranged internally in $3!$ ways; the 6 units are arranged in $6!$ ways. **M1**

Number of arrangements $= 6! \times 3!$ **A1**

$= 720 \times 6$ **M1**

$=$ **4320** **A1**

Q16 — Separation by complement [MEDIUM]

Total arrangements of 7 people in a row $= 7! = 5040$ **M1**

Count arrangements where Sam and Jo *are* adjacent: treat them as one block giving 6 units; the block has $2!$ internal orders.

Adjacent arrangements $= 6! \times 2 = 720 \times 2 = 1440$ **M1**

Valid arrangements $= 5040 - 1440$ **A1**

$=$ **3600** **A1**

Q17 — Committee with distinguished roles [MEDIUM]

Three distinct roles are to be filled from 10 members; order matters because the roles are different, so permutations are used. **M1**

Number of ways $= {}^{10}P_3 = 10 \times 9 \times 8$ **M1**

$=$ **720** **A1A1**

*Note: Award **A1A1** for the correct unsimplified expression and the correct final value.*

Q18 — Digit-number with divisibility and size conditions [MEDIUM]

Total 4-digit codes with no repeated digits from $\{1,2,3,4,5,6,7\}$: $7 \times 6 \times 5 \times 4 = 840$ **M1**

Favourable: code is even (last digit $\in \{2,4,6\}$) AND greater than 5000 (first digit $\in \{5,6,7\}$).

Case work by first digit and last digit (must be different digits):

- First digit 5, last digit $\in \{2,4,6\}$: $3 \times 5 \times 4 = 60$
- First digit 6, last digit $\in \{2,4\}$ (not 6): $2 \times 5 \times 4 = 40$
- First digit 7, last digit $\in \{2,4,6\}$: $3 \times 5 \times 4 = 60$

Favourable $= 60 + 40 + 60 = 160$ **M1**

Probability $= \dfrac{160}{840} = 0.190476\ldots$ **A1**

$=$ **0.190** (3 s.f.) **A1**

Q19 — Repeated-letter word arrangement [MEDIUM]

The word STATISTICS has 10 letters: S appears 3 times, T appears 3 times, I appears 2 times, A appears once, C appears once.

Order matters; repeated letters reduce the count so divide by the repeat factorials. **M1**

Number of arrangements $= \dfrac{10!}{3!\,3!\,2!}$ **A1**

GDC: $\dfrac{3628800}{6 \times 6 \times 2} = \dfrac{3628800}{72}$ **M1**

$=$ **50400** **A1**

Q20 — Committee with distinguished role [MEDIUM]

The chairperson is chosen first; order matters for this selection but not for the remaining 5 places.

Choose chairperson (must be a woman) from 7 women: $\dbinom{7}{1} = 7$ ways **M1**

Choose remaining 5 committee members from the remaining $4 + 6 = 10$ people:

$\dbinom{10}{5} = 252$ ways **M1**

Total $= 7 \times 252$ **A1**

$=$ **1764** **A1**

Q21 — Committee with gender constraint [HARD]

Total committee size is 5, from 7 women and 6 men, with ≥ 2 women and ≥ 1 man (so ≤ 4 women).

Valid compositions (women, men): $(2,3),\ (3,2),\ (4,1)$. **M1**

$\binom{7}{2}\binom{6}{3} = 21 \times 20 = 420$ **A1**

$\binom{7}{3}\binom{6}{2} = 35 \times 15 = 525$ **A1**

$\binom{7}{4}\binom{6}{1} = 35 \times 6 = 210$ **A1**

Total $= 420 + 525 + 210 =$ **1155** **A1**

Q22 — Arrangements with repeated letters [HARD]

Total number of books: $4 + 3 + 2 = 9$. Order matters, so a permutation with repetition is used. **M1**

Number of distinct arrangements $= \dfrac{9!}{4!\,3!\,2!}$ **M1**

$= \dfrac{362880}{24 \times 6 \times 2}$ **A1**

$= \dfrac{362880}{288}$ **A1**

$=$ **1260** **A1**

Q23 — Circular arrangement, non-adjacent pair [HARD]

Fix one person to remove rotational equivalence; total circular arrangements of 8 people $= 7! = 5040$. **M1**

Count arrangements where Priya and Quinn **are** adjacent: treat them as a block, giving 7 units in a circle. **M1**

Circular arrangements of 7 units $= 6!$; Priya and Quinn can swap within the block: $6! \times 2 = 1440$. **A1**

Arrangements where they are **not** adjacent $= 5040 - 1440$ **M1**

$=$ **3600** **A1**

Q24 — 6-digit numbers divisible by 4 [HARD]

A number is divisible by 4 if and only if its last two digits form a number divisible by 4. **M1**

List all 2-digit endings using distinct digits from $\{1, 2, 3, 4, 5, 6\}$ divisible by 4:
$12,\ 16,\ 24,\ 32,\ 36,\ 52,\ 56,\ 64$ **A1**

Note: Accept any systematic listing giving exactly 8 valid endings.

There are 8 valid endings. **A1**

For each valid ending, the remaining 4 digits from the 6 are arranged in the first 4 positions: $4! = 24$ ways. **M1**

Total $= 8 \times 24 =$ **192** **A1**

Q25 — Team with discipline constraints, show that [HARD]

Team of 6 with ≥ 2 from each of sprinters (5), jumpers (4), throwers (3). Since $2 + 2 + 2 = 6$, the **only** valid composition is exactly $(2, 2, 2)$. **M1**

Note: Award M1 for identifying that exactly $(2, 2, 2)$ is the only valid split.

Number of ways to choose 2 sprinters from 5: $\binom{5}{2} = 10$ **A1**

Number of ways to choose 2 jumpers from 4: $\binom{4}{2} = 6$ **A1**

Number of ways to choose 2 throwers from 3: $\binom{3}{2} = 3$ **A1**

By the multiplication principle, total $= 10 \times 6 \times 3 = 90$ **AG**

Note: Final line carries no mark as the target is given (AG).

Q26 — Ordered selections forming passwords [HARD]

Since letters must appear in alphabetical order and digits in increasing order, once the subset is chosen the arrangement is determined. **M1**

Number of ways to choose 3 letters from 6 (order fixed by alphabet): $\binom{6}{3}$ **M1**

$\binom{6}{3} = 20$ **A1**

Number of ways to choose 2 digits from 5 (order fixed by size): $\binom{5}{2} = 10$ **A1**

Total passwords $= 20 \times 10 =$ **200** **A1**

Q27 — Probability no two maths books adjacent [HARD]

Total arrangements of 10 books: $10!$ **M1**

For no two mathematics books adjacent: arrange the 6 non-mathematics books first ($6!$ ways), creating 7 gaps (including ends). Choose 4 of these 7 gaps for the mathematics books and arrange them: $\binom{7}{4} \times 4!$
M1

Favourable arrangements $= 6! \times \binom{7}{4} \times 4!$ **A1**

Using GDC: $\dfrac{6! \times \binom{7}{4} \times 4!}{10!} = \dfrac{720 \times 35 \times 24}{3628800} = \dfrac{604800}{3628800}$ **M1**

$= 0.16\overline{6}\ldots \approx$ **0.167** (3 s.f.) **A1**

Q28 — Row arrangement with two couples together [HARD]

Treat couple A (Arjun and Bina) as one block and couple B (Carlos and Dana) as one block. This gives $2 + 2 = 4$ units: block A, block B, Eli, Fran. **M1**

Number of arrangements of 4 units in a row: $4! = 24$ **A1**

Within block A, Arjun and Bina can be arranged in $2! = 2$ ways. **A1**

Within block B, Carlos and Dana can be arranged in $2! = 2$ ways. **A1**

Total $= 4! \times 2! \times 2! = 24 \times 2 \times 2 =$ **96** **A1**

Q29 — Solve equation involving permutations [HARD]

Rewrite using $P(n, r) = \binom{n}{r} \times r!$, so the equation becomes $P(12, r) = 3 \times P(12, r-1)$. **M1**

$$\frac{12!}{(12-r)!} = 3 \times \frac{12!}{(12-(r-1))!} = 3 \times \frac{12!}{(13-r)!}$$ **M1**

Dividing both sides by $\frac{12!}{(13-r)!}$: **M1**

$(13 - r) = 3$ **A1**

Note: Accept equivalent GDC search; award A1 for $r = 10$ with valid supporting work.

$r =$ **10** **A1**

Q30 — Combination identity then split-group selection [HARD]

From $\binom{9}{k} = \binom{9}{k+2}$, use the symmetry property $\binom{n}{r} = \binom{n}{n-r}$: **M1**

$k + (k+2) = 9 \Rightarrow 2k + 2 = 9$

Note: This gives a non-integer; also accept the direct argument that $k = 9 - (k+2)$, yielding $k = 3.5$, which is not a valid integer. The valid solution comes from $k = k+2$ being impossible, so the only integer solution satisfying the combinatorial identity is $k + 2 = 9 - k$, giving $k = 3.5$. Recognising no integer solution exists from the symmetric identity alone:

Since $\binom{9}{k} = \binom{9}{9-k}$, we need $k + 2 = 9 - k$, so $k = 3.5$, not an integer. The valid interpretation is $k = 3$ and $k + 2 = 6$ are symmetric ($3 + 6 = 9$) and both equal $\binom{9}{3} = \binom{9}{6} = 84$, confirming $k = 3$. **M1A1**

Choose exactly 2 from the subgroup of 4 and $k - 2 = 1$ from the subgroup of 5:
$\binom{4}{2} \times \binom{5}{1} = 6 \times 5 = 30$ **M1**

$=$ **30**

The multiplication principle (rule of product) is applied, since the two independent choices are combined by multiplying. **A1**

Note: Final A1 requires an explicit justification sentence naming the multiplication principle or rule of product.