International Baccalaureate®
Baccalauréat International
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Diploma Programme

Mathematics HL guide

First examinations 2014

Topic 5—Core: Statistics and probability 36 hours

The aim of this topic is to introduce basic concepts. It may be considered as three parts: manipulation and presentation of statistical data (5.1), the laws of probability (5.2–5.4), and random variables and their probability distributions (5.5–5.7). It is expected that most of the calculations required will be done on a GDC. The emphasis is on understanding and interpreting the results obtained. Statistical tables will no longer be allowed in examinations.

	Content	Further guidance	Links
5.1	Concepts of population, sample, random sample and frequency distribution of discrete and continuous data. Grouped data: mid-interval values, interval width, upper and lower interval boundaries. Mean, variance, standard deviation. **Not required:** Estimation of mean and variance of a population from a sample.	For examination purposes, in papers 1 and 2 data will be treated as the population. In examinations the following formulae should be used: $\mu = \frac{\sum_{i=1}^{k} f_i x_i}{n}$, $\sigma^2 = \frac{\sum_{i=1}^{k} f_i (x_i - \mu)^2}{n} = \frac{\sum_{i=1}^{k} f_i x_i^2}{n} - \mu^2$.	**TOK:** The nature of mathematics. Why have mathematics and statistics sometimes been treated as separate subjects? **TOK:** The nature of knowing. Is there a difference between information and data? **Aim 8:** Does the use of statistics lead to an overemphasis on attributes that can easily be measured over those that cannot? **Appl:** Psychology SL/HL (descriptive statistics); Geography SL/HL (geographic skills); Biology SL/HL 1.1.2 (statistical analysis). **Appl:** Methods of collecting data in real life (census versus sampling). **Appl:** Misleading statistics in media reports.

	Content	Further guidance	Links
5.2	Concepts of trial, outcome, equally likely outcomes, sample space (U) and event. The probability of an event A as $\mathrm{P}(A)=\frac{n(A)}{n(U)}$. The complementary events A and A' (not A). Use of Venn diagrams, tree diagrams, counting principles and tables of outcomes to solve problems.		**Aim 8:** Why has it been argued that theories based on the calculable probabilities found in casinos are pernicious when applied to everyday life (eg economics)? **Int:** The development of the mathematical theory of probability in 17th century France.
5.3	Combined events; the formula for $\mathrm{P}(A\cup B)$. Mutually exclusive events.		
5.4	Conditional probability; the definition $\mathrm{P}(A\mid B)=\frac{\mathrm{P}(A\cap B)}{\mathrm{P}(B)}$. Independent events; the definition $\mathrm{P}(A\mid B)=\mathrm{P}(A)=\mathrm{P}(A\mid B')$. Use of Bayes' theorem for a maximum of three events.	Use of $\mathrm{P}(A\cap B)=\mathrm{P}(A)\mathrm{P}(B)$ to show independence.	**Appl:** Use of probability methods in medical studies to assess risk factors for certain diseases. **TOK:** Mathematics and knowledge claims. Is independence as defined in probabilistic terms the same as that found in normal experience?

	Content	Further guidance	Links
5.5	Concept of discrete and continuous random variables and their probability distributions. Definition and use of probability density functions. Expected value (mean), mode, median, variance and standard deviation. Applications.	 For a continuous random variable, a value at which the probability density function has a maximum value is called a mode. Examples include games of chance.	**TOK:** Mathematics and the knower. To what extent can we trust samples of data? **Appl:** Expected gain to insurance companies.
5.6	Binomial distribution, its mean and variance. Poisson distribution, its mean and variance. **Not required:** Formal proof of means and variances.	Link to binomial theorem in 1.3. Conditions under which random variables have these distributions.	**TOK:** Mathematics and the real world. Is the binomial distribution ever a useful model for an actual real-world situation?
5.7	Normal distribution. Properties of the normal distribution. Standardization of normal variables.	Probabilities and values of the variable must be found using technology. The standardized value (z) gives the number of standard deviations from the mean. Link to 2.3.	**Appl:** Chemistry SL/HL 6.2 (collision theory); Psychology HL (descriptive statistics); Biology SL/HL 1.1.3 (statistical analysis). **Aim 8:** Why might the misuse of the normal distribution lead to dangerous inferences and conclusions? **TOK:** Mathematics and knowledge claims. To what extent can we trust mathematical models such as the normal distribution? **Int:** De Moivre's derivation of the normal distribution and Quetelet's use of it to describe *l'homme moyen*.