Cambridge Assessment
International Education

Guide to prior learning for Paper 4 Further Probability and Statistics

Cambridge International AS & A Level Further Mathematics 9231

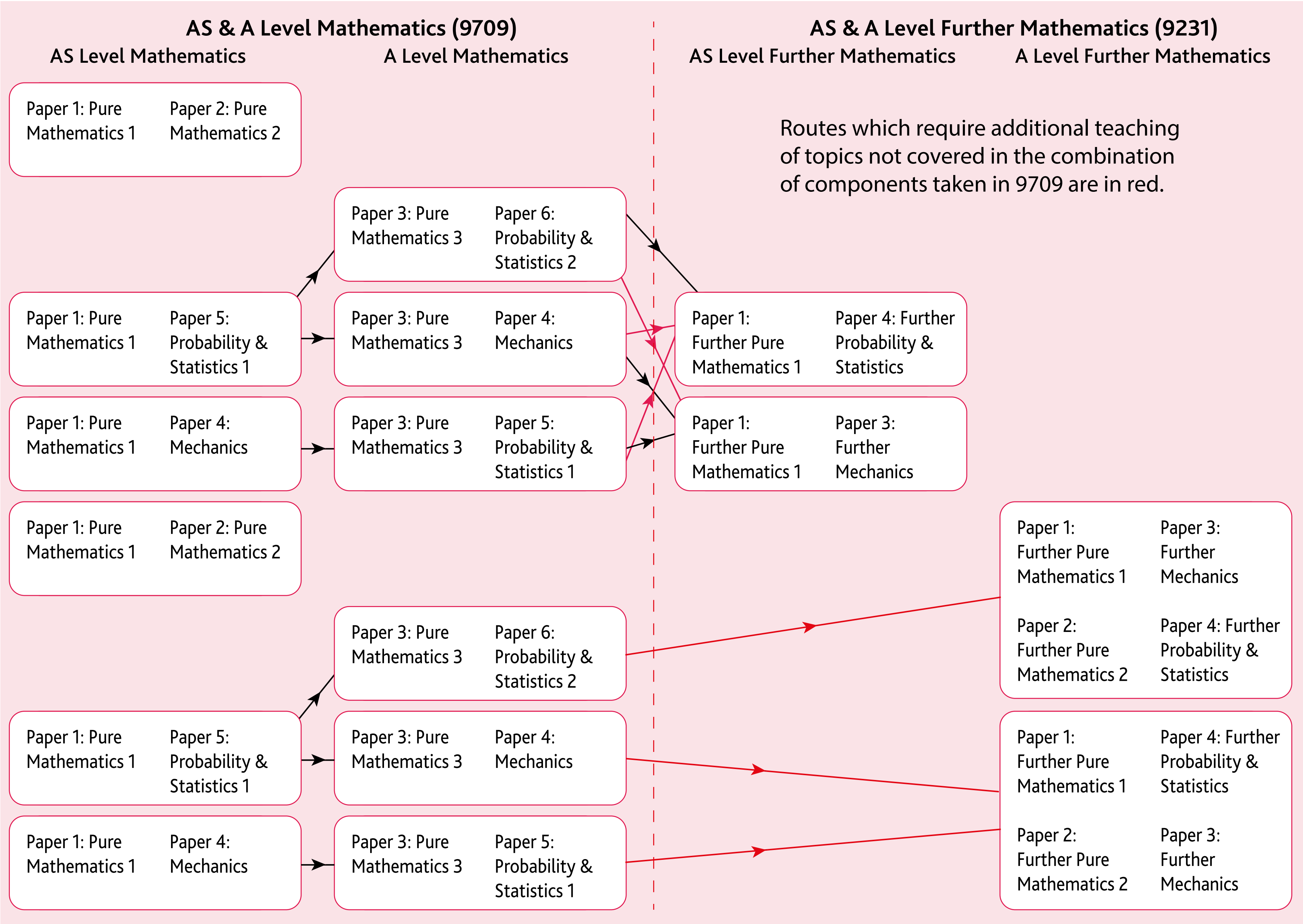
For assessment from 2020

Version 1

Cambridge Pathway

Contents

Routes through the 2020 syllabus for AS & A Level Mathematics and AS & A Level Further Mathematics



What is required from 9709 Probability & Statistics for 9231 Further Probability & Statistics?

Ideally, candidates will cover all the material in A Level Mathematics 9709 Paper 6: Probability & Statistics 2, building on their grounding of Paper 5: Probability & Statistics 1, in order to prepare for AS & A Level Further Mathematics 9231 Paper 4: Further Probability & Statistics.

However, it is recognised that time pressures on teaching may make this difficult, and so this section offers some guidance as to which content is required, which content is recommended and which may be considered as not required.

Required (not highlighted)

The non-highlighted sections of the syllabus for A Level Mathematics 0709 Paper 6: Probability & Statistics 2 are required knowledge for A Level Further Mathematics 9231 Paper 4: Further Probability & Statistics. Candidates may be required to demonstrate such knowledge in answering questions, although this knowledge will not be the main focus of the question. For example, the Poisson distribution may be used as the theoretical distribution in a goodness-of-fit test, or in a probability generating function. Questions which are solely about the Poisson distribution will not be set.

Recommended (highlighted in yellow)

An understanding of these areas of the syllabus is essential as a foundation for some of the topics in A Level Further Mathematics 9231 Paper 4: Further Probability & Statistics. For example, the actual confidence intervals and hypothesis tests required in A Level Mathematics 0709 Paper 6: Probability & Statistics 2 will not be directly tested in A Level Further Mathematics 9231 Paper 4: Further Probability & Statistics, but they form a basis of understanding for confidence intervals and tests.

Not required (highlighted in grey)

Knowledge of these areas is **not** required for A Level Further Mathematics 9231 Paper 4: Further Probability & Statistics

Suggested timings are given for required, recommended and not required topics.

9709 AS & A Level Mathematics

Probability & Statistics 2 (Paper 6)

6.1 The Poisson distribution learning objectives	Suggested teaching time (hours)
• use formulae to calculate probabilities for the distribution Po(λ)	2
• use the fact that if $X \sim$ Po(λ) then the mean and variance of X are each equal to λ; proofs are not required	1
• understand the relevance of the Poisson distribution to the distribution of random events, and use the Poisson distribution as a model	2
• use the Poisson distribution as an approximation to the binomial distribution where appropriate; the conditions that n is large and p is small should be known; $n > 50$ and $np < 5$, approximately	1
• use the normal distribution, with continuity correction, as an approximation to the Poisson distribution where appropriate; the condition that λ is large should be known; $\lambda > 15$, approximately	1

6.2 Linear combinations of random variables learning objectives	Suggested teaching time (hours)
• use, when solving problems, the results that: – $\mathrm{E}(aX + b) = a\mathrm{E}(X) + b$ and $\mathrm{Var}(aX + b) = a^2\mathrm{Var}(X)$ – $\mathrm{E}(aX + bY) = a\mathrm{E}(X) + b\mathrm{E}(Y)$ – $\mathrm{Var}(aX + bY) = a^2\mathrm{Var}(X) + b^2\mathrm{Var}(Y)$ for independent X and Y – if X has a normal distribution then so does $aX + b$ – if X and Y have independent normal distributions then $aX + bY$ has a normal distribution – if X and Y have independent Poisson distributions then $X + Y$ has a Poisson distribution	7

6.3 Continuous random variables learning objectives	Suggested teaching time (hours)
• understand the concept of a continuous random variable, and recall and use properties of a probability density function; for density functions defined over a single interval only; the domain may be infinte, e.g. $\frac{3}{x^4}$ for $x \geqslant 1$	3
• use a probability density function to solve problems involving probabilities, and to calculate the mean and variance of a distribution; including location of the median or other percentiles of a distribution by direct consideration of an area using the density function; explicit knowledge of the cumulative distribution function is not included	4

6.4 Sampling and estimation learning objectives	Suggested teaching time (hours)
• understand the distinction between a sample and a population, and appreciate the necessity for randomness in choosing samples	1
• explain in simple terms why a given sampling method may be unsatisfactory; including an elementary understanding of the use of random numbers in producing random samples; knowledge of particular sampling methods, such as quota or stratified sampling, is not required	2
• recognise that a sample mean can be regarded as a random variable, and use the facts that $\mathrm{E}(\bar{X}) = \mu$ and that $\mathrm{Var}(\bar{X}) = \frac{\sigma^2}{n}$	4
• use the fact that $(\bar{X})$ has a normal distribution if X has a normal distribution	3
• use the Central Limit Theorem where appropriate; only an informal understanding of the Central Limit Theorem (CLT) is required; for large sample sizes, the distribution of a sample mean is approximately normal	4
• calculate unbiased estimates of the population mean and variance from a sample, using either raw or summarised data; only a simple understanding of the term ‘unbiased’ is required, e.g. that although individual estimates will vary the process gives an accurate result ‘on average’	3
• determine and interpret a confidence interval for a population mean in cases where the population is normally distributed with known variance or where a large sample is used	3
• determine, from a large sample, an approximate confidence interval for a population proportion	3

6.5 Hypothesis tests learning objectives	Suggested teaching time (hours)
• understand the nature of a hypothesis test, the difference between one-tailed and two-tailed tests, and the terms null hypothesis, alternative hypothesis, significance level, rejection region (or critical region), acceptance region and test statistic	3
• formulate hypotheses and carry out a hypothesis test in the context of a single observation from a population which has a binomial or Poisson distribution, using – direct evaluation of probabilities – a normal approximation to the binomial or the Poisson distribution, where appropriate	6
• formulate hypotheses and carry out a hypothesis test concerning the population mean in cases where the population is normally distributed with known variance or where a large sample is used	6
• understand the terms Type I error and Type II error in relation to hypothesis tests	3
• calculate the probabilities of making Type I and Type II errors in specific situations involving tests based on a normal distribution or direct evaluation of binomial or Poisson probabilities	3

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Zhai Xiaoning, Deputy Principal, The High School Affiliated to Renmin University of China

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