# Teacher Delivery Guide Statistics 5.02 Discrete Random Variables

| **OCR Ref.** | **Subject Content** | **Stage 1 learners should…** | **Stage 2 learners should additionally…** |
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| **5.02 Discrete Random Variables** |
| 5.02a | Probability distributions for general discrete random variables | a) Understand and be able to use discrete probability distributions.*Includes using and constructing probability distribution tables and functions relating to a given situation involving a discrete random variable.**Any defined non-standard distribution will be finite.* |  |
| 5.02b |  | b) Understand and be able to calculate the expectation and variance of a discrete random variable.*Includes knowing and being able to use the formulae* .[*Proof of these results is excluded.*] |  |
| 5.02c |  | c) Know and be able to use the effects of linear coding on the mean and variance of a random variable. |  |

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| **5.02 Discrete Random Variables** |
| 5.02d | The binomial distribution | d) Know and be able to use the formulae and  for a binomial distribution.*[Proof of these results is excluded.]**For the underlying content on binomial distributions, see H240 sections 2.04b and 2.04c.*  |  |
| 5.02e | The discrete uniform distribution | e) Know and be able to use the conditions under which a random variable will have a discrete uniform distribution, and be able to calculate probabilities and the mean and variance for a given discrete uniform distribution.*Includes use of the notationfor the uniform distribution over the interval* . |  |
| 5.02f | The geometric distribution | f) Know and be able to use the conditions under which a random variable will have a geometric distribution.*Includes use of the notation, where X is the number of trials up to and including the first success.* |  |
| 5.02g |  | g) Be able to calculate probabilities using the geometric distribution.*Learners may use the formulae  and .* |  |
| 5.02h |  | h) Know and be able to use the formulae and  for a geometric distribution.[*Proof of these results is excluded.*] |  |
| 5.02i | The Poisson distribution | i) Understand informally the relevance of the Poisson distribution to the distribution of random events, and be able to use the Poisson distribution as a model.*Includes use of the notation , where X is the number of events in a given interval.* |  |
| 5.02j |  | j) Understand and be able to use the formula . |  |
| 5.02k |  | k) Be able to calculate probabilities using the Poisson distribution, using appropriate calculator functions.*Learners are expected to have a calculator with the ability to access probabilities from the Poisson distribution.*[*Use of the Poisson distribution to calculate numerical approximations for a binomial distribution is excluded.*] |  |

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| **OCR Ref.** | **Subject Content** | **Stage 1 learners should…** | **Stage 2 learners should additionally…** |
| 5.02l |  | l) Know and be able to use the conditions under which a random variable will have a Poisson distribution.*Learners will be expected to identify which of the modelling conditions [assumptions] is/are relevant to a given scenario and to explain them in context.* |  |
| 5.02m |  | m) Be able to use the result that if  then the mean and variance of *X* are each equal to . |  |
| 5.02n |  | n) Know and be able to use the result that the sum of independent Poisson variables has a Poisson distribution. |  |

# Thinking Conceptually

### General approaches

The work in this section builds on previous work on Probability (2.03) and Statistical Distributions (2.04) in the AS and A Level specification. Students will need to recall the idea of a random variable and the subject matter of probability distributions. They will also need to use their knowledge of probability in general.

### Conceptual links to other areas of the specification

This section covers all of the further maths advanced level work on discrete random variables and includes various different probability distributions. It links with the stage 2 work on continuous random variables (5.03) and linear combinations of random variables (5.04). Indeed, the more able students might make the conceptual leap and conjecture that there should be *continuous* probability distributions too.

# Thinking Contextually

Use examples from the A-level Mathematics course to illustrate what a discrete random variable is. Something simple like a die rolled and the probability distribution expressed in a table can be used to look at the effect of linear coding. Once the students calculate the expectation and variance of , they can then find the values of the expectation and variance of  for various values of  and  directly and probably manage to conjecture the effect that linear coding has on these values.

The mathematics of discrete variables and their probabilities can be found in many different contexts. These range from card and coin games to medical research; sports; phone calls and the birth of babies. The resources list contains many examples and ideas of contexts which require discrete models and where we want to find probabilities.

# Resources

| **Title** | **Organisation** | **Description** | **Ref** |
| --- | --- | --- | --- |
| [Discrete Probability Distributions Introductory Lecture](https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-041-probabilistic-systems-analysis-and-applied-probability-fall-2010/video-lectures/lecture-5-discrete-variables-probability-expectations/) | MIT | Accessible lecture which explores discrete random variables and discrete probability distributions. The lecturer is John Tsitsiklis. 50 minutes long. Could be used for flipped learning.  | 5.02a and 5.02b |
| [PowerPoint with clear description of a probability distribution](https://projects.ncsu.edu/crsc/events/ugw06/presentations/scheywar/finalundergrad.pdf)  | North Carolina State University | Good general PowerPoint. Clear slides include random variable, probability distribution and probability mass function, with an example. | 5.02a |
| [Statistics 101: Discrete Random Variables Basics](https://www.youtube.com/watch?v=fGKd6ZtuTzM) | Brandon Foltz | An introduction to discrete random variables. A 13 minute video. May be useful within a starter or as part of homework activities. | 5.02a |
| [Examples of Discrete Probability Distributions](http://homepage.divms.uiowa.edu/~rdecook/stat2020/notes/ch3_pt1.pdf) | University of Iowa | Some clear example slides which could be used within an explanation in class or as a reference resource. | 5.02a |
| [Discrete Random Variable Simulator](https://www.geogebra.org/m/cqMQwFC5) | Geogebra | Create your own Discrete Random Variable by inputting probabilities into spreadsheet. And compare simulation with theoretical distribution. Could be used within a plenary. | 5.02a |
| [Demonstration of E(X) and Var(X)](http://www.jbstatistics.com/expected-value-and-variance-of-discrete-random-variables/)  | JBstatistics | 8 minute video which demonstrates how to obtain E(X), Var(X) and the standard deviation. Good as a starter.  | 5.02b |
| [DRVs from a Bag](http://www.s253053503.websitehome.co.uk/msv/msv-5.html) | Making Statistics Vital (MSV) | An exercise designed to ensure that students know how to find E(X) and Var(X) for a discrete random variable, and that the probabilities in a probability distribution will always add to one. | 5.02b |
| [The four sided Dice](http://www.s253053503.websitehome.co.uk/msv/msv-31.html) | MSV | Investigate whether a four-sided dice with positive integer faces including one or more odd number faces can ever have the expectation of its score equal to the variance? | 5.02b |
| [Double or Add](http://www.s253053503.websitehome.co.uk/msv/msv-19.html) | MSV | Investigation of how does 'rolling a dice and doubling' differ from 'rolling two dice and adding'? | 5.02c |
| [Linear Combinations of Discrete Random Variables](https://www.examsolutions.net/tutorials/linear-combinations-discrete-random-variables/?level=A-Level&board=Edexcel&module=S1&topic=1836) | Exam Solutions | A collection of 3 videos showing how linear combinations work with the mean and variance. | 5.02c |
| [Video Lecture: Introduction to the Binomial Distribution](https://www.coursera.org/learn/basic-statistics/lecture/sMjTp/4-08-the-binomial-distribution) | University of Amsterdam / Coursera | Short and good introductory lecture about the Binomial Distribution. Roughly 8 minutes long. Could be used in class or for flipped learning.  | 5.02d |
| [Video Lecture Binomial Distribution](https://www.youtube.com/watch?v=k2BB0p8byGA) | Harvard University | Enjoyable and informative 50 minute lecture given by Professor Joe Blitzstein from the Department of Statistics at Harvard University. Accessible with stretch. | 5.02d |
| [Most Likely Value](http://www.s253053503.websitehome.co.uk/msv/msv-3.html) | MSV | This activity offers a slightly different slant on the standard question, 'What is the most likely value for a Binomial Distribution to give?' | 5.02d |
| [Binomial Reverse](http://www.s253053503.websitehome.co.uk/msv/msv-11.html) | MSV | Here is a standard (and maybe a little dull?) Binomial question that livens up when reversed. | 5.02d |
| [Uniform Distribution Introduction](https://www.youtube.com/watch?v=pc92J_DIwZo) | University of Oklahoma Dr Kash Barker | 2.5 minute video introduction. Good starter resource. | 5.02e |
| [Uniform Distribution (Discrete): U(N) with PDF and CDF](https://www.geogebra.org/m/DSwmHTVA) | Geogebra | Compare pdf and cdf for the uniform distribution. | 5.02e |
| [Geometric Distribution Introduction](http://www.jbstatistics.com/introduction-to-the-geometric-distribution/) | JBstatistics | 11 minute video which introduces the Geometric Distribution. Excellent starter or plenary resource. Very clear. | 5.02f,g |
| [Brief Introduction to the Geometric Distribution with clear guide to notation](http://people.wku.edu/david.neal/382/discrete/Geometric.pdf) | Western Kentucky University | Reference document which introduces the Geometric Distribution with clear examples. | 5.02f,g,h |
| [Explanation of the Geometric Distribution](http://arnoldkling.com/apstats/geometric.html) | Arnold Kling (Economist)  | Concise notes on the Geometric Distribution. Useful as a homework or revision reference resource. | 5.02f,g,h |
| [Geometric Probability](https://www.geogebra.org/m/BYJtavUB#material/ddyJFGmS) | Geogebra | Set of interesting geometric simulations. | 5.02f , 5.02g and 5.02h |
| [Introduction to the Poisson Distribution](http://www.jbstatistics.com/introduction-to-the-poisson-distribution/) | JBstatistics | 9 minute video, good as a starter, which introduces the Poisson Distribution. | 5.02i, j, k, l,m |
| [Introduction to the Poisson Distribution](http://www.stats.ox.ac.uk/~marchini/teaching/L5/L5.notes.pdf) | Oxford University Department of Statistics | Comprehensive notes with examples on the Poisson Distribution. | 5.02i, j, k, l, m, n |
| [Poisson Distribution](https://www.geogebra.org/m/utauAHgF) | Geogebra | Interactive Poisson Distribution generator. | 5.02i, 5.02j and 5.02k |
| [Poisson Distribution / Poisson Curve: Simple Definition](http://www.statisticshowto.com/poisson-distribution/) | Statistics How to | Notes and examples of the Poisson distribution. Includes a short section on the criteria for using Poisson or Binomial. | 5.02j |
| [Adding Two Poissons](http://www.s253053503.websitehome.co.uk/msv/msv-38.html) | MSV | Investigation of the resulting distribution when you add two independent Poisson variables. | 5.02n |

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