GCSE MATHEMATICS

FOUNDATION TIER

COMPREHENSIVE LESSON NOTEBOOK

UNIT 5 | PROBABILITY

TEACH-FROM-SCRATCH • FREE WEBSITE EDITION

11 detailed chapters • original diagrams • worked examples • guided practice • answers

Student: _____ Target grade: _____

START HERE

STUDY ROUTINE

How to learn from this notebook

Meaning first. Method second. Practice third.

THE FIVE-PASS ROUTINE

1 Read the key idea without a calculator. 2 Cover each solution and reproduce it. 3 Complete the practice independently. 4 Mark in a different colour and repair errors. 5 Retest after 2–7 days.

What a complete mathematics answer contains

- A clear model or calculation, not only a calculator display.
- Enough working for another person to follow the reasoning.
- Exact values until approximation is requested.
- Units and sensible rounding in context.
- A final sentence when the result must be interpreted.

Error log

REPAIR, DO NOT MERELY CORRECT

Label each error: concept, operation, arithmetic, calculator entry, accuracy, unit or interpretation. Write the corrected step and one sentence explaining the change.

Foundation does not mean superficial

Foundation Tier rewards secure fluency and connected reasoning. Grade 4–5 questions often combine several familiar skills, hide the required operation inside a context, or ask whether an answer is reasonable. The notebook therefore explains why methods work as well as how to use them.

SPECIFICATION MAP

PEARSON EDEXCEL 1MA1

Unit 5 coverage map

Probability content organised into a teachable sequence.

CH 01	P3	Probability language and the 0-to-1 scale
CH 02	P2, P7	Theoretical probability and equally likely outcomes
CH 03	P6, P7	Sample spaces and systematic listing
CH 04	P4	Mutually exclusive events and complements
CH 05	P3, P5	Experimental probability and relative frequency
CH 06	P2	Expected frequency and prediction
CH 07	P6, P8	Combined events using tables and lists
CH 08	P8	Tree diagrams with and without replacement
CH 09	P1, P6	Two-way tables, frequency trees and Venn diagrams
CH 10	P1-P8	Mixed probability modelling and decision making
CH 11	P1	Frequency trees and analysing experimental outcomes

IMPORTANT TIER NOTE

This notebook follows the Foundation-assessable content identified in the Pearson Edexcel GCSE Mathematics (1MA1) specification. Higher-only material is excluded from the core lesson sequence unless it is clearly labelled as optional enrichment.

REFERENCE

PROBABILITY FACTS AND METHODS

Fast-reference method bank

Understand each formula before memorising it.

Probability range	$0 \le P(A) \le 1$
Equally likely model	favourable outcomes ÷ total outcomes
Complement	$P(A')=1-P(A)$
Experimental probability	event frequency ÷ trials
Expected frequency	probability × trials
Independent A and B	$P(A)\times P(B)$
Mutually exclusive A or B	$P(A)+P(B)$
Tree route	multiply along branches
Several routes	add terminal route probabilities
Conditional probability	required frequency ÷ restricted total

CHAPTER 01 • P3

Probability language and the 0-to-1 scale

Turn everyday likelihood into precise mathematical statements.

SPECIFICATION FOCUS

Pearson Edexcel content references P3. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Probability measures long-run likelihood from 0 to 1 inclusive. An impossible event has probability 0, a certain event has probability 1, and an even chance has probability 0.5. Fractions, decimals and percentages describe the same scale, but words such as “unlikely” describe only approximate regions.

KEY VOCABULARY

outcome • event • impossible • unlikely • even chance • likely • certain • probability

Why the method works

- Every probability lies in the interval $0 \leq P(A) \leq 1$.
- Events nearer 1 are more likely than events nearer 0.
- Probability describes uncertainty before an outcome; it does not guarantee what happens once.
- Equivalent fractions, decimals and percentages occupy the same position on the scale.

CHECK BEFORE MOVING ON

Answer mentally: 1) Write impossible event probability. 2) Write certain event probability. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 01 • P3 • METHODS

Probability language and the 0-to-1 scale — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify the event precisely.
- Decide whether it is impossible, certain or between these extremes.
- Convert all given values to one representation before comparing.
- Use the context to reject impossible values below 0 or above 1.

WORKED EXAMPLE 1

Place probabilities 0.15, 3/5 and 85% in increasing order.

1. Convert: 3/5=0.60 and 85%=0.85.
2. Compare on the 0-to-1 scale.

ANSWER: 0.15, 3/5, 85%

WORKED EXAMPLE 2

A forecast gives probability of rain 1.2. Is it valid?

1. A probability cannot exceed 1.

ANSWER: No

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Convert 0.35 to percentage. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 01 • P3 • APPLICATION

P3

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Weather, medical risk and quality control use probability to communicate uncertainty. “A 20% chance of rain” does not mean rain for exactly 20% of one day; it summarises the frequency expected across comparable forecasts.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why probability 1.04 is invalid. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 01 • P3 • PRACTICE

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Write impossible event probability.**

2. **Write certain event probability.**

3. **Convert 0.35 to percentage.**

4. **Convert 72% to decimal.**

5. **Order 1/4,0.2,30%.**

6. **Which is more likely: 0.62 or 3/5?**

7. **Give a probability for an even chance.**

8. **Explain why probability 1.04 is invalid.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 02 • P2, P7

Theoretical probability and equally likely outcomes

Count favourable outcomes only after confirming fairness.

SPECIFICATION FOCUS

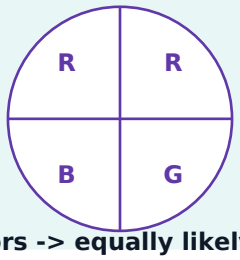
Pearson Edexcel content references P2, P7. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

For a finite set of equally likely outcomes, P(event)=number of favourable outcomes divided by total outcomes. The denominator counts all possible outcomes once; the numerator counts those satisfying the event. Fair coins, unbiased dice and equal spinner sectors support equal-likelihood models. Unequal sectors or biased devices require different probabilities.

KEY VOCABULARY

favourable • possible • equally likely • fair • unbiased • theoretical probability



equal sectors -> equally likely outcomes

Why the method works

- Equal counting works only when individual outcomes have equal probability.
- The favourable outcomes form a subset of the complete outcome set.
- Simplifying a fraction changes its form, not its probability.
- Symmetry can justify equal likelihood when the physical model is fair.

CHECK BEFORE MOVING ON

Answer mentally: 1) Fair die: P(odd). 2) Fair die: P(number >4). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 02 • P2, P7 • METHODS

P2, P7

Theoretical probability and equally likely outcomes — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- List the complete outcome set.
- Check that outcomes are equally likely.
- Count favourable and total outcomes.
- Write, simplify and sense-check the fraction.

WORKED EXAMPLE 1

A fair die is rolled. Find P(multiple of 3).

1. Outcomes are 1,2,3,4,5,6.
2. Favourable outcomes are 3 and 6.
3. Probability=2/6.

ANSWER: 1/3

WORKED EXAMPLE 2

A bag has 5 red, 3 blue and 2 green counters. Find P(not blue).

1. Total=10.
2. Not blue means red or green: 5+2=7.

ANSWER: 7/10

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Bag 4 red,6 blue: P(red). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 02 • P2, P7 • APPLICATION

P2, P7

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Games are fair only if the assigned prizes reflect the event probabilities. A spinner with differently sized sectors cannot be analysed by counting colours alone; sector angles or areas determine likelihood.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain when favourable/total is valid. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 02 • P2, P7 • PRACTICE

P2, P7

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Fair die: P(odd).**

2. **Fair die: P(number >4).**

3. **Bag 4 red,6 blue: P(red).**

4. **Cards 1–10: P(prime).**

5. **Alphabet tiles A,A,B,C: P(A).**

6. **Spinner equal sectors R,R,B,G: P(not R).**

7. **Can probability 3/7 be based on 21 equally likely outcomes? Give favourable count.**

8. **Explain when favourable/total is valid.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 03 • P6, P7

P6, P7

Sample spaces and systematic listing

Organise every outcome once so the denominator is proved complete.

SPECIFICATION FOCUS

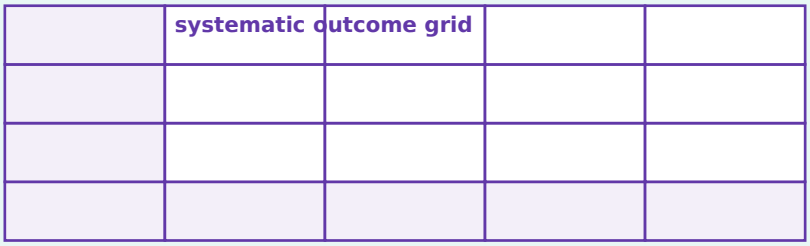
Pearson Edexcel content references P6, P7. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A sample space lists all possible outcomes of an experiment. For two stages, an ordered pair records the first and second result. A grid or systematic list prevents omission and duplication. If stages and their outcomes are equally likely, each cell has the same probability; otherwise the grid organises outcomes but not equal weights.

KEY VOCABULARY

sample space • ordered pair • outcome • event • systematic • grid



Why the method works

- A complete sample space is evidence that every possible result was considered.
- Order matters when first and second stages have distinct roles.
- For independent fair stages, the number of combined outcomes is the product of stage counts.
- Restrictions are applied after creating or carefully pruning the complete structure.

CHECK BEFORE MOVING ON

Answer mentally: 1) List outcomes for coin and die 1–3. 2) Two coins: P(two tails). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 03 • P6, P7 • METHODS

P6, P7

Sample spaces and systematic listing — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Write outcomes of stage one in rows and stage two in columns.
- Fill every cell with an ordered pair or combined value.
- Mark cells satisfying the event.
- Count marked cells only when all cells are equally likely.

WORKED EXAMPLE 1

Two fair coins are tossed. Find P(exactly one head).

1. Sample space: HH, HT, TH, TT.
2. Favourable: HT, TH.
3. Probability=2/4.

ANSWER: 1/2

WORKED EXAMPLE 2

Two fair dice are rolled. Find P(total 9).

1. There are 36 ordered pairs.
2. Favourable: (3,6),(4,5),(5,4),(6,3).

ANSWER: 1/9

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Two dice: P(total 7). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 03 • P6, P7 • APPLICATION

P6, P7

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Product menus and PIN construction use the same multiplication principle as sample spaces. Four starters and three mains create 4×3=12 pairs, provided every starter can be combined with every main.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why (1,2) differs from (2,1) for two dice. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 03 • P6, P7 • PRACTICE

P6, P7

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **List outcomes for coin and die 1–3.**

2. **Two coins: P(two tails).**

3. **Two dice: P(total 7).**

4. **Two dice: P(double).**

5. **Cards A,B then 1,2,3: number of pairs.**

6. **Digits 2,4,6 without repetition: two-digit outcomes.**

7. **Two spinners with 3 and 5 equal sectors: total outcomes.**

8. **Explain why (1,2) differs from (2,1) for two dice.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 04 • P4

Mutually exclusive events and complements

Use a complete total of 1 to find missing probability.

SPECIFICATION FOCUS

Pearson Edexcel content references P4. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Events are mutually exclusive when they cannot occur together in one trial. Their probabilities may be added for “A or B”. Exhaustive events cover every possible outcome, so their probabilities total 1. The complement A′ means “not A”, giving $P(A') = 1 - P(A)$. Events can be exhaustive without being equally likely.

KEY VOCABULARY

mutually exclusive • exhaustive • complement • intersection • union

event + complement = 1

Why the method works

- The total probability of all mutually exclusive exhaustive outcomes is 1.
- An event and its complement are always mutually exclusive and exhaustive.
- Addition for A or B is valid directly when overlap is impossible.
- If events overlap, adding both probabilities double-counts their intersection.

CHECK BEFORE MOVING ON

Answer mentally: 1) P(A)=0.37: find P(not A). 2) Outcomes probabilities 0.2,0.35,x: find x. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 04 • P4 • METHODS

P4

Mutually exclusive events and complements — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Decide whether the events can happen together.
- Identify whether the listed outcomes cover the whole sample space.
- Write a probability equation before substituting.
- Subtract from 1 for a complement or missing exhaustive outcome.

WORKED EXAMPLE 1

P(red)=0.28, P(blue)=0.47 and only red, blue or green are possible. Find P(green).

1. The colour events are mutually exclusive and exhaustive.
2. P(green)=1−0.28−0.47.

ANSWER: 0.25

WORKED EXAMPLE 2

P(bus late)=0.12. Find P(bus not late).

1. Late and not late are complements.
2. 1−0.12=0.88.

ANSWER: 0.88

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Fair die: P(1 or 6). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 04 • P4 • APPLICATION

P4

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Insurance categories must be defined so cases do not overlap accidentally. “Under 25” and “student” can overlap, while “under 25” and “25 or older” are complementary.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why mutually exclusive events cannot be independent when both have positive probability. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 04 • P4 • PRACTICE

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **P(A)=0.37: find P(not A).**

2. **Outcomes probabilities 0.2,0.35,x: find x.**

3. **Fair die: P(1 or 6).**

4. **Are odd and even on a die mutually exclusive?**

5. **Are prime and odd mutually exclusive on a die?**

6. **P(R)=0.4,P(B)=0.15,disjoint: P(R or B).**

7. **Events A and not A total what?**

8. **Explain why mutually exclusive events cannot be independent when both have positive probability.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 05 • P3, P5

P3, P5

Experimental probability and relative frequency

Use observed frequency to estimate an unknown long-run probability.

SPECIFICATION FOCUS

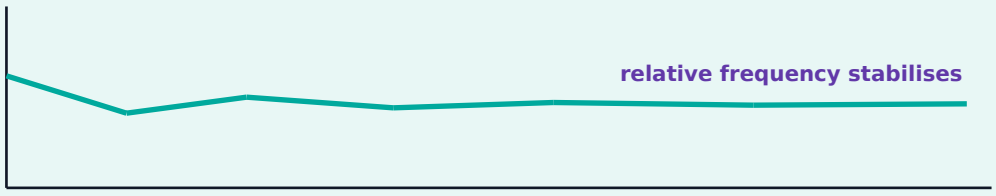
Pearson Edexcel content references P3, P5. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Experimental probability, or relative frequency, is event frequency divided by number of trials. It estimates the underlying probability from data. Small samples fluctuate substantially; as trials increase, relative frequency often stabilises near the true probability, although it need not move closer on every step. A biased sample or changing conditions can still produce a poor estimate.

KEY VOCABULARY

trial • frequency • relative frequency • experimental probability • estimate • bias



Why the method works

- Relative frequency=event frequency÷number of trials.
- Larger representative samples usually reduce random variation.
- An estimate is not proof of the exact theoretical probability.
- Combining compatible trials increases the evidence base by adding frequencies and totals.

CHECK BEFORE MOVING ON

Answer mentally: 1) 18 heads in 30 tosses: estimate. 2) 72 sixes in 420 rolls: estimate. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 05 • P3, P5 • METHODS

P3, P5

Experimental probability and relative frequency — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Confirm the event count and total number of trials.
- Divide frequency by trials and convert form if requested.
- Assess whether the sample is large and representative.
- Compare estimates using both sample size and experimental conditions.

WORKED EXAMPLE 1

A drawing pin lands point-up 138 times in 240 trials. Estimate probability.

1. Relative frequency=138÷240.
2. Simplify or convert.

ANSWER: 0.575

WORKED EXAMPLE 2

Trials give 42 successes in 60, then 65 in 100. Find combined estimate.

1. Combined successes=107.
2. Combined trials=160.
3. Estimate=107/160.

ANSWER: 0.66875

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

A colour occurs 45 of 150: percentage. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 05 • P3, P5 • APPLICATION

P3, P5

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Manufacturers test product defects using samples. Selecting only one machine or one time of day may introduce bias even when the sample is large.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why experimental and theoretical probabilities may differ. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 05 • P3, P5 • PRACTICE

P3, P5

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **18 heads in 30 tosses: estimate.**

2. **72 sixes in 420 rolls: estimate.**

3. **A colour occurs 45 of 150: percentage.**

4. **Combine 12/20 and 35/50 successes.**

5. **Which is more reliable: 8/10 or 790/1000?**

6. **Estimate failures if 23 of 500 fail.**

7. **State effect of more trials.**

8. **Explain why experimental and theoretical probabilities may differ.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 06 • P2

P2

Expected frequency and prediction

Scale a probability to a number of repeated trials, then interpret sensibly.

SPECIFICATION FOCUS

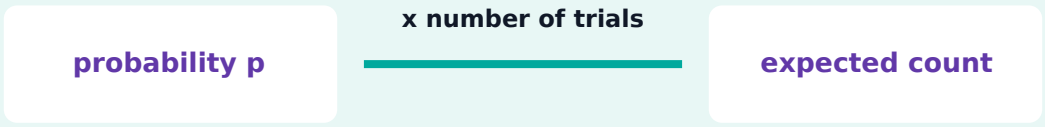
Pearson Edexcel content references P2. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Expected frequency is probability multiplied by number of trials. It is a long-run model, not a promise. The result can be non-integer because it represents an average across many repetitions. Conversely, an observed frequency and total can be used to estimate probability before predicting a larger population.

KEY VOCABULARY

expected frequency • prediction • trial • population • long-run average



expectation is a long-run average, not a guarantee

Why the method works

- Expected frequency=n×p because p is the expected fraction of n trials.
- Predictions inherit uncertainty from both chance and any estimated probability.
- Expected counts across exhaustive events add to the total number of trials.
- A non-integer expected value is valid as a statistical expectation.

CHECK BEFORE MOVING ON

Answer mentally: 1) p=0.3 over 200 trials: expected. 2) p=3/8 over 480 trials. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 06 • P2 • METHODS

P2

Expected frequency and prediction — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify or estimate the probability.
- Multiply by the future number of trials.
- Round only when the context requires a whole count.
- Describe the answer as an estimate, not certainty.

WORKED EXAMPLE 1

A seed germinates with probability 0.82. Predict germinations from 350 seeds.

1. Expected frequency=350×0.82.

ANSWER: 287

WORKED EXAMPLE 2

In 80 checks, 6 items fail. Predict failures among 1,200.

1. Estimated probability=6/80=0.075.
2. Expected failures=1200×0.075.

ANSWER: 90

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

12 defective of 300: predict in 2000. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 06 • P2 • APPLICATION

P2

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Staffing forecasts may use expected customer arrivals, but managers need contingency because the actual count varies. The mathematical expectation supports planning rather than guaranteeing demand.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why expected frequency need not occur exactly. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 06 • P2 • PRACTICE

P2

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **p=0.3 over 200 trials: expected.**

2. **p=3/8 over 480 trials.**

3. **12 defective of 300: predict in 2000.**

4. **54 rainy days of 180: predict in 365.**

5. **Expected red 45 of 150: inferred p.**

6. **p=0.07 over 250 gives non-integer expected value. Find it.**

7. **Expected successes 96 with p=0.4: trials.**

8. **Explain why expected frequency need not occur exactly.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 07 • P6, P8

P6, P8

Combined events using tables and lists

Use addition for alternatives and multiplication for successive independent choices.

SPECIFICATION FOCUS

Pearson Edexcel content references P6, P8. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Combined-event problems contain more than one stage or category. A two-way outcome table displays all combinations. For independent stages, probabilities along a route multiply because the second-stage probability is unaffected by the first. Probabilities of separate favourable routes add when those complete routes are mutually exclusive.

KEY VOCABULARY

combined event • independent • route • product rule • sum rule • outcome table

	systematic outcome grid			

Why the method works

- “And” along a complete independent route leads to multiplication.
- “Or” between mutually exclusive complete routes leads to addition.
- A table protects against reversed or missing ordered pairs.
- Independence is a model statement, not something to assume from different labels.

CHECK BEFORE MOVING ON

Answer mentally: 1) Coin and die: P(T and even). 2) Two dice: P(both six). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 07 • P6, P8 • METHODS

P6, P8

Combined events using tables and lists — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Represent every first-stage and second-stage combination.
- Calculate the probability of each required route.
- Add routes satisfying the event.
- Check all terminal route probabilities total 1.

WORKED EXAMPLE 1

A fair coin and fair die are used. Find P(head and number >4).

1. P(head)=1/2; P(number>4)=2/6.
2. Independent, so multiply.

ANSWER: 1/6

WORKED EXAMPLE 2

Two fair coins: find P(at least one head).

1. Use complement: 1−P(TT).
2. 1−(1/2×1/2).

ANSWER: 3/4

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Two dice: P(at least one six). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 07 • P6, P8 • APPLICATION

P6, P8

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A café can model drink-and-snack choices with a table, but multiplication of observed proportions is justified only if snack choice is independent of drink choice.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain “at least one” complement. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 07 • P6, P8 • PRACTICE

P6, P8

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Coin and die: P(T and even).**

2. **Two dice: P(both six).**

3. **Two dice: P(at least one six).**

4. **Spinner p(red)=0.4 twice independently: P(two red).**

5. **Same spinner: P(exactly one red).**

6. **Choose letter A/B and digit 1/2/3: outcomes.**

7. **Independent P(A)=0.3,P(B)=0.5: P(A and B).**

8. **Explain “at least one” complement.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 08 • P8

Tree diagrams with and without replacement

Follow each route in order and update probabilities when the contents change.

SPECIFICATION FOCUS

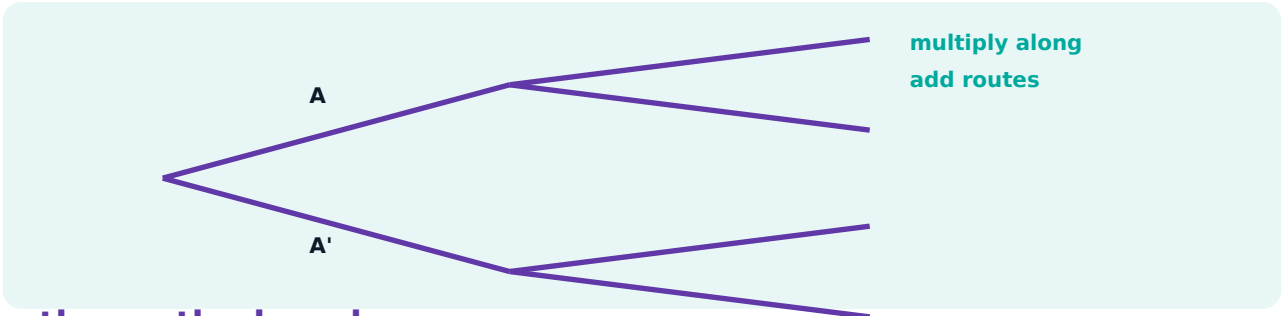
Pearson Edexcel content references P8. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A probability tree displays sequential events. Branches from the same node total 1. Multiply along a route and add separate terminal routes. With replacement, probabilities remain constant and repeated selections are independent. Without replacement, totals and relevant category counts change after the first selection.

KEY VOCABULARY

branch • stage • route • replacement • without replacement • dependent



Why the method works

- Every split represents a complete set of next-stage possibilities, so branches total 1.
- A route is an intersection of stage events, so its probabilities multiply.
- Different complete routes are mutually exclusive, so their probabilities add.
- Without replacement, the second denominator is one smaller and the numerator may change.

CHECK BEFORE MOVING ON

Answer mentally: 1) Fair coin twice: P(HH). 2) p(success)=0.7 twice independent: P(exactly one). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 08 • P8 • METHODS

Tree diagrams with and without replacement — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Label events and complements on every split.
- Write branch probabilities before calculating.
- Multiply along each required route.
- Add required routes and check against a complement where possible.

WORKED EXAMPLE 1

Bag has 3 red, 2 blue. Two selected without replacement. Find P(two red).

1. First red=3/5.
2. Then red=2/4.
3. Multiply=6/20.

ANSWER: 3/10

WORKED EXAMPLE 2

Same bag: find P(one of each colour).

1. Routes RB and BR.
2. 3/5×2/4 + 2/5×3/4=12/20.

ANSWER: 3/5

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Bag 4R,1B without replacement: P(B then R). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 08 • P8 • APPLICATION

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Medical screening and reliability models use tree diagrams to separate stages. Conditional branch probabilities must refer to the population reaching that node, not the original total.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain denominator change without replacement. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 08 • P8 • PRACTICE

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Fair coin twice: P(HH).**

2. **p(success)=0.7 twice independent: P(exactly one).**

3. **Bag 4R,1B without replacement: P(B then R).**

4. **Bag 4R,1B: P(two R).**

5. **With replacement 4R,1B: P(two R).**

6. **Branches from node 0.36 and x: x.**

7. **P(no success) if p(success)=0.2 twice independently.**

8. **Explain denominator change without replacement.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 09 • P1, P6

P1, P6

Two-way tables, frequency trees and Venn diagrams

Separate frequencies from probabilities and make every region explicit.

SPECIFICATION FOCUS

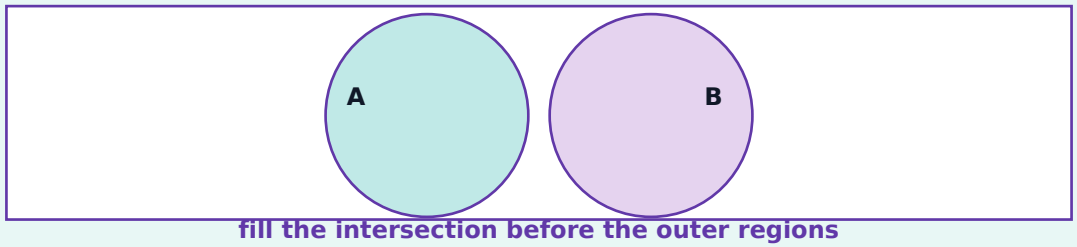
Pearson Edexcel content references P1, P6. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Two-way tables classify each individual by two categorical variables; row and column totals expose missing frequencies. Frequency trees show successive subgroup counts. Venn diagrams display sets: the overlap represents both, the non-overlap regions represent exactly one, and the exterior represents neither. Fill an overlap before subtracting from totals.

KEY VOCABULARY

set • union • intersection • complement • overlap • neither • frequency • two-way table



fill the intersection before the outer regions

Why the method works

- A grand total must equal every set of row totals and every set of column totals.
- In a Venn diagram, set totals include the intersection.
- A∩B means both; A∪B means at least one.
- Probability from a frequency diagram divides the required region by the universal total.

CHECK BEFORE MOVING ON

Answer mentally: 1) U=50,A=27,B=21,both=8: A only. 2) Same data: B only. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 09 • P1, P6 • METHODS

P1, P6

Two-way tables, frequency trees and Venn diagrams — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Place the intersection first.
- Subtract the intersection from each set total.
- Find the outside region from the universal total.
- Check all disjoint regions add to the universal total.

WORKED EXAMPLE 1

In 40 students, 22 study French, 18 Spanish and 9 both. Find neither.

1. French only=13; Spanish only=9.
2. Union=13+9+9=31.
3. Neither=40−31.

ANSWER: 9

WORKED EXAMPLE 2

A table has 60 pupils: 28 boys; 35 travel by bus; 16 boys use bus. Find girls not using bus.

1. Girls=32.
2. Girls using bus=35−16=19.
3. Girls not bus=32−19.

ANSWER: 13

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Same data: neither. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 09 • P1, P6 • APPLICATION

P1, P6

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Customer data can be classified by membership and purchase. Overlapping categories must not be added without removing the double-counted intersection.

Common mistakes and how to repair them

MISTAKE 1

Treating outcomes as equally likely without evidence. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding probabilities when events must both occur. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a decimal without explaining the event or checking it lies from 0 to 1. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why A+B double-counts overlap. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 09 • P1, P6 • PRACTICE

P1, P6

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **U=50,A=27,B=21,both=8: A only.**

2. **Same data: B only.**

3. **Same data: neither.**

4. **U=80,A=45,B=38,both=20: union.**

5. **Two-way total 100, male 46, glasses 39, male glasses 18: female glasses.**

6. **From previous: female without glasses.**

7. **Write symbol for both A and B.**

8. **Explain why A+B double-counts overlap.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 10 • P1-P8

P1-P8

Mixed probability modelling and decision making

Choose a complete representation, calculate accurately and evaluate the model.

SPECIFICATION FOCUS

Pearson Edexcel content references P1-P8. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Mixed Foundation probability problems combine frequency information, theoretical models, complements, sample spaces and dependent or independent stages. A reliable solution defines the event, chooses a table, grid, frequency tree or probability tree, and distinguishes an exact theoretical result from an estimate based on experiment.

KEY VOCABULARY

event • frequency tree • probability tree • sample space • complement • independent • dependent • estimate

The condition determines the denominator.

Why the method works

- Frequency trees carry counts; probability trees carry branch probabilities.
- Experimental estimates depend on sample size and possible bias.
- Independent repeated events keep the same branch probabilities.
- Without replacement changes both the total and possibly the favourable count.

CHECK BEFORE MOVING ON

Answer mentally: 1) Fair die: P(not 6). 2) Two fair coins: P(exactly one head). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 10 • P1-P8 • METHODS

P1-P8

Mixed probability modelling and decision making — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Define the event and identify whether data are frequencies or probabilities.
- Choose a complete table, grid or tree.
- Multiply along routes and add mutually exclusive terminal routes.
- Check the total, then interpret exactness and assumptions.

WORKED EXAMPLE 1

A bag has 4 red and 6 blue counters. Two are selected without replacement. Find P(two red).

1. First red=4/10.
2. Second red=3/9.
3. Multiply and simplify.

ANSWER: 2/15

WORKED EXAMPLE 2

In 200 trials an event occurs 74 times. Predict occurrences in 850 trials.

1. Estimate p=74/200=0.37.
2. Expected count=850×0.37.

ANSWER: 314.5, about 315

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Bag 3R,2B without replacement: P(two blue). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 10 • P1-P8 • APPLICATION

P1-P8

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Quality-control decisions combine sample evidence with cost and risk. A probability estimate supports planning, but a limited or biased sample should not be presented as certainty.

Common mistakes and how to repair them

MISTAKE 1

Using a conditional restricted denominator, which belongs to Higher-only P9. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Keeping a denominator unchanged without replacement. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Mixing frequency counts with probabilities on the same tree. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

State one assumption behind an equally likely model. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 10 • P1-P8 • PRACTICE

P1-P8

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Fair die: P(not 6).**

2. **Two fair coins: P(exactly one head).**

3. **Bag 3R,2B without replacement: P(two blue).**

4. **p=0.24 for 500 trials: expected frequency.**

5. **96 successes in 160: estimate p.**

6. **Grid of 4 by 3 equally likely outcomes: total outcomes.**

7. **P(A)=0.35: P(not A).**

8. **State one assumption behind an equally likely model.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 11 • P1

Frequency trees and analysing experimental outcomes

Carry counts through branches and check that every split preserves its total.

SPECIFICATION FOCUS

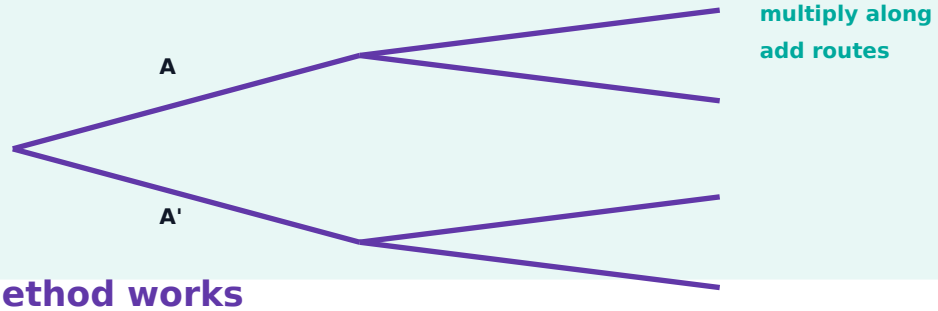
Pearson Edexcel content references P1. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A frequency tree records numbers of observations through successive categories. Unlike a probability tree, branches contain frequencies. The two child frequencies from any node add to the parent frequency. Missing values are found by subtraction, and probabilities are calculated only after the relevant final frequency and denominator are identified.

KEY VOCABULARY

frequency tree • parent total • branch frequency • outcome • experimental data



Why the method works

- Child frequencies add to their parent frequency.
- The first split totals the complete sample.
- Frequency and probability labels must not be mixed.
- An experimental probability divides the required final count by the appropriate overall trial count.

CHECK BEFORE MOVING ON

Answer mentally: 1) Using branch probabilities instead of counts. 2) Subtracting from the grand total instead of the parent node. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 11 • P1 • METHODS

P1

Frequency trees and analysing experimental outcomes — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Place the overall total at the start.
- Complete each split using subtraction.
- Check terminal frequencies add to the original total.
- Convert to probability only when requested.

WORKED EXAMPLE 1

Of 120 items, 70 are type A. Of type A, 18 fail. Find A items passing.

1. 70−18.

ANSWER: 52

WORKED EXAMPLE 2

There are 50 type B items and 6 fail. Find P(random item is B and fails) if total is 120.

1. The terminal frequency is 6 of the complete 120.

ANSWER: 1/20

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Dividing by a subgroup when an overall probability is requested. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 11 • P1 • APPLICATION

P1

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Factories and surveys use frequency trees to preserve subgroup counts through stages. The tree reveals which denominator belongs to an overall proportion.

Common mistakes and how to repair them

MISTAKE 1

65 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

54 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

39 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 4

200 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 5

81/200 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 6

18 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 7

60 Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 8

CHAPTER 11 • P1 • PRACTICE

P1

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Using branch probabilities instead of counts.**

2. **Subtracting from the grand total instead of the parent node.**

3. **Dividing by a subgroup when an overall probability is requested.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

PRACTICE ANSWERS

CHAPTER 01

Practice answers and repair notes

Probability language and the 0-to-1 scale

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Write impossible event probability. **ANSWER: 0**

Method cue: Identify the event precisely. Then check the sign, size, accuracy and units of the result.

2. Write certain event probability. **ANSWER: 1**

Method cue: Decide whether it is impossible, certain or between these extremes. Then check the sign, size, accuracy and units of the result.

3. Convert 0.35 to percentage. **ANSWER: 35%**

Method cue: Convert all given values to one representation before comparing. Then check the sign, size, accuracy and units of the result.

4. Convert 72% to decimal. **ANSWER: 0.72**

Method cue: Use the context to reject impossible values below 0 or above 1. Then check the sign, size, accuracy and units of the result.

5. Order 1/4,0.2,30%. **ANSWER: 0.2,1/4,30%**

Method cue: Identify the event precisely. Then check the sign, size, accuracy and units of the result.

6. Which is more likely: 0.62 or 3/5? **ANSWER: 0.62**

Method cue: Decide whether it is impossible, certain or between these extremes. Then check the sign, size, accuracy and units of the result.

7. Give a probability for an even chance. **ANSWER: 0.5**

Method cue: Convert all given values to one representation before comparing. Then check the sign, size, accuracy and units of the result.

8. Explain why probability 1.04 is invalid. **ANSWER: greater than 1**

Method cue: Use the context to reject impossible values below 0 or above 1. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 02

Practice answers and repair notes

Theoretical probability and equally likely outcomes

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Fair die: P(odd). **ANSWER: 1/2**

Method cue: List the complete outcome set. Then check the sign, size, accuracy and units of the result.

2. Fair die: P(number >4). **ANSWER: 1/3**

Method cue: Check that outcomes are equally likely. Then check the sign, size, accuracy and units of the result.

3. Bag 4 red,6 blue: P(red). **ANSWER: 2/5**

Method cue: Count favourable and total outcomes. Then check the sign, size, accuracy and units of the result.

4. Cards 1–10: P(prime). **ANSWER: 2/5**

Method cue: Write, simplify and sense-check the fraction. Then check the sign, size, accuracy and units of the result.

5. Alphabet tiles A,A,B,C: P(A). **ANSWER: 1/2**

Method cue: List the complete outcome set. Then check the sign, size, accuracy and units of the result.

6. Spinner equal sectors R,R,B,G: P(not R). **ANSWER: 1/2**

Method cue: Check that outcomes are equally likely. Then check the sign, size, accuracy and units of the result.

7. Can probability 3/7 be based on 21 equally likely outcomes? Give favourable count. **ANSWER: yes,9**

Method cue: Count favourable and total outcomes. Then check the sign, size, accuracy and units of the result.

8. Explain when favourable/total is valid. **ANSWER: when outcomes equally likely**

Method cue: Write, simplify and sense-check the fraction. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 03

Practice answers and repair notes

Sample spaces and systematic listing

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. List outcomes for coin and die 1–3. **ANSWER: H1,H2,H3,T1,T2,T3**

Method cue: Write outcomes of stage one in rows and stage two in columns. Then check the sign, size, accuracy and units of the result.

2. Two coins: P(two tails). **ANSWER: 1/4**

Method cue: Fill every cell with an ordered pair or combined value. Then check the sign, size, accuracy and units of the result.

3. Two dice: P(total 7). **ANSWER: 1/6**

Method cue: Mark cells satisfying the event. Then check the sign, size, accuracy and units of the result.

4. Two dice: P(double). **ANSWER: 1/6**

Method cue: Count marked cells only when all cells are equally likely. Then check the sign, size, accuracy and units of the result.

5. Cards A,B then 1,2,3: number of pairs. **ANSWER: 6**

Method cue: Write outcomes of stage one in rows and stage two in columns. Then check the sign, size, accuracy and units of the result.

6. Digits 2,4,6 without repetition: two-digit outcomes. **ANSWER: 24,26,42,46,62,64**

Method cue: Fill every cell with an ordered pair or combined value. Then check the sign, size, accuracy and units of the result.

7. Two spinners with 3 and 5 equal sectors: total outcomes. **ANSWER: 15**

Method cue: Mark cells satisfying the event. Then check the sign, size, accuracy and units of the result.

8. Explain why (1,2) differs from (2,1) for two dice. **ANSWER: different die gives each value**

Method cue: Count marked cells only when all cells are equally likely. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 04

Practice answers and repair notes

Mutually exclusive events and complements

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. P(A)=0.37: find P(not A). **ANSWER: 0.63**

Method cue: Decide whether the events can happen together. Then check the sign, size, accuracy and units of the result.

2. Outcomes probabilities 0.2,0.35,x: find x. **ANSWER: 0.45**

Method cue: Identify whether the listed outcomes cover the whole sample space. Then check the sign, size, accuracy and units of the result.

3. Fair die: P(1 or 6). **ANSWER: 1/3**

Method cue: Write a probability equation before substituting. Then check the sign, size, accuracy and units of the result.

4. Are odd and even on a die mutually exclusive? **ANSWER: yes**

Method cue: Subtract from 1 for a complement or missing exhaustive outcome. Then check the sign, size, accuracy and units of the result.

5. Are prime and odd mutually exclusive on a die? **ANSWER: no**

Method cue: Decide whether the events can happen together. Then check the sign, size, accuracy and units of the result.

6. P(R)=0.4,P(B)=0.15,disjoint: P(R or B). **ANSWER: 0.55**

Method cue: Identify whether the listed outcomes cover the whole sample space. Then check the sign, size, accuracy and units of the result.

7. Events A and not A total what? **ANSWER: 1**

Method cue: Write a probability equation before substituting. Then check the sign, size, accuracy and units of the result.

8. Explain why mutually exclusive events cannot be independent. **ANSWER: Both have a positive probability of occur**

Method cue: Subtract from 1 for a complement or missing exhaustive outcome. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 05

Practice answers and repair notes

Experimental probability and relative frequency

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. 18 heads in 30 tosses: estimate. **ANSWER: 0.6**

Method cue: Confirm the event count and total number of trials. Then check the sign, size, accuracy and units of the result.

2. 72 sixes in 420 rolls: estimate. **ANSWER: 6/35 or 0.1714**

Method cue: Divide frequency by trials and convert form if requested. Then check the sign, size, accuracy and units of the result.

3. A colour occurs 45 of 150: percentage. **ANSWER: 30%**

Method cue: Assess whether the sample is large and representative. Then check the sign, size, accuracy and units of the result.

4. Combine 12/20 and 35/50 successes. **ANSWER: 47/70**

Method cue: Compare estimates using both sample size and experimental conditions. Then check the sign, size, accuracy and units of the result.

5. Which is more reliable: 8/10 or 790/1000? **ANSWER: 790/1000**

Method cue: Confirm the event count and total number of trials. Then check the sign, size, accuracy and units of the result.

6. Estimate failures if 23 of 500 fail. **ANSWER: 0.046**

Method cue: Divide frequency by trials and convert form if requested. Then check the sign, size, accuracy and units of the result.

7. State effect of more trials. **ANSWER: usually more stable**

Method cue: Assess whether the sample is large and representative. Then check the sign, size, accuracy and units of the result.

8. Explain why experimental and theoretical probabilities may differ. **ANSWER: random variation/model imperfections**

Method cue: Compare estimates using both sample size and experimental conditions. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 06

Practice answers and repair notes

Expected frequency and prediction

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. p=0.3 over 200 trials: expected. **ANSWER: 60**

Method cue: Identify or estimate the probability. Then check the sign, size, accuracy and units of the result.

2. p=3/8 over 480 trials. **ANSWER: 180**

Method cue: Multiply by the future number of trials. Then check the sign, size, accuracy and units of the result.

3. 12 defective of 300: predict in 2000. **ANSWER: 80**

Method cue: Round only when the context requires a whole count. Then check the sign, size, accuracy and units of the result.

4. 54 rainy days of 180: predict in 365. **ANSWER: 109.5 about 110**

Method cue: Describe the answer as an estimate, not certainty. Then check the sign, size, accuracy and units of the result.

5. Expected red 45 of 150: inferred p. **ANSWER: 0.3**

Method cue: Identify or estimate the probability. Then check the sign, size, accuracy and units of the result.

6. p=0.07 over 250 gives non-integer expected value. Find it. **ANSWER: 17.5**

Method cue: Multiply by the future number of trials. Then check the sign, size, accuracy and units of the result.

7. Expected successes 96 with p=0.4: trials. **ANSWER: 240**

Method cue: Round only when the context requires a whole count. Then check the sign, size, accuracy and units of the result.

8. Explain why expected frequency need not occur exactly. **ANSWER: chance causes variation**

Method cue: Describe the answer as an estimate, not certainty. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 07

Practice answers and repair notes

Combined events using tables and lists

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Coin and die: P(T and even). **ANSWER: 1/4**

Method cue: Represent every first-stage and second-stage combination. Then check the sign, size, accuracy and units of the result.

2. Two dice: P(both six). **ANSWER: 1/36**

Method cue: Calculate the probability of each required route. Then check the sign, size, accuracy and units of the result.

3. Two dice: P(at least one six). **ANSWER: 11/36**

Method cue: Add routes satisfying the event. Then check the sign, size, accuracy and units of the result.

4. Spinner p(red)=0.4 twice independently: P(two red). **ANSWER: 0.16**

Method cue: Check all terminal route probabilities total 1. Then check the sign, size, accuracy and units of the result.

5. Same spinner: P(exactly one red). **ANSWER: 0.48**

Method cue: Represent every first-stage and second-stage combination. Then check the sign, size, accuracy and units of the result.

6. Choose letter A/B and digit 1/2/3: outcomes. **ANSWER: A1,A2,A3,B1,B2,B3**

Method cue: Calculate the probability of each required route. Then check the sign, size, accuracy and units of the result.

7. Independent P(A)=0.3,P(B)=0.5: P(A and B). **ANSWER: 0.15**

Method cue: Add routes satisfying the event. Then check the sign, size, accuracy and units of the result.

8. Explain “at least one” complement. **ANSWER: exclude only zero occurrences**

Method cue: Check all terminal route probabilities total 1. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 08

Practice answers and repair notes

Tree diagrams with and without replacement

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Fair coin twice: P(HH). **ANSWER: 1/4**

Method cue: Label events and complements on every split. Then check the sign, size, accuracy and units of the result.

2. p(success)=0.7 twice independent: P(exactly one). **ANSWER: 0.42**

Method cue: Write branch probabilities before calculating. Then check the sign, size, accuracy and units of the result.

3. Bag 4R,1B without replacement: P(B then R). **ANSWER: 1/5**

Method cue: Multiply along each required route. Then check the sign, size, accuracy and units of the result.

4. Bag 4R,1B: P(two R). **ANSWER: 3/5**

Method cue: Add required routes and check against a complement where possible. Then check the sign, size, accuracy and units of the result.

5. With replacement 4R,1B: P(two R). **ANSWER: 16/25**

Method cue: Label events and complements on every split. Then check the sign, size, accuracy and units of the result.

6. Branches from node 0.36 and x: x. **ANSWER: 0.64**

Method cue: Write branch probabilities before calculating. Then check the sign, size, accuracy and units of the result.

7. P(no success) if p(success)=0.2 twice independently. **ANSWER: 0.64**

Method cue: Multiply along each required route. Then check the sign, size, accuracy and units of the result.

8. Explain denominator change without replacement. **ANSWER: one item has been removed**

Method cue: Add required routes and check against a complement where possible. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 09

Practice answers and repair notes

Two-way tables, frequency trees and Venn diagrams

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. U=50,A=27,B=21,both=8: A only. **ANSWER: 19**

Method cue: Place the intersection first. Then check the sign, size, accuracy and units of the result.

2. Same data: B only. **ANSWER: 13**

Method cue: Subtract the intersection from each set total. Then check the sign, size, accuracy and units of the result.

3. Same data: neither. **ANSWER: 10**

Method cue: Find the outside region from the universal total. Then check the sign, size, accuracy and units of the result.

4. U=80,A=45,B=38,both=20: union. **ANSWER: 63**

Method cue: Check all disjoint regions add to the universal total. Then check the sign, size, accuracy and units of the result.

5. Two-way total 100, male 46, glasses 39, male glasses 18: female glasses. **ANSWER: 21**

Method cue: Place the intersection first. Then check the sign, size, accuracy and units of the result.

6. From previous: female without glasses. **ANSWER: 33**

Method cue: Subtract the intersection from each set total. Then check the sign, size, accuracy and units of the result.

7. Write symbol for both A and B. **ANSWER: A∩B**

Method cue: Find the outside region from the universal total. Then check the sign, size, accuracy and units of the result.

8. Explain why A+B double-counts overlap. **ANSWER: intersection belongs to both totals**

Method cue: Check all disjoint regions add to the universal total. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 10

Practice answers and repair notes

Mixed probability modelling and decision making

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Fair die: P(not 6). **ANSWER: 5/6**

Method cue: Define the event and identify whether data are frequencies or probabilities. Then check the sign, size, accuracy and units of the result.

2. Two fair coins: P(exactly one head). **ANSWER: 1/2**

Method cue: Choose a complete table, grid or tree. Then check the sign, size, accuracy and units of the result.

3. Bag 3R,2B without replacement: P(two blue). **ANSWER: 1/10**

Method cue: Multiply along routes and add mutually exclusive terminal routes. Then check the sign, size, accuracy and units of the result.

4. p=0.24 for 500 trials: expected frequency. **ANSWER: 120**

Method cue: Check the total, then interpret exactness and assumptions. Then check the sign, size, accuracy and units of the result.

5. 96 successes in 160: estimate p. **ANSWER: 0.6**

Method cue: Define the event and identify whether data are frequencies or probabilities. Then check the sign, size, accuracy and units of the result.

6. Grid of 4 by 3 equally likely outcomes: total outcomes. **ANSWER: 12**

Method cue: Choose a complete table, grid or tree. Then check the sign, size, accuracy and units of the result.

7. P(A)=0.35: P(not A). **ANSWER: 0.65**

Method cue: Multiply along routes and add mutually exclusive terminal routes. Then check the sign, size, accuracy and units of the result.

8. State one assumption behind an equally likely model. **ANSWER: device is fair/outcomes equally likely**

Method cue: Check the total, then interpret exactness and assumptions. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 11

Practice answers and repair notes

Frequency trees and analysing experimental outcomes

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Using branch probabilities instead of counts. **ANSWER: Total 200,yes 135: no.**

Method cue: Place the overall total at the start. Then check the sign, size, accuracy and units of the result.

2. Subtracting from the grand total instead of the parent node. **ANSWER: Yes 135,success 81: yes-fail.**

Method cue: Complete each split using subtraction. Then check the sign, size, accuracy and units of the result.

3. Dividing by a subgroup when an overall probability is requested. **ANSWER: No 65,success 26: no-fail.**

Method cue: Check terminal frequencies add to the original total. Then check the sign, size, accuracy and units of the result.

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Independent authorship and release check

Unit 5: Probability • Foundation Tier

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