



UNIVERSITY *of* CAMBRIDGE  
International Examinations

Cambridge  
**O Level**

# SYLLABUS

**Cambridge O Level**

**Statistics**

**4040**

For examination in November 2014

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# 1. Introduction

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## 1.1 Why choose Cambridge?

University of Cambridge International Examinations is the world's largest provider of international education programmes and qualifications for 5 to 19 year olds. We are part of the University of Cambridge, trusted for excellence in education. Our qualifications are recognised by the world's universities and employers.

### Developed for an international audience

Cambridge O Levels have been designed for an international audience and are sensitive to the needs of different countries. These qualifications are designed for students whose first language may not be English and this is acknowledged throughout the examination process. The Cambridge O Level syllabus also allows teaching to be placed in a localised context, making it relevant in varying regions.

### Recognition

Every year, thousands of learners gain the Cambridge qualifications they need to enter the world's universities.

Cambridge O Level is internationally recognised by schools, universities and employers as equivalent to UK GCSE. Learn more at [www.cie.org.uk/recognition](http://www.cie.org.uk/recognition)

### Excellence in education

We understand education. We work with over 9000 schools in over 160 countries who offer our programmes and qualifications. Understanding learners' needs around the world means listening carefully to our community of schools, and we are pleased that 98% of Cambridge schools say they would recommend us to other schools.

Our mission is to provide excellence in education, and our vision is that Cambridge learners become confident, responsible, innovative and engaged.

Cambridge programmes and qualifications help Cambridge learners to become:

- **confident** in working with information and ideas – their own and those of others
- **responsible** for themselves, responsive to and respectful of others
- **innovative** and equipped for new and future challenges
- **engaged** intellectually and socially, ready to make a difference

### Support in the classroom

We provide a world-class support service for Cambridge teachers and exams officers. We offer a wide range of teacher materials to Cambridge schools, plus teacher training (online and face-to-face), expert advice and learner-support materials. Exams officers can trust in reliable, efficient administration of exams entry and excellent, personal support from our customer services. Learn more at [www.cie.org.uk/teachers](http://www.cie.org.uk/teachers)

### Not-for-profit, part of the University of Cambridge

We are a part of Cambridge Assessment, a department of the University of Cambridge and a not-for-profit organisation.

We invest constantly in research and development to improve our programmes and qualifications.

## 1.2 Why choose Cambridge O Level?

Cambridge helps your school improve learners' performance. Learners develop not only knowledge and understanding, but also skills in creative thinking, enquiry and problem solving, helping them to perform well and prepare for the next stage of their education.

Schools worldwide have helped develop Cambridge O Levels, which provide an excellent preparation for Cambridge International AS and A Levels.

Cambridge O Level incorporates the best in international education for learners at this level. It develops in line with changing needs, and we update and extend it regularly.

## 1.3 Why choose Cambridge O Level Statistics?

Cambridge O Levels are established qualifications that keep pace with educational developments and trends. The Cambridge O Level curriculum places emphasis on broad and balanced study across a wide range of subject areas. The curriculum is structured so that candidates attain both practical skills and theoretical knowledge.

Cambridge O Level Statistics is recognised by universities and employers throughout the world as proof of statistical knowledge and understanding. Successful Cambridge O Level Statistics candidates acquire knowledge of basic statistical ideas, methods and terminology. Study of the content of the syllabus enables candidates to:

- Represent and use statistical data in graphical, diagrammatic and tabular forms.
- Interpret statistical statements, calculations and diagrams.
- Perform statistical calculations accurately.
- Acquire knowledge of elementary ideas in probability.

Cambridge O Level Statistics provides a suitable foundation for further study in the subject, as well as developing concepts which are relevant in a wide range of other subjects.

## 1.4 How can I find out more?

If you are already a Cambridge school

You can make entries for this qualification through your usual channels. If you have any questions, please contact us at **[international@cie.org.uk](mailto:international@cie.org.uk)**

If you are not yet a Cambridge school

Learn about the benefits of becoming a Cambridge school at **[www.cie.org.uk/startcambridge](http://www.cie.org.uk/startcambridge)**.

Email us at **[international@cie.org.uk](mailto:international@cie.org.uk)** to find out how your organisation can become a Cambridge school.

## 2. Assessment at a glance

All candidates take both Paper 1 and Paper 2.

### Paper 1

2 hours 15 minutes

A written paper of two sections.

**Section A:** Six compulsory short questions worth 36 marks

**Section B:** Candidates choose four out of five longer questions worth 64 marks.

and

### Paper 2

2 hours 15 minutes

A written paper of two sections.

**Section A:** Six compulsory short questions worth 36 marks

**Section B:** Candidates choose four out of five longer questions worth 64 marks.

A high standard of accuracy will be expected in calculations and in the drawing of diagrams and graphs. All working must be clearly shown. **The use of an electronic calculator is expected in both papers.**

Past papers are available from Cambridge.

## Electronic Calculators

1. At all centres, the use of silent electronic calculators is expected.
2. The General Regulations concerning the use of electronic calculators are contained in the *Cambridge Handbook*.

## Mathematical Instruments

Apart from the usual mathematical instruments, candidates may use flexicurves in this examination.

## Mathematical Notation

Please see the list of mathematical notation at the end of this booklet.

## Examiners' Reports (SR(I) booklets)

Reports on the November examinations are distributed to International Centres in April/May.

## Availability

This syllabus is examined in the October/November examination series.

This syllabus is available to private candidates.

Cambridge O Levels are available to Centres in Administrative Zones 3, 4 and 5. Centres in Administrative Zones 1, 2 or 6 wishing to enter candidates for Cambridge O Level examinations should contact Cambridge Customer Services.

## Combining this with other syllabuses

Candidates can combine this syllabus in an examination series with any other Cambridge syllabus, except:

- syllabuses with the same title at the same level

Please note that Cambridge IGCSE, Cambridge International Level 1/Level 2 Certificates and Cambridge O Level syllabuses are at the same level.

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## 3. Syllabus aims and objectives

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### 3.1 Aims

The course should enable students to:

- appreciate that much of the information encountered in a wide variety of contexts in everyday life has a statistical base;
- recognise the suitability of this information for statistical analysis;
- appreciate the extent of the accuracy of this information;
- acquire an understanding of the elementary concepts of statistics and probability which are useful and relevant for carrying out such analysis;
- apply appropriate methods based on these concepts to numerical information;
- draw appropriate conclusions from the results of the application of statistical methods;
- interpret both primary statistical information and the conclusions of statistical analysis;
- be aware of the limitations and levels of accuracy of interpretations and conclusions, and their relevance in an everyday societal context.

### 3.2 Assessment objectives

The examination tests the ability of candidates to:

- define/describe elementary statistical concepts and procedures;
- present data in a suitable form for analysis;
- justify the use of a particular method in a given situation;
- solve statistical and probability problems numerically;
- perform relevant statistical calculations accurately;
- communicate conclusions and interpretations.



## 4. Curriculum content

Syllabus	Notes
1. General ideas of sampling and surveys. Bias: how it arises and is avoided.	Including knowledge of the terms: random sample, stratified random sample, quota sample, systematic sample.
2. The nature of a variable.	Including knowledge of the terms: discrete, continuous, quantitative and qualitative.
3. Classification, tabulation and interpretation of data. Pictorial representation of data; the purpose and use of various forms, their advantages and disadvantages.	Including pictograms, pie charts, bar charts, sectional and percentage bar charts, dual bar charts, change charts.
4. Frequency distributions; frequency polygons and histograms.	Including class boundaries and mid-points, class intervals.
5. Cumulative frequency distributions, curves (ogives) and polygons.	
6. Measures of central tendency and their appropriate use; mode and modal class, median and mean. Measures of dispersion and their appropriate use; range, interquartile range, variance and standard deviation.	<p>Calculation of the mean, the variance and the standard deviation from a set of numbers, a frequency distribution and a grouped frequency distribution, including the use of an assumed mean.</p> <p>Estimation of the median, quartiles and percentiles from a set of numbers, a cumulative frequency curve or polygon and by linear interpolation from a cumulative frequency table.</p> <p>The effect on mean and standard deviation of adding a constant to each observation and of multiplying each observation by a constant. Linear transformation of data to a given mean and standard deviation.</p>
7. Index numbers, composite index numbers, price relatives, crude and standardised rates.	
8. Moving averages.	Including knowledge of the terms: time series, trend, seasonal variation, cyclic variation. Centering will be expected, where appropriate.

9. Scatter diagrams; lines of best fit.	Including the method of semi-averages for fitting a straight line; the derivation of the equation of the fitted straight line in the form $y = mx + c$ .
10. Elementary ideas of probability.	Including the treatment of mutually exclusive and independent events.
11. Simple probability and frequency distributions for a discrete variable. Expectation.	Including expected profit and loss in simple games; idea of a fair game.

## 5. Mathematical notation

The list which follows summarises the notation used in the Cambridge's Mathematics examinations. Although primarily directed towards Advanced/HSC (Principal) level, the list also applies, where relevant, to examinations at Cambridge O Level/S.C.

### 1. Set Notation

$\in$	is an element of
$\notin$	is not an element of
$\{x_1, x_2, \dots\}$	the set with elements $x_1, x_2, \dots$
$\{x: \dots\}$	the set of all $x$ such that...
$n(A)$	the number of elements in set $A$
$\emptyset$	the empty set
$\mathcal{E}$	universal set
$A'$	the complement of the set $A$
$\mathbb{N}$	the set of positive integers, $\{1, 2, 3, \dots\}$
$\mathbb{Z}$	the set of integers $\{0, \pm 1, \pm 2, \pm 3, \dots\}$
$\mathbb{Z}^+$	the set of positive integers $\{1, 2, 3, \dots\}$
$\mathbb{Z}_n$	the set of integers modulo $n$ , $\{0, 1, 2, \dots, n-1\}$
$\mathbb{Q}$	the set of rational numbers
$\mathbb{Q}^+$	the set of positive rational numbers, $\{x \in \mathbb{Q}: x > 0\}$
$\mathbb{Q}_0^+$	the set of positive rational numbers and zero, $\{x \in \mathbb{Q}: x \geq 0\}$
$\mathbb{R}$	the set of real numbers
$\mathbb{R}^+$	the set of positive real numbers $\{x \in \mathbb{R}: x > 0\}$
$\mathbb{R}_0^+$	the set of positive real numbers and zero $\{x \in \mathbb{R}: x \geq 0\}$
$\mathbb{R}^n$	the real $n$ -tuples
$\mathbb{C}$	the set of complex numbers
$\subseteq$	is a subset of
$\subset$	is a proper subset of
$\not\subseteq$	is not a subset of
$\not\subset$	is not a proper subset of
$\cup$	union
$\cap$	intersection
$[a, b]$	the closed interval $\{x \in \mathbb{R}: a \leq x \leq b\}$
$[a, b)$	the interval $\{x \in \mathbb{R}: a \leq x < b\}$
$(a, b]$	the interval $\{x \in \mathbb{R}: a < x \leq b\}$
$(a, b)$	the open interval $\{x \in \mathbb{R}: a < x < b\}$
$yRx$	$y$ is related to $x$ by the relation $R$
$y \sim x$	$y$ is equivalent to $x$ , in the context of some equivalence relation

## 2. Miscellaneous Symbols

$=$	is equal to
$\neq$	is not equal to
$\equiv$	is identical to or is congruent to
$\approx$	is approximately equal to
$\cong$	is isomorphic to
$\propto$	is proportional to
$<, \ll$	is less than, is much less than
$\leq, \nless$	is less than or equal to, is not greater than
$>, \gg$	is greater than, is much greater than
$\geq, \ngtr$	is greater than or equal to, is not less than
$\infty$	infinity

## 3. Operations

$a + b$	$a$ plus $b$
$a - b$	$a$ minus $b$
$a \times b, ab, a.b$	$a$ multiplied by $b$
$a \div b, \frac{a}{b}, a/b$	$a$ divided by $b$
$a : b$	the ratio of $a$ to $b$
$\sum_{i=1}^n a_i$	$a_1 + a_2 + \dots + a_n$
$\sqrt{a}$	the positive square root of the real number $a$
$ a $	the modulus of the real number $a$
$n!$	$n$ factorial for $n \in \mathbb{N}$ ( $0! = 1$ )
$\binom{n}{r}$	the binomial coefficient $\frac{n!}{r!(n-r)!}$ , for $n, r \in \mathbb{N}$ , $0 \leq r \leq n$

$$\frac{n(n-1)\dots(n-r+1)}{r!}, \text{ for } n \in \mathbb{Q}, r \in \mathbb{N}$$

#### 4. Functions

$f$	function $f$
$f(x)$	the value of the function $f$ at $x$
$f: A \rightarrow B$	$f$ is a function under which each element of set $A$ has an image in set $B$
$f: x \mapsto y$	the function $f$ maps the element $x$ to the element $y$
$f^{-1}$	the inverse of the function $f$
$g \circ f, gf$	the composite function of $f$ and $g$ which is defined by $(g \circ f)(x)$ or $gf(x) = g(f(x))$
$\lim_{x \rightarrow a} f(x)$	the limit of $f(x)$ as $x$ tends to $a$
$\Delta x; \delta x$	an increment of $x$
$\frac{dy}{dx}$	the derivative of $y$ with respect to $x$
$\frac{d^n y}{dx^n}$	the $n$ th derivative of $y$ with respect to $x$
$f'(x), f''(x), \dots, f^{(n)}(x)$	the first, second, ..., $n$ th derivatives of $f(x)$ with respect to $x$
$\int y \, dx$	indefinite integral of $y$ with respect to $x$
$\int_a^b y \, dx$	the definite integral of $y$ with respect to $x$ for values of $x$ between $a$ and $b$
$\frac{\partial y}{\partial x}$	the partial derivative of $y$ with respect to $x$
$\dot{x}, \ddot{x}, \dots$	the first, second, ... derivatives of $x$ with respect to time

#### 5. Exponential and Logarithmic Functions

$e$	base of natural logarithms
$e^x, \exp x$	exponential function of $x$
$\log_a x$	logarithm to the base $a$ of $x$
$\ln x$	natural logarithm of $x$
$\lg x$	logarithm of $x$ to base 10

## 6. Circular and Hyperbolic Functions and Relations

$\sin, \cos, \tan,$ $\operatorname{cosec}, \sec, \cot$	}	the circular functions
$\sin^{-1}, \cos^{-1}, \tan^{-1},$ $\operatorname{cosec}^{-1}, \sec^{-1}, \cot^{-1}$	}	the inverse circular relations
$\sinh, \cosh, \tanh,$ $\operatorname{cosech}, \operatorname{sech}, \coth$	}	the hyperbolic functions
$\sinh^{-1}, \cosh^{-1}, \tanh^{-1},$ $\operatorname{cosech}^{-1}, \operatorname{sech}^{-1}, \coth^{-1}$	}	the inverse hyperbolic relations

## 7. Complex Numbers

$i$	square root of $-1$
$z$	a complex number, $z = x + iy$  $= r(\cos \theta + i \sin \theta), r \in \mathbb{R}_0^+$  $= re^{i\theta}, r \in \mathbb{R}_0^+$
$\operatorname{Re} z$	the real part of $z$ , $\operatorname{Re}(x + iy) = x$
$\operatorname{Im} z$	the imaginary part of $z$ , $\operatorname{Im}(x + iy) = y$
$ z $	the modulus of $z$ , $ x + iy  = \sqrt{(x^2 + y^2)}, / r(\cos \theta + i \sin \theta)  = r$
$\arg z$	the argument of $z$ , $\arg(r(\cos \theta + i \sin \theta)) = \theta, -\pi < \theta \leq \pi$
$z^*$	the complex conjugate of $z$ , $(x + iy)^* = x - iy$

## 8. Matrices

$\mathbf{M}$	a matrix $\mathbf{M}$
$\mathbf{M}^{-1}$	the inverse of the square matrix $\mathbf{M}$
$\mathbf{M}^T$	the transpose of the matrix $\mathbf{M}$
$\det \mathbf{M}$	the determinant of the square matrix $\mathbf{M}$

## 9. Vectors

$\mathbf{a}$	the vector $\mathbf{a}$
$\overrightarrow{AB}$	the vector represented in magnitude and direction by the directed line segment $AB$
$\hat{\mathbf{a}}$	a unit vector in the direction of the vector $\mathbf{a}$
$\mathbf{i}, \mathbf{j}, \mathbf{k}$	unit vectors in the directions of the cartesian coordinate axes
$ \mathbf{a} $	the magnitude of $\mathbf{a}$
$ \overrightarrow{AB} $	the magnitude of $\overrightarrow{AB}$
$\mathbf{a} \cdot \mathbf{b}$	the scalar product of $\mathbf{a}$ and $\mathbf{b}$
$\mathbf{a} \times \mathbf{b}$	the vector product of $\mathbf{a}$ and $\mathbf{b}$

## 10. Probability and Statistics

$A, B, C$ etc.	events
$A \cup B$	union of events $A$ and $B$
$A \cap B$	intersection of the events $A$ and $B$
$P(A)$	probability of the event $A$
$A'$	complement of the event $A$ , the event 'not $A$ '
$P(A B)$	probability of the event $A$ given the event $B$
$X, Y, R$ , etc.	random variables
$x, y, r$ , etc.	values of the random variables $X, Y, R$ , etc.
$x_1, x_2, \dots$	observations
$f_1, f_2, \dots$	frequencies with which the observations $x_1, x_2, \dots$ occur
$p(x)$	the value of the probability function $P(X = x)$ of the discrete random variable $X$
$p_1, p_2, \dots$	probabilities of the values $x_1, x_2, \dots$ of the discrete random variable $X$
$f(x), g(x), \dots$	the value of the probability density function of the continuous random variable $X$

$F(x), G(x), \dots$	the value of the (cumulative) distribution function $P(X \leq x)$ of the random variable $X$
$E(X)$	expectation of the random variable $X$
$E[g(X)]$	expectation of $g(X)$
$\text{Var}(X)$	variance of the random variable $X$
$G(t)$	the value of the probability generating function for a random variable which takes integer values
$B(n, p)$	binomial distribution, parameters $n$ and $p$
$N(\mu, \sigma^2)$	normal distribution, mean $\mu$ and variance $\sigma^2$
$\mu$	population mean
$\sigma^2$	population variance
$\sigma$	population standard deviation
$\bar{x}$	sample mean
$s^2$	unbiased estimate of population variance from a sample, $s^2 = \frac{1}{n-1} \sum (x - \bar{x})^2$
$\phi$	probability density function of the standardised normal variable with distribution $N(0, 1)$
$\Phi$	corresponding cumulative distribution function
$\rho$	linear product-moment correlation coefficient for a population
$r$	linear product-moment correlation coefficient for a sample
$\text{Cov}(X, Y)$	covariance of $X$ and $Y$



## 6. Resource list

These titles represent some of the texts available in the UK at the time of printing this booklet. Teachers are encouraged to choose texts for class use which they feel will be of interest to their candidates and will support their own teaching style. ISBN numbers are provided wherever possible.

### Suggested Books

Author	Title	Date	Publisher	ISBN Number
Caswell	<i>Success in Statistics</i>	1994	John Murray	019572029
Chalmers	<i>O Level Statistics</i>	2003	Voila Publishers	9991255907
Clegg	<i>Simple Statistics</i>	1983	Cambridge University Press	0521288029
Hartley	<i>Statistics Book 1</i>	1998	Impart Books	8120203089
Plews	<i>Introductory Statistics</i>	1979	Heinemann	0435537504
Walker, McLean and Matthew	<i>Statistics – a first course</i>	1993	Hodder and Stoughton Educational	0340552468

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## 7. Additional information

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### 7.1 Guided learning hours

Cambridge O Level syllabuses are designed on the assumption that candidates have about 130 guided learning hours per subject over the duration of the course. ('Guided learning hours' include direct teaching and any other supervised or directed study time. They do not include private study by the candidate.)

However, this figure is for guidance only, and the number of hours required may vary according to local curricular practice and the candidates' prior experience of the subject.

### 7.2 Recommended prior learning

Candidates beginning this course are not expected to have studied Statistics previously.

### 7.3 Progression

Cambridge O Level Certificates are general qualifications that enable candidates to progress either directly to employment, or to proceed to further qualifications.

Candidates who are awarded grades C to A\* in Cambridge O Level Statistics are well prepared to follow courses leading to Cambridge International AS and A Level Statistics, or the equivalent.

### 7.4 Component codes

Because of local variations, in some cases component codes will be different in instructions about making entries for examinations and timetables from those printed in this syllabus, but the component names will be unchanged to make identification straightforward.

### 7.5 Grading and reporting

Cambridge O Level results are shown by one of the grades A\*, A, B, C, D or E indicating the standard achieved, Grade A\* being the highest and Grade E the lowest. 'Ungraded' indicates that the candidate's performance fell short of the standard required for Grade E. 'Ungraded' will be reported on the statement of results but not on the certificate.

Percentage uniform marks are also provided on each candidate's statement of results to supplement their grade for a syllabus. They are determined in this way:

- A candidate who obtains...
  - ... the minimum mark necessary for a Grade A\* obtains a percentage uniform mark of 90%.
  - ... the minimum mark necessary for a Grade A obtains a percentage uniform mark of 80%.
  - ... the minimum mark necessary for a Grade B obtains a percentage uniform mark of 70%.
  - ... the minimum mark necessary for a Grade C obtains a percentage uniform mark of 60%.
  - ... the minimum mark necessary for a Grade D obtains a percentage uniform mark of 50%.

- ... the minimum mark necessary for a Grade E obtains a percentage uniform mark of 40%.
- ... no marks receives a percentage uniform mark of 0%.

Candidates whose mark is none of the above receive a percentage mark in between those stated according to the position of their mark in relation to the grade 'thresholds' (i.e. the minimum mark for obtaining a grade). For example, a candidate whose mark is halfway between the minimum for a Grade C and the minimum for a Grade D (and whose grade is therefore D) receives a percentage uniform mark of 55%.

The percentage uniform mark is stated at syllabus level only. It is not the same as the 'raw' mark obtained by the candidate, since it depends on the position of the grade thresholds (which may vary from one series to another and from one subject to another) and it has been turned into a percentage.

## 7.6 Access

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments and to demonstrate what they know and what they can do. For this reason, very few candidates will have a complete barrier to the assessment. Information on reasonable adjustments is found in the *Cambridge Handbook* which can be downloaded from the website **www.cie.org.uk**

Candidates who are unable to access part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award based on the parts of the assessment they have taken.

## 7.7 Support and resources

Copies of syllabuses, the most recent question papers and Principal Examiners' reports for teachers are on the Syllabus and Support Materials CD-ROM, which we send to all Cambridge International Schools. They are also on our public website – go to **www.cie.org.uk/olevel**. Click the **Subjects** tab and choose your subject. For resources, click 'Resource List'.

You can use the 'Filter by' list to show all resources or only resources categorised as 'Endorsed by Cambridge'. Endorsed resources are written to align closely with the syllabus they support. They have been through a detailed quality-assurance process. As new resources are published, we review them against the syllabus and publish their details on the relevant resource list section of the website.

Additional syllabus-specific support is available from our secure Teacher Support website **http://teachers.cie.org.uk** which is available to teachers at registered Cambridge schools. It provides past question papers and examiner reports on previous examinations, as well as any extra resources such as schemes of work or examples of candidate responses. You can also find a range of subject communities on the Teacher Support website, where Cambridge teachers can share their own materials and join discussion groups.

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