Cambridge IGCSE · Mathematics 0580 · Notes

Combined events and conditional probability

Read online at **pastopic.com/cambridge/mathematics-0580/notes/combined-and-conditional-probability**

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Read first: **Probability and expected frequency**, **Types of number and sets**, **Fractions, decimals, ordering and the four operations**

What you need to know

By the end of this topic you should be able to:

1. **Work out the probability of two (or more) events happening together**, such as two dice rolls, two picks from a bag or two days in a row, using whichever of these fits the question:
   - a **sample space diagram** (a table or list of every equally likely outcome);
   - a **Venn diagram** (**Core:** two sets; **Extended:** may have more);
   - a **tree diagram**, with the outcomes at the ends of the branches and the probabilities written beside them.
2. **Core:** every combined event is **with replacement** (the first pick goes back, so nothing changes for the second pick). **Extended only:** combined events can also be **without replacement**, where the first pick changes the probabilities for the second.
3. **Extended only:** understand the notation $P(A \cap B)$ (the probability of A **and** B) and $P(A \cup B)$ (the probability of A **or** B or both) when it is used with a Venn diagram.
4. **Extended only:** work out a **conditional probability**, the probability of an event when you already know that something else has happened ("given that...", "a person picked from those who..."), from a Venn diagram, a tree diagram or a table. You don't need the notation $P(A \mid B)$ or any formula for it.

Single events, "not" probabilities and expected frequency are in the note on probability and expected frequency.

Understand it

"And" means multiply

Two events are **independent** when one happening makes no difference to the chance of the other. Rolling a dice twice, spinning two spinners, or taking a counter, putting it back and taking another are all independent.

For independent events, the probability that **both** happen is found by **multiplying**:

$$P(A \text{ and } B) = P(A) \times P(B).$$

The probability of rolling a 6 and then another 6 on a fair dice is $\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$. Multiplying makes sense: a 6 comes up on $\frac{1}{6}$ of first rolls, and on $\frac{1}{6}$ of **those** the second roll is also a 6.

The same rule works for three or more events: the chance of three 6s in a row is $\frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} = \frac{1}{216}$.

"Or" means add

If an event can happen in **different ways** that can't both happen, **add** the probabilities of the ways. Getting exactly one 6 in two rolls happens as "6 then not 6" **or** "not 6 then 6":

$$\frac{1}{6} \times \frac{5}{6} + \frac{5}{6} \times \frac{1}{6} = \frac{5}{36} + \frac{5}{36} = \frac{10}{36}.$$

So: **multiply along** each way it can happen, then **add** the ways.

Sample space diagrams

When two things each have a few equally likely outcomes, list **every** combination in a table. Spinner A is numbered 1, 2, 3, 4 and spinner B is numbered 1, 4, 6. Both are fair and the scores are added:

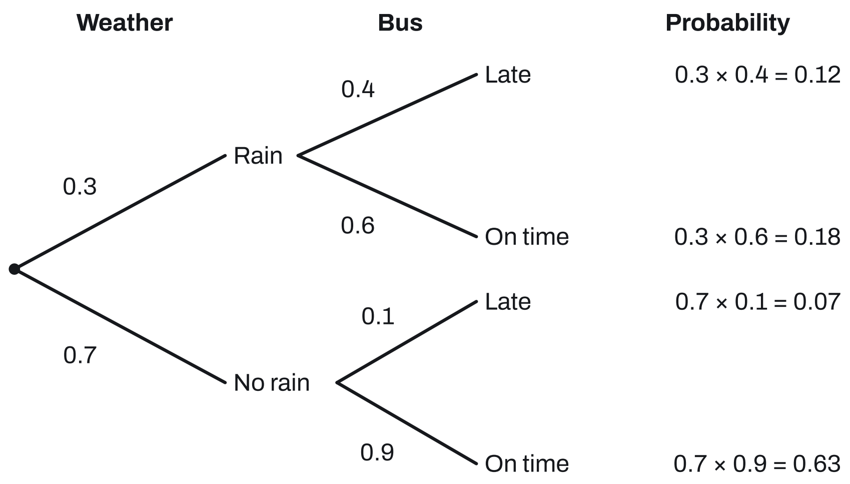
+	1	2	3	4
1	2	3	4	5
4	5	6	7	8
6	7	8	9	10

There are $4 \times 3 = 12$ equally likely outcomes, so each cell has probability $\frac{1}{12}$. A total of 7 happens in 2 cells, so $P(\text{total } 7) = \frac{2}{12} = \frac{1}{6}$. A total of 8 or more happens in 4 cells: $\frac{4}{12} = \frac{1}{3}$.

Tree diagrams

A tree diagram shows the events one stage at a time. Each set of branches from one point covers everything that can happen next, so **the probabilities on each set of branches add up to 1**. To find the probability of a path, **multiply along the branches**. The ends of all the paths together add up to 1.

The chance of rain on a morning is 0.3. When it rains, the bus is late with probability 0.4; when it doesn't, it is late with probability 0.1. The second-stage probabilities depend on which first branch you are on.



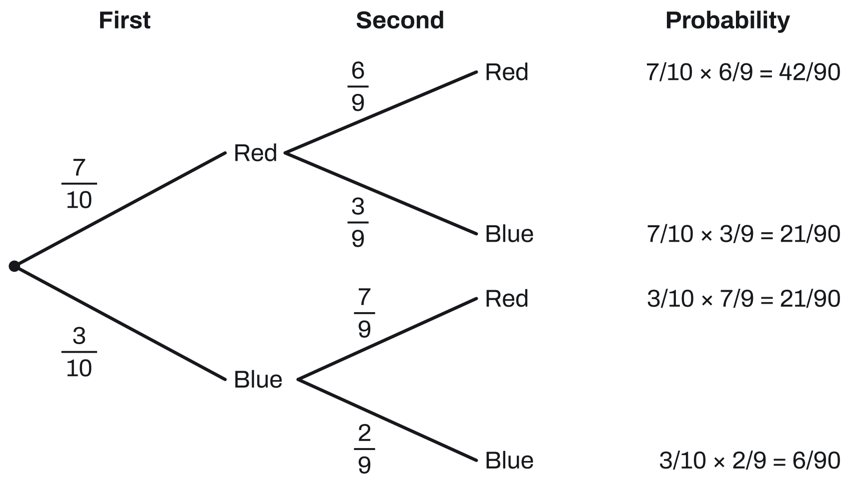
The bus is late in two ways, "rain and late" or "no rain and late":

$$P(\text{late}) = 0.3 \times 0.4 + 0.7 \times 0.1 = 0.12 + 0.07 = 0.19.$$

A question doesn't always print the tree. If it gives you a chance for a first event and then chances that depend on it ("when it is sunny... when it is not sunny..."), sketch the tree yourself.

Without replacement (Extended only)

Extended only: if the first item is **not** put back, the bag changes. A bag holds 7 red and 3 blue counters, and two are taken without replacement. After a red counter, the bag has 6 red and 3 blue, so the second counter is red with probability $\frac{6}{9}$. After a blue one, it has 7 red and 2 blue.



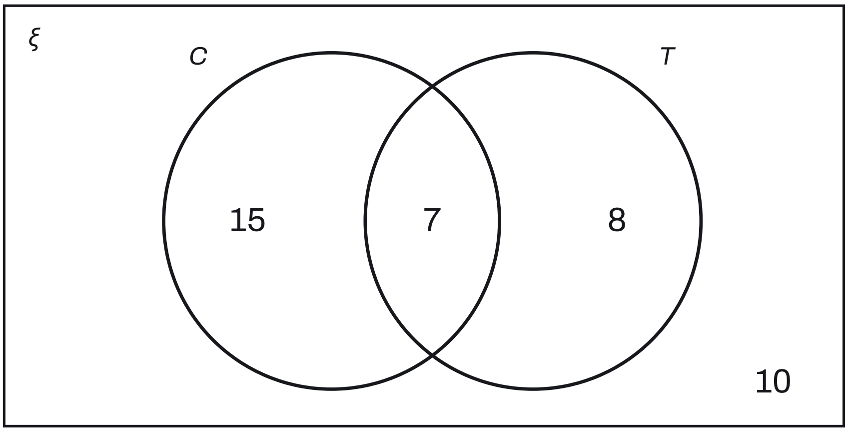
On every second-stage branch **the total goes down by one** (10 becomes 9), and so does the count of the colour that was taken first. From the tree:

- both red: $\frac{7}{10} \times \frac{6}{9} = \frac{42}{90}$;
- one of each colour: $\frac{7}{10} \times \frac{3}{9} + \frac{3}{10} \times \frac{7}{9} = \frac{21}{90} + \frac{21}{90} = \frac{42}{90}$;
- the same colour: $\frac{42}{90} + \frac{6}{90} = \frac{48}{90}$, which is also $1 - \frac{42}{90}$.

With **three** picks, keep going: 3 counters red, red, blue has probability $\frac{7}{10} \times \frac{6}{9} \times \frac{3}{8}$, and the denominators go $10, 9, 8$.

Venn diagrams

A Venn diagram sorts a group into regions. In this one, 40 people were asked whether they drink coffee (C) and tea (T).



Each region is a separate group, so a person picked at random is in exactly one region. Add the regions you want and divide by 40, the total of **all four** numbers:

- drinks coffee: $\frac{15+7}{40} = \frac{22}{40}$;
- drinks tea but not coffee: $\frac{8}{40}$;
- drinks neither: $\frac{10}{40}$.

To **fill in** a Venn diagram from totals, start with the overlap. If $n(C) = 22$, $n(T) = 15$ and 10 drink neither, then $40 - 10 = 30$ people are inside the circles, but $22 + 15 = 37$, so the overlap was counted twice: it holds $37 - 30 = 7$. Then coffee only is $22 - 7 = 15$ and tea only is $15 - 7 = 8$.

Extended only: $P(C \cap T)$ means coffee **and** tea (the overlap), $\frac{7}{40}$. $P(C \cup T)$ means coffee **or** tea **or** both (everything inside the circles), $\frac{15+7+8}{40} = \frac{30}{40}$. A dash means "not": $P(C')$ is everything outside C, $\frac{8+10}{40} = \frac{18}{40}$, and $P(C \cup T')$ is everything in C or outside T: $\frac{15+7+10}{40} = \frac{32}{40}$.

Conditional probability (Extended only)

Extended only: sometimes you are told something has already happened, and it **shrinks the group** you are picking from. The probability is then

$$\frac{\text{number (or probability) of outcomes in the smaller group where the event happens}}{\text{number (or probability) of outcomes in the smaller group}}.$$

- **Venn diagram.** A tea drinker is picked at random. The probability that they also drink coffee is $\frac{7}{15}$: there are $7 + 8 = 15$ tea drinkers, and 7 of them drink coffee. The denominator is **15, not 40**.

- **Table.** Given that the spinners' total above is odd, the probability that spinner B shows 4: the odd totals are $3, 5, 5, 7, 7, 9$ (6 cells), and 2 of them (5 and 7 in the "4" row) have $B = 4$, so the answer is $\frac{2}{6} = \frac{1}{3}$.
- **Tree.** Given that the bus was late, the probability it rained is the "rain and late" path divided by all the "late" paths: $\frac{0.12}{0.19} = \frac{12}{19}$.
- **Two picks from a group.** "Two tea drinkers are picked at random. Find the probability that both drink coffee." Only the 15 tea drinkers are in the bag, and the second pick is without replacement: $\frac{7}{15} \times \frac{6}{14} = \frac{42}{210} = \frac{1}{5}$.

Key facts and formulas

None of these is on the List of formulas printed in the exam paper, so you must know them all.

Formula	Status
Independent events: $P(A \text{ and } B) = P(A) \times P(B)$	Learn it
Different ways that can't happen together: add their probabilities	Learn it
Probabilities on each set of branches add up to 1; so do the probabilities at the ends of all the paths	Learn it
Probability of a path on a tree = the probabilities along it multiplied	Learn it
Sample space: $\text{probability} = \dfrac{\text{number of cells where the event happens}}{\text{total number of cells}}$	Learn it
Extended only: without replacement, each later pick has the total reduced by 1 (and the colour taken reduced by 1)	Learn it
Extended only: $P(A \cap B)$ = both; $P(A \cup B)$ = either or both; $P(A') = 1 - P(A)$	Learn it
Extended only: conditional probability $= \dfrac{\text{outcomes in the known group where the event happens}}{\text{outcomes in the known group}}$	Learn it
At least one $= 1 - P(\text{none})$	Learn it
First success on attempt n: $P(\text{fail})^{n-1} \times P(\text{success})$	Learn it

How to do it

In the questions we have tagged for this topic (43 questions from Papers 1–4, 2021–2025), the types came up this often. 18 of the 43 questions mix two or more types, so the counts add up to more than 43.

Question type	Questions
Picking two or three items without replacement	23
Tree diagrams	13
Conditional probability	12
Venn diagrams	7
Independent events and repeated trials	5
Working backwards to a probability or a number of trials	5
Sample space diagrams	4

1. Picking two or three items without replacement (23 questions)

Extended only (Core questions are always with replacement).

1. **Write the counts and the total**, for example 3 green, 4 red, 7 blue: 14 beads.
2. **Write each way the event can happen** as an ordered list: "different colours" is GR, GB, RG, RB, BG, BR.
3. **Multiply along each way**, taking one off the total (and off the colour just taken) at each pick: GR is $\frac{3}{14} \times \frac{4}{13}$.
4. **Add the ways.** If there are many, use $1 - P(\text{the opposite})$ instead: different colours $= 1 - P(\text{GG} + \text{RR} + \text{BB})$.

Variations you will meet:

- **"One of each" or "one is A and one is not A"**: there are **two orders**, so double the product: $2 \times \frac{4}{11} \times \frac{7}{10}$ for one green and one not green from 4 green out of 11.
- **"Both the same colour" or "different colours"**: list every colour; the two answers add to 1.
- **"The first is black and the second is white"**: the order is fixed, so there is only one product.
- **Three items**: "2 blue and 1 red" from 4 blue and 6 red can come in 3 orders (BBR, BRB, RBB). Each order has the same product, so multiply one of them by 3: $3 \times \frac{4}{10} \times \frac{3}{9} \times \frac{6}{8}$.
- **"At least two"** of three: add "exactly two" (3 orders) and "all three".
- **From a table of data** (heights, times, masses, a stem-and-leaf diagram): read the counts from the table first, then pick without replacement from the total number of people or items.
- **Cards with numbers** (a product or a sum as the score): list the pairs of cards that give the score, remembering both orders; with n cards the denominators are n then $n - 1$.
- **Impossible events**: asking for two items of a colour when the bag holds only one of that colour gives probability 0.
- **An item moved from one bag to another**: bag A changes the contents of bag B. Use a two-stage tree: for each colour moved, write the new bag B (one more of that colour, total one bigger), then multiply and add.

2. Tree diagrams (13 questions)

1. **Fill in the first set of branches.** The second branch is $1-$ the first (0.35 gives 0.65; $\frac{2}{9}$ gives $\frac{7}{9}$). A ratio of $2:5$ gives $\frac{2}{7}$ and $\frac{5}{7}$.
2. **Fill in the second set.** With replacement or independent events, it repeats the first. Without replacement, change the fractions. If the chances depend on the first event ("when it is sunny..."), write each one on its own branch.
3. **Multiply along** the path (or paths) you need.
4. **Add** the paths if there is more than one.

Variations you will meet:

- **"Neither event happens"**: one path. If the chances of stopping at two sets of lights are 0.25 and 0.55, not stopping at either is $0.75 \times 0.45 = 0.3375$.
- **"Late on the first day but not the second"**: one path in that order.
- **"One is yellow", "exactly one"**: two paths, add them.
- **"The event happens on any day"** when the first branches have their own chances (like the bus above): add every path that ends in that event.
- **An expected number afterwards**: probability $\times$ number of trials (see probability and expected frequency).

3. Conditional probability (12 questions)

Extended only.

1. **Find the known group** from the words "given that...", "from those who...", "a person who has a car is chosen".
2. **Count (or add the probabilities of) the whole known group.** This is your denominator.
3. **Count the part of that group where the event also happens.** This is your numerator.
4. For **two picks from the group**, pick without replacement from the group's total: $\frac{a}{n} \times \frac{a-1}{n-1}$.

Variations you will meet:

- **Venn diagram**: "a person with a car is picked; find the probability they have a job" is $\frac{\text{overlap}}{\text{whole car circle}}$.
- **Sample space table, "given that the total is odd"**: count the odd cells (the new total), then count how many of those have the feature asked about. "One of the numbers is 8" means one of the **picked** numbers, not the total.
- **Tree diagram**: "given that he was late, find the probability it rained" is $\frac{\text{the path you want}}{\text{sum of all the paths that were late}}$.
- **Grouped data**: "two people are chosen from those taller than 1.6 m": add the frequencies above 1.6 m for the new total.

4. Venn diagrams (7 questions)

1. **Complete the diagram**, overlap first. Overlap $= n(A) + n(B) - (\text{total} - \text{neither})$.
2. **Fill the other regions**: A only $= n(A) - \text{overlap}$, B only $= n(B) - \text{overlap}$, neither outside the circles. Check that all four add up to the total.
3. **Add the regions asked for** and divide by the total (or by the known group, for a conditional question).

Variations you will meet:

- **Notation (Extended only)**: $A \cap B$ is the overlap; $A \cup B$ is everything inside the circles; A' is everything outside A; $A \cup B'$ is A plus the part outside both circles.
- **"Does not study geography and does not study history"**: the number outside both circles.
- **Two people picked from the whole diagram**, such as "one studies both and one studies only chemistry": two orders, without replacement.
- **Extended only: a Venn diagram with three sets** works the same way: add the numbers in the regions you need, and divide by the total (or by the known group).

5. Independent events and repeated trials (5 questions)

1. **Find each single probability** (a number greater than 5 on a fair 8-sided dice is $\frac{3}{8}$).
2. **Multiply** for "and": both times $\frac{3}{8} \times \frac{3}{8} = \frac{9}{64}$.
3. For "exactly one", "one or the other but not both", or "the same", **add** the separate ways.

Variations you will meet:

- **"Passes" meaning passes both parts**: with chances 0.85 and 0.7, that is $0.85 \times 0.7 = 0.595$. "Passes one part but not both" is $0.85 \times 0.3 + 0.15 \times 0.7 = 0.36$.
- **"With replacement, the same colour"**: add the "both red" and "both blue" products.
- **A spinner with repeated numbers** (2, 2, 5, 7, 7): count every section, so P(7) $= \frac{2}{5}$.

6. Working backwards to a probability or a number of trials (5 questions)

1. **Write the product** with a letter for the unknown: $P(\text{red from } A) \times p = P(\text{both red})$.
2. **Solve**: if P(red from A) $= \frac{3}{4}$ and P(both red) $= \frac{3}{10}$, then $\frac{3}{4} \times p = \frac{3}{10}$ gives $p = \frac{3}{10} \div \frac{3}{4} = \frac{2}{5}$. Then use it: "not red from both" is $\left(1 - \frac{3}{4}\right)\left(1 - \frac{2}{5}\right) = \frac{3}{20}$.
3. **The first success on attempt** n: it takes $n-1$ failures and then a success, so the probability is $(\text{fail})^{n-1} \times \text{success}$. Match the power in the given denominator: with $P(\text{hit}) = \frac{1}{4}$, the probability $\frac{27}{256} = \left(\frac{3}{4}\right)^3 \times \frac{1}{4}$, so $n - 1 = 3$ and $n = 4$.
4. **Without replacement**, the first green on pick n: multiply "not green" fractions (total going down by 1 each time) until the product with the green fraction matches the given value.

7. Sample space diagrams (4 questions)

1. **Complete the table**: each cell combines its row and column (add, multiply, or write the pair).
2. The number of equally likely outcomes is (number of rows) $\times$ (number of columns).
3. **Count the cells** that match and divide by that total, or by the known group for a "given that" question.

If no table is printed, draw one yourself: it is the easiest way not to miss an outcome.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
- **A1** accuracy mark: for a correct answer; it needs the M mark before it.
- **B1** mark for a correct result on its own, with no method needed.

Example 1

A bag contains 4 red counters and 7 blue counters. Omar takes a counter at random, notes its colour and puts it back. He then takes a second counter at random.

(a) Draw a tree diagram to show this information. **[2]**

(b) Find the probability that both counters are blue. **[2]**

(c) Find the probability that the counters are different colours. **[3]**

(a) First counter: red $\frac{4}{11}$, blue $\frac{7}{11}$. The counter is put back, so the second set of branches is the same: red $\frac{4}{11}$, blue $\frac{7}{11}$ after each first counter. **B1** for the first set, **B1** for both second sets.

(b) $\frac{7}{11} \times \frac{7}{11} = \frac{49}{121}$. **M1** for multiplying along the path, **A1**.

(c) Red then blue, or blue then red: **M1** for one product, **M1** for adding both

$$\frac{4}{11} \times \frac{7}{11} + \frac{7}{11} \times \frac{4}{11} = \frac{28}{121} + \frac{28}{121} = \frac{56}{121}.$$

A1

Example 2

Spinner A is numbered 1, 2, 3 and 4. Spinner B is numbered 1, 4 and 6. Both spinners are fair. Lina spins both and adds the two numbers.

(a) Complete a sample space diagram to show all the possible totals. **[2]**

(b) Find the probability that the total is 8 or more. **[1]**

(c) **Extended only:** Given that the total is odd, find the probability that spinner B lands on 4. **[2]**

(a) The table in "Understand it" (Sample space diagrams). **B2** for all 12 totals correct (**B1** for at least 8 correct).

(b) Totals 8, 8, 9 and 10: $\frac{4}{12} = \frac{1}{3}$. **B1**

(c) The odd totals are 3, 5, 5, 7, 7 and 9, so 6 cells. **B1** for seeing the denominator 6. Of these, 5 $(1+4)$ and 7 ($3+4$) have $B = 4$: $\frac{2}{6} = \frac{1}{3}$. **B1**

Example 3 (Extended)

There are 30 students in a class. 18 play football (F), 12 play tennis (T) and 6 play neither.

(a) Complete a Venn diagram to show this information. **[2]**

(b) A student is picked at random. Find $P(F \cap T')$. **[1]**

(c) A student who plays tennis is picked at random. Find the probability that this student also plays football. **[1]**

(d) Two of the students who play football are picked at random. Find the probability that both of them also play tennis. **[2]**

(a) Inside the circles: $30 - 6 = 24$. Overlap $= 18 + 12 - 24 = 6$. **M1**. F only $= 18 - 6 = 12$, T only $= 12 - 6 = 6$, neither $= 6$. **A1** (check: $12 + 6 + 6 + 6 = 30$).

(b) $F \cap T'$ is football but not tennis: $\frac{12}{30} = \frac{2}{5}$. **B1**

(c) There are $6 + 6 = 12$ tennis players, and 6 of them play football: $\frac{6}{12} = \frac{1}{2}$. **B1**

(d) Only the 18 footballers are picked from, and 6 of them play tennis. Without replacement: **M1**

$$\frac{6}{18} \times \frac{5}{17} = \frac{30}{306} = \frac{5}{51}.$$

A1

Example 4 (Extended)

A box contains 3 red pens, 4 green pens and 5 yellow pens. Two pens are taken at random without replacement.

(a) Show that the probability that both pens are the same colour is $\frac{19}{66}$. **[3]**

(b) Find the probability that the pens are different colours. **[1]**

(c) The two pens are put back. Three pens are now taken at random without replacement. Find the probability that exactly two of them are yellow. **[3]**

(a) Both red, both green or both yellow. **M1** for one correct product, **M1** for adding all three:

$$\frac{3}{12} \times \frac{2}{11} + \frac{4}{12} \times \frac{3}{11} + \frac{5}{12} \times \frac{4}{11} = \frac{6 + 12 + 20}{132} = \frac{38}{132} = \frac{19}{66}.$$

A1, the given answer reached with the working shown.

(b) $1 - \frac{19}{66} = \frac{47}{66}$. **B1**

(c) Yellow, yellow, not yellow: $\frac{5}{12} \times \frac{4}{11} \times \frac{7}{10} = \frac{140}{1320}$. **M1**. This can happen in 3 orders (YYN, YNY, NYY). **M1** for $\times 3$:

$$3 \times \frac{140}{1320} = \frac{420}{1320} = \frac{7}{22}.$$

A1

Common mistakes

- **Adding when you should multiply.** "Both" or "and" along a path means multiply. Adding $\frac{3}{8} + \frac{3}{8}$ for "both blue" gives the wrong answer, and a sum bigger than 1 is a sure sign something is wrong.
- **Treating "with replacement" as "without", or the other way round.** Examiners see this every year on tree diagrams: branches with changed denominators when the counter was put back, or unchanged ones when it wasn't. Read the question for "replaces", "puts it back" or "without replacement" before you draw the tree.
- **Mixing the two**: taking one off the numerator but not the denominator ($\frac{7}{10} \times \frac{6}{10}$). Without replacement, both go down.
- **Forgetting the second order.** "One green and one not green" is green then not green **or** not green then green. Many answers give only one product and lose most of the marks. For three items, count every order.
- **Not listing every way.** "Different colours" with three colours has six orders. If the list is long, use $1 - P(\text{same colour})$ instead.
- **Branch probabilities that don't add to 1**, for example 0.4 and 0.4 on one set of branches. Check each pair.
- **Using the whole group as the denominator in a conditional question.** "Picked from those who have a car" divides by the number with a car, not by everyone. The same applies to two picks: "two students who study history" start from the history total, not the class total.
- **Miscounting a Venn diagram.** Putting $n(A)$ in the "A only" region, or forgetting the number outside the circles in the total.
- **Missing cells in a sample space.** List the whole table rather than guessing, and use rows $\times$ columns for the total.
- **Probabilities greater than 1 or negative** in the working. They can't be right, so stop and check.
- **Rounding too early.** Keep fractions, or at least 4 significant figures, until the end.

How to get the marks

- **Write the products down.** A method mark is usually given for one correct product (such as $\frac{4}{11} \times \frac{3}{10}$), and a second for adding all the right ones, even if the arithmetic then slips. A bare answer that is wrong gets nothing.
- **Tree diagrams**: marks are for the right probabilities on the right branches; outcomes are already printed at the ends. Answers to later parts follow through from **your** tree, as long as your probabilities are between 0 and 1.
- **Special case marks**: working a "without replacement" question as if it were with replacement sometimes earns one mark, but only when the method is otherwise right. Don't rely on it.
- **"Show that"**: write every product and the sum, then the given fraction. The final line must match the printed answer.
- **Form of the answer**: fractions, decimals or percentages are all fine and don't have to be simplified unless the question says so. Never give a ratio. A non-exact decimal needs 3 significant figures.
- **"Complete the Venn diagram"** needs a number in every region, including outside the circles (write 0 if it is empty).
- **"Given that"** questions are often worth only 1 or 2 marks: a mark for the right denominator (the size of the known group) is common, so write the fraction before simplifying.

Quick check

1. The probability that Ana picks a red sweet from bag A is $\frac{2}{3}$. The probability that she picks a red sweet from bag A and a red sweet from bag B is $\frac{1}{4}$. Find (a) the probability of a red sweet from bag B, (b) the probability that neither sweet is red.
2. On any day, the probability that a printer jams is 0.15, independently of other days. Find the probability that it jams on exactly one of two days.
3. **Extended only:** A bag holds 6 red and 4 white balls. Two balls are taken at random without replacement. Find the probability that both are white.
4. In a group of 50 people, 28 are in set A, 20 are in set B and 8 are in both. Find (a) $P(A \cup B)$, (b) **Extended only:** the probability that a person picked at random from set B is also in set A.
5. The probability that Kofi scores with a penalty is $\frac{1}{3}$ on each attempt. The probability that he scores for the first time on attempt n is $\frac{16}{243}$. Find n.

Answers

1. (a) $\frac{2}{3} \times p = \frac{1}{4}$, so $p = \frac{1}{4} \div \frac{2}{3} = \frac{3}{8}$. (b) $\left(1 - \frac{2}{3}\right) \times \left(1 - \frac{3}{8}\right) = \frac{1}{3} \times \frac{5}{8} = \frac{5}{24}$.
2. Jams then doesn't, or doesn't then jams: $0.15 \times 0.85 + 0.85 \times 0.15 = 0.1275 + 0.1275 = 0.255$.
3. $\frac{4}{10} \times \frac{3}{9} = \frac{12}{90} = \frac{2}{15}$.
4. (a) Inside the circles: $28 + 20 - 8 = 40$, so $P(A \cup B) = \frac{40}{50} = \frac{4}{5}$. (b) 20 people are in B and 8 of them are in A: $\frac{8}{20} = \frac{2}{5}$.
5. He misses $n - 1$ times, then scores: $\left(\frac{2}{3}\right)^{n-1} \times \frac{1}{3} = \frac{16}{243}$, so $\left(\frac{2}{3}\right)^{n-1} = \frac{16}{81} = \left(\frac{2}{3}\right)^4$. So $n - 1 = 4$ and $n = 5$.

Past questions to try

- **0580/21/M/J/25 Q17**: with replacement, then a tree diagram without replacement.
- **0580/22/O/N/22 Q19**: a "given that the total is even" question from two lists of numbers.
- **0580/43/M/J/21 Q6**: completing a Venn diagram, then picking one and two students.
- **0580/22/M/J/23 Q23**: working backwards from a probability of both.