General Certificate of Education
Ordinary Level

Syllabus

STATISTICS 4040

For examination in November 2010

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Notes

Available in the November examination only.

Mathematical Tables
The Cambridge Elementary Mathematical Tables (Second Edition) will continue to be provided for use where necessary in SC/O level Statistics (Papers 4040/1 and 2). Further copies of these tables may be obtained from the Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge and through booksellers. No mathematical tables other than these are permitted in this examination.

Electronic Calculators
1. At **all centres** the use of silent electronic calculators is **expected** in SC/O Level Statistics (4040).
2. The General Regulations concerning the use of electronic calculators are contained in the Handbook for Centres.

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

Mathematical Notation
Attention is drawn to 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.

STATISTICS (4040)

ORDINARY LEVEL AND SCHOOL CERTIFICATE
(AVAILABLE ONLY IN THE NOVEMBER EXAMINATION)

Scheme of Papers

There will be two written papers, each of 2¼ hours. Each will consist of six compulsory short questions in Section A (36 marks) and a choice of four out of five longer questions in Section B (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 CIE.

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	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. 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. 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.
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.

MATHEMATICAL NOTATION

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

Mathematical Notation

1. *Set Notation*

$\in$	is an element of
$\notin$	is not an element of
$\{x_1, x_2, \ldots\}$	the set with elements $x_1, x_2, \ldots$
$\{x: \ldots\}$	the set of all x such that…
$\mathrm{n}(A)$	the number of elements in set A
$\varnothing$	the empty set
$\mathscr{E}$	universal set
A'	the complement of the set A
$\mathbb{N}$	the set of positive integers, {1, 2, 3, …}
$\mathbb{Z}$	the set of integers {0, ± 1, ± 2, ± 3, …}
$\mathbb{Z}^+$	the set of positive integers {1, 2, 3, …}
$\mathbb{Z}_n$	the set of integers modulo n, {0, 1, 2, …, 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, $\{x \in \mathbb{Q}: x \geqslant 0\}$
$\mathbb{R}$	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 $\{x \in \mathbb{R}: x \geqslant 0\}$
$\mathbb{R}^n$	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 $\{x \in \mathbb{R}: a \leqslant x \leqslant b\}$
$[a, b)$	the interval $\{x \in \mathbb{R}: a \leqslant x < b\}$
$(a, b]$	the interval $\{x \in \mathbb{R}: a < x \leqslant b\}$
(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
$\leqslant$, $\not>$	is less than or equal to, is not greater than
$>$; $\gg$	is greater than, is much greater than
$\geqslant$, $\not<$	is greater than or equal to, is not less than
∞	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
$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + \ldots + a_n$
$\sqrt{a}$	the positive square root of the real number a
$\lvert a \rvert$	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 $n, r \in \mathbb{N}$, $0 \leqslant r \leqslant n$
	$\frac{n(n-1)\ldots(n-r+1)}{r!}$, for $n \in \mathbb{Q}$, $r \in \mathbb{N}$

4. *Functions*

f	function f
$\mathrm{f}(x)$	the value of the function f at x
$\mathrm{f} : A \to B$	f is a function under which each element of set A has an image in set B
$\mathrm{f} : x \mapsto y$	the function f maps the element x to the element y
f^{-1}	the inverse of the function f
$\mathrm{g} \circ \mathrm{f}$, gf	the composite function of f and g which is defined by $(\mathrm{g} \circ \mathrm{f})(x)$ or $\mathrm{gf}(x) = \mathrm{g}(\mathrm{f}(x))$
$\lim_{x \to a} \mathrm{f}(x)$	the limit of $\mathrm{f}(x)$ as x tends to a
Δx; δx	an increment of x
$\frac{\mathrm{d}y}{\mathrm{d}x}$	the derivative of y with respect to x
$\frac{\mathrm{d}^n y}{\mathrm{d}x^n}$	the nth derivative of y with respect to x
$\mathrm{f}'(x)$, $\mathrm{f}''(x)$, …, $\mathrm{f}^{(n)}(x)$	the first, second, …, nth derivatives of $\mathrm{f}(x)$ with respect to x
$\int y \mathrm{d}x$	indefinite integral of y with respect to x
$\int_a^b y \, \mathrm{d}x$	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
$\dot{x}, \ddot{x}, ...$	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, cosec, sec, cot	the circular functions
$\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, cosec^{-1}, $\sec^{-1}$, $\cot^{-1}$	the inverse circular relations
sinh, cosh, tanh, cosech, sech, coth	the hyperbolic functions
$\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, cosech^{-1}, sech^{-1}, $\coth^{-1}$	the inverse hyperbolic relations

7. *Complex Numbers*

i	square root of –1
z	a complex number, $z = x + iy$ $= r(\cos\theta + i\sin\theta), r \in \mathbb{R}_0^+$ $= re^{i\theta}, r \in \mathbb{R}_0^+$
$\text{Re}\, z$	the real part of z, $\text{Re}(x + iy) = x$
$\text{Im}\, z$	the imaginary part of z, $\text{Im}(x + iy) = y$
$\lvert z \rvert$	the modulus of z, $\lvert x + iy \rvert = \sqrt{(x^2 + y^2)}$, $\lvert r(\cos\theta + i\sin\theta) \rvert = r$
$\arg z$	the argument of z, $\arg(r(\cos\theta + i\sin\theta)) = \theta$, $-\pi < \theta \leqslant \pi$
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 $\mathbf{M}$
$\mathbf{M}^{\mathrm{T}}$	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
$\lvert \mathbf{a} \rvert$	the magnitude of $\mathbf{a}$
$\lvert \overrightarrow{AB} \rvert$	the magnitude of $\overrightarrow{AB}$
$\mathbf{a} . \mathbf{b}$	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
$\mathrm{P}(A)$	probability of the event A
A'	complement of the event A, the event 'not A'
$\mathrm{P}(A\|B)$	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.
$x_1, x_2, \ldots$	observations
$f_1, f_2, \ldots$	frequencies with which the observations $x_1, x_2, \ldots$ occur
$\mathrm{p}(x)$	the value of the probability function $\mathrm{P}(X = x)$ of the discrete random variable X
$p_1, p_2, \ldots$	probabilities of the values $x_1, x_2, \ldots$ of the discrete random variable X
$\mathrm{f}(x), \mathrm{g}(x), \ldots$	the value of the probability density function of the continuous random variable X
$\mathrm{F}(x), \mathrm{G}(x), \ldots$	the value of the (cumulative) distribution function $\mathrm{P}(X \leqslant x)$ of the random variable X
$\mathrm{E}(X)$	expectation of the random variable X
$\mathrm{E}[\mathrm{g}(X)]$	expectation of $\mathrm{g}(X)$
$\mathrm{Var}(X)$	variance of the random variable X
$\mathrm{G}(t)$	the value of the probability generating function for a random variable which takes integer values
$\mathrm{B}(n, p)$	binomial distribution, parameters n and p
$\mathrm{Po}(\mu)$	Poisson distribution, mean μ
$\mathrm{N}(\mu, \sigma^2)$	normal distribution, mean μ and variance σ^2
μ	population mean
σ^2	population variance
σ	population standard deviation
$\bar{x}$	sample mean
s^2	unbiased estimate of population variance from a sample, $s^2 = \frac{1}{n-1}\sum (x - \bar{x})^2$
ϕ	probability density function of the standardised normal variable with distribution $\mathrm{N}(0, 1)$
Φ	corresponding cumulative distribution function
ρ	linear product-moment correlation coefficient for a population
r	linear product-moment correlation coefficient for a sample
$\mathrm{Cov}(X, Y)$	covariance of X and Y

BOOKLIST

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 students and will support their own teaching style. ISBN numbers are provided wherever possible.

O LEVEL STATISTICS 4040

Suggested Books

Caswell *Success in Statistics* (John Murray, 1994) 0 7195 7202 9

Clegg *Simple Statistics* (Cambridge University Press, 1983) 0 521 28802 9

Hartley *Statistics Book 1* (Impart Books, 1998) 81 202 0308 9

Plews *Introductory Statistics* (Heinemann, 1979) 0 435 53750 4

Walker, McLean and Matthew *Statistics – a first course* (Hodder & Stoughton Educational, 1993) 0 340 55246 8