Oxford Cambridge and RSA Examinations

AS GCE STATISTICS (MEI)

OCR ADVANCED SUBSIDIARY GCE IN STATISTICS (MEI) (H132)

Key Features

- **Meets the needs of statistics users across the curriculum.**
- **Unrivalled levels of support and advice.**
- **Web-based resources.**
- **Clear and appropriate progression from GCSE.**
- **User-friendly.**

This specification was devised by Mathematics in Education and Industry (MEI) and is administered by OCR.

Across the Curriculum

This specification covers the statistics that students will meet in other GCE subjects, and provides a good background for those who will go on to use statistics in Higher Education or employment.

Support and Advice

The specification is accompanied by a complete support package provided by MEI and OCR. The two organisations work closely together with MEI taking responsibility for the curriculum and teaching aspects of the course, and OCR the assessment.

- Advice is always available at the end of the telephone or by e-mail.
- One-day INSET courses provided by both MEI and OCR.
- The MEI annual three-day conference.
- MEI branch meetings.
- An e-mail user group run by OCR.
- Regular newsletters from MEI.
- Specimen and past examination papers, mark schemes and examiners' reports.

Web-based Support

This specification is supported by a purpose-built website designed to help students and teachers.

Progression

Students meet statistics in the data-handling strand of GCSE Mathematics. This specification builds on the knowledge that they have acquired (at Intermediate Tier).

User friendliness

This specification has been designed by teachers for students. Thus the accompanying text book is accessible to students, easy to read and work from. The MEI *Students' Handbook* provides a particularly helpful source of information.

First assessment for Unit *Z1* January 2006 QAN 100/5039/5
First assessment for Units *Z2* and *Z3* June 2006

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SECTION A: SPECIFICATION OVERVIEW

This course is designed for those who need more statistics than that contained in GCSE Mathematics, but do not want to take AS GCE or Advanced GCE Mathematics. It is particularly useful for those taking other GCE subjects that involve some statistics: Geography, Biology, Business Studies, Psychology, Economics etc.

The mathematical demands of this AS Statistics specification have been kept to the minimum consistent with the subject. In particular, no knowledge of calculus is required.

The AS Statistics qualification is based on **three** compulsory units, designated *Z1*, *Z2* and *Z3*. Each of them is assessed by an examination lasting 1½ hours. Examinations for all three units are available in June, and there is an examination for *Z1* available in January as well. There are no coursework requirements. Students are expected to study Unit *Z1* first. Units *Z2* and *Z3* may be studied at the same time but the assessment of Unit *Z3* (particularly for the long Section B question) may draw upon material from Units *Z1* and *Z2*.

The first unit, *Z1*, is identical with the MEI Structured Mathematics unit Statistics 1, *S1*. After that, however, the two courses diverge. The remaining two units for AS Statistics, *Z2* and *Z3*, are unrelated to Statistics 2 and 3 (*S2* and *S3*) in the Structured Mathematics suite.

SECTION B: GENERAL INFORMATION

1 Introduction

1.1 RATIONALE

1.1.1 This Specification

This booklet contains the specification for AS GCE Statistics for first teaching in September 2005. This specification was developed by Mathematics in Education and Industry (MEI) and is assessed by OCR. Support for those delivering the specification comes from both bodies and this is one of its particular strengths.

The criteria for GCE Mathematics were revised in 2002-3, leading to new mathematics specifications for first teaching in September 2004. The new criteria allow fewer certification titles from the units designed for GCE Mathematics and Further Mathematics. In consequence the title 'Statistics' is no longer available from within the suite of mathematics units and, from now on, GCE qualifications with the title Statistics are to be independent. The intention is that they should concentrate on the needs of users, whereas the statistics units in GCE Mathematics provide more of the underlying mathematical theory. It is, however, accepted that the first unit of both courses might reasonably be common. (This is the case in this specification which shares the unit *Z1* with the MEI Structured Mathematics *S1*.)

Underlying this change was the feeling that the provision for statistics within the mathematics suite had led to the GCE Statistics qualifications being quite mathematical in nature, making them inaccessible to many students following courses like Business Studies, Psychology, Geography, Biology etc. In this specification, the mathematical demand is no more than is required by the subject, but there is a correspondingly increased emphasis on interpretation and modelling.

This specification has been designed to provide many more students with access to the statistics that they actually need, both immediately and as a starting point when they proceed into Higher Education or employment.

MEI is a curriculum development body and in devising this specification the long term needs of students have been its paramount concern.

This specification meets the requirements of the Common Criteria (QCA, 1999), the GCE Advanced Subsidiary Qualification-Specific Criteria (QCA, 1999) and relevant sections of the Subject Criteria for Mathematics (QCA, 2002).

1.1.2 Structure

AS GCE Statistics consists of three equally-weighted units – *Z1*, *Z2* and *Z3*. The first of these, *Z1*, is identical to the unit Statistics 1, *S1* (having a common Question Paper) in the MEI GCE Mathematics specification.

1.1.3 Outline of Content

Z1: Processes
Data Presentation
Probability
Discrete Random Variables
The Binomial Distribution and its use in Hypothesis Testing

Z2: Probability Models
Poisson Distribution
Normal Distribution
Sample Data: Estimation and Hypothesis Testing

Z3: Sampling
Design of Experiments
Estimation and Hypothesis Testing
Correlation

1.1.4 MEI and OCR

MEI is a long established, independent curriculum development body, with a membership consisting almost entirely of working teachers. MEI provides advice and INSET relating to all the curriculum and teaching aspects of the course. It also provides teaching materials, and the accompanying textbook is the product of a partnership between MEI and a major publishing house. A particular feature of this specification is the website support (see Section 7). Students can access this at school or college, or when working at home. Not only does this help them with their immediate statistics course; it also develops the skills they will need for independent learning throughout their lives.

OCR's involvement is primarily centred on the assessment, awarding and issuing of results. However, members of the Qualification Team are available to give advice, receive feedback and give general support.

OCR also provides INSET and materials such as examiners' reports, mark schemes and past papers.

It is thus a feature of this specification that an exceptional level of help is always available to teachers and students, at the end of the telephone or on-line.

1.1.5 New Opportunities

The 2002-3 changes to the subject criteria for mathematics, published by QCA in December 2002, are intended to make statistics more accessible for students. This specification is designed to take full advantage of the opportunities this opens up.

1.1.6 A Route of Progression

AS GCE Statistics is designed to provide a realistic route of progression for users of the subject, starting at Intermediate Tier GCSE through Level 3 study and into Higher Education. The specification is also, by design, entirely suitable for those who are already in employment, or are intending to progress directly into employment.

1.2 CERTIFICATION TITLE

This specification will be shown on a certificate as:

OCR Advanced Subsidiary GCE in Statistics (MEI)

1.3 LANGUAGE

This specification, and all associated assessment materials, are available only in English. The language used in all question papers will be plain, clear, free from bias and appropriate to the qualification.

1.4 EXCLUSIONS

This qualification is **not** subject to any rules about prohibited combinations with other OCR qualifications. However, there are restrictions on combinations of *unit entries* for this specification and MEI Structured Mathematics.

Concurrent entries for Unit *S1* in the MEI Structured Mathematics specification and Unit *Z1* in this specification will **not** be accepted.

Every specification is assigned to a national classification code indicating the subject area to which it belongs. Centres should be aware that candidates who enter for more than one GCE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The classification code for this specification is 2260.

1.5 KEY SKILLS

In accordance with the aims of MEI, this scheme has been designed to meet the request of industry (e.g. the CBI) that students be provided with opportunities to use and develop Key Skills.

If the units are taught with Key Skills in mind, they provide rich opportunities for fostering all of the Key Skills, as indicated in the table below for Level 3.

Unit		Communication	Application of Number	Information Technology	Working with Others	Improving Own Learning and Performance	Problem Solving
Z1	G241	✓	✓	✓	✓	✓	✓
Z2	G242	✓	✓	✓	✓	✓	✓
Z3	G243	✓	✓	✓	✓	✓	✓

1.6 CODE OF PRACTICE REQUIREMENTS

The qualifications will comply with the grading, awarding and certification requirements of the GCE section of the Code of Practice.

1.7 SPIRITUAL, MORAL, ETHICAL, SOCIAL AND CULTURAL ISSUES

Students are required to examine arguments critically and so to distinguish between truth and falsehood. They are also expected to interpret the results of statistical and modelling exercises and there are times when this inevitably raises moral and cultural issues. Such issues will not be assessed in the examination questions.

1.8 ENVIRONMENTAL EDUCATION, EUROPEAN DIMENSION AND HEALTH AND SAFETY ISSUES

While the work developed in teaching this specification may use examples that raise environmental issues, these issues do not in themselves form part of the specification.

The work developed in teaching this specification may at times involve examples that raise health and safety issues. These issues do not in themselves form part of this specification.

OCR has taken account of the 1988 Resolution of the Council of the European Community and the Report *Environmental Responsibility: An Agenda for Further and Higher Education*, 1993 in preparing this specification and associated specimen assessment materials.

Teachers should be aware that students may be exposed to risks when doing coursework. They should apply usual laboratory precautions when experimental work is involved. Students should not be expected to collect data on their own when outside their Centre.

Teachers should be aware of the dangers of repetitive strain injury for any student who spends a long time working on a computer.

1.9 AVOIDANCE OF BIAS

MEI and OCR have taken great care in the preparation of this specification and assessment materials to avoid bias of any kind.

1.10 CALCULATORS

Students are expected to make appropriate use of calculators.

2 Specification Aims

2.1 AIMS OF MEI

'To promote the links between education and industry at Secondary School level, and to produce relevant examination and teaching specifications and support material.'

2.2 AIMS OF THIS SPECIFICATION

This course should encourage students to:

- develop their understanding of statistics and statistical processes in a way that promotes confidence and fosters enjoyment;
- develop the ability to use data to argue a case and to recognise incorrect reasoning;
- extend their range of statistical skills and techniques and judge when it is appropriate to use them;
- recognise how statistics may be used to model a situation and understand the relationship between 'real world' problems and standard statistical models, and how these can be refined and improved;
- understand what is involved in statistical experiments;
- use statistics as an effective means of communication;
- read and comprehend arguments and articles concerning applications of statistics;
- acquire the skills needed to use the statistical functions on calculators and in computer software effectively, recognise when such use may be inappropriate and be aware of the limitations of any outputs;
- develop an awareness of the relevance of statistics to other fields of study, to the world of work and to society in general.

3 Assessment Objectives

3.1 APPLICATION

This specification requires students to demonstrate the following assessment objectives in the context of the knowledge, understanding and skills prescribed.

Students should be able to demonstrate that they can:

AO1

- recall, select and use their knowledge of statistical facts, concepts and techniques in a variety of contexts.

AO2

- construct rigorous statistical arguments and proofs through use of precise statements, logical deduction and inference, including the construction of extended arguments for handling substantial problems presented in unstructured form.

AO3

- recall, select and use their knowledge of statistical models to represent situations in the real world;
- recognise and understand given representations involving statistical models;
- present and interpret results from such models in terms of the original situation, including discussion of assumptions made and refinement of such models.

AO4

- comprehend translations of common realistic contexts into statistical models;
- use the results of calculations to make predictions, or comment on the context;
- interpret statistical information;
- where appropriate, read critically and comprehend longer statistical arguments or examples of applications.

AO5

- use contemporary calculator technology, formulae booklets and statistical tables accurately and efficiently;
- understand when not to use such technology, and its limitations;
- give answers to appropriate accuracy.

3.2 SPECIFICATION GRID

The table below gives the permitted allocation of marks to assessment objectives for the various units. The figures given are percentages.

Entry Code	Unit Code	Unit Name	Weighting of Assessment Objective (%)				
			AO1	AO2	AO3	AO4	AO5
G241	Z1	AS Statistics 1	20-30	20-30	25-35	10-20	5-15
G242	Z2	AS Statistics 2	10-20	10-20	30-40	20-30	5-15
G243	Z3	AS Statistics 3	10-20	10-20	30-40	20-30	5-15

These correspond to the following allocations of actual marks.

Entry Code	Unit Code	Unit Name	Weighting of Assessment Objective (%)				
			AO1	AO2	AO3	AO4	AO5
G241	Z1	AS Statistics 1	15-21	15-21	18-25	8-14	4-10
G242	Z2	AS Statistics 2	8-14	8-14	22-28	15-21	4-10
G243	Z3	AS Statistics 3	8-14	8-14	22-28	15-21	4-10

4 Scheme of Assessment

4.1 CENTRE REGISTRATION

Please note that centres must be registered with OCR in order to make any entries, including estimated entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Centres should be aware that a minimum of ten candidates for summer examinations is normally required.

4.2 UNITS OF ASSESSMENT

4.2.1 Summary Table

Entry Code	Unit Code	Unit Name	Examination Questions* (approximate mark allocation)	Time (hours)
G241	Z1	AS Statistics 1	A: (5-7) × ≤ 8, total 36; B: 2 × (17-19), total 36	1½
G242	Z2	AS Statistics 2	5 × (13-16), total 72	1½
G243	Z3	AS Statistics 3	A: 3 × (15-16), total (45-48); B: 1 × (24-27), total (24-27); paper total 72	1½

* number of questions x number of marks for each

4.2.2 Weighting

For all certifications, the contribution of each unit is the same. Thus each unit carries $33^{1}/_{3}$% of the total marks for an Advanced Subsidiary certification.

4.3 STRUCTURE

4.3.1 Recommended Order

Students are expected to study Unit *Z1* first. Units *Z2* and *Z3* may be studied at the same time but the assessment of Unit *Z3* (particularly for the long Section B question) may draw upon material from Units *Z1* and *Z2*.

4.3.2 Synoptic Assessment

There are no requirements concerning synoptic assessment relating to the certification of Advanced Subsidiary GCE Statistics.

4.4 FINAL CERTIFICATION

Each unit is given a grade and a Uniform Mark, using procedures laid down by QCA in the document '*GCE A and AS Code of Practice*'. The relationship between total Uniform Mark and subject grade follows the national scheme.

To claim an award at the end of the course, candidates' unit results must be aggregated. This does not happen automatically and Centres must make separate 'certification entries'.

4.4.1 Awarding of Grades

Advanced Subsidiary GCE qualifications are awarded on the scale A to E or U (unclassified).

4.4.2 Enquiries on Results

Candidates will receive their final unit results at the same time as their subject results. In common with other Advanced Subsidiary GCE results, the subject results are at that stage provisional to allow enquiries on results. Enquiries concerning marking are made at the unit level and so only those units taken at the last sitting may be the subject of such appeals. Enquiries are subject to OCR's general regulations.

4.5 AVAILABILITY

4.5.1 Unit Availability

Z1: There are two examination sessions each year, in January and June.
Z2 and *Z3*: There is one examination session each year in June.

4.5.2 Certification Availability

Certification is available following the June examinations.

4.5.3 Shelf-life of Units

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the specifications.

4.6 RE-SITS

4.6.1 Re-sits of Units

There is no limit to the number of times a candidate may re-sit a unit. The best result will count.

4.6.2 Re-sits of the Whole Qualification

Candidates may take the whole qualification more than once.

4.7 QUESTION PAPERS

4.7.1 Style of Question Papers

The assessment requirements of the three units are summarised in the table in Section 4.1.1.

The three units are each assessed by a single question paper lasting 1½ hours and all questions are compulsory.

Z1: Has two sections, A and B.
Questions in Section A are shorter (no more than 8 marks) and test techniques.
The two questions in Section B are longer (17-19 marks each).

Z2: The five questions are all about (but not exactly) the same length (13-16 marks each).

Z3: Has two sections, A and B.
The three questions in Section A are all about (but not necessarily exactly) the same length (15-16 marks each). Section B consists of a single extended question, (24-27 marks) and tests candidates' ability to follow an extended piece of statistics.

4.7.2 Use of Language

Candidates are expected to use clear, precise and appropriate mathematical language, as described in Assessment Objective 2.

4.7.3 Thresholds

At the time of setting, each examination paper will be designed so that 50% of the marks are available to grade E candidates , 75% to grade C and 100% to grade A. Typically candidates are expected to achieve about four fifths of the marks available to achieve a grade, giving design grades of : A 80%, B 70%, C 60%, D 50% and E 40%. The actual grading is carried out by the Awarding Committee. They make allowance for examination performance and for any features of a particular paper that only become apparent after it has been taken. Thus some variation from the design grades can be expected in the award.

4.7.4 Calculators

Candidates are expected to have calculators with the standard statistical functions.

Questions may be set requiring interpretation of tabular and/or graphical output from calculators, spreadsheets and statistical computing packages. Knowledge of any particular software is **not** required.

4.7.5 Formulae and Statistical Tables

A booklet containing formulae and statistical tables is available for the use of candidates in all unit examinations.

A fuller booklet, entitled *Students' Handbook*, is also available for students' use during the course. This includes all relevant formulae for each unit. The *Students' Handbook* also includes a list of the notation to be used and the statistical tables. Schools and colleges needing copies for their students' use may obtain them from the MEI Office (see Section 7 for the address).

4.8 SPECIAL ARRANGEMENTS

For candidates who are unable to complete the full assessment or whose performance may be unduly affected through no fault of their own, teachers should consult the *Inter-Board Regulations and Guidance Booklet for Special Arrangements and Special Consideration*. In such cases advice should be sought from OCR as early as possible during the course.

4.9 DIFFERENTIATION

In the question papers differentiation is achieved by setting questions which are designed to assess candidates at their appropriate levels of ability and which are intended to allow candidates to demonstrate what they know, understand and can do.

4.10 GRADE DESCRIPTIONS

The following grade descriptions indicate the level of attainment characteristic of the given grade at Advanced Subsidiary GCE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

Grade A

Candidates recall or recognise almost all the statistical facts, concepts and techniques that are needed, and select appropriate ones to use in a wide variety of contexts.

Candidates manipulate statistical expressions and use graphs, sketches and diagrams, all with high accuracy and skill. They use statistical language correctly and proceed logically and rigorously through extended arguments. When confronted with unstructured problems, they can often devise and implement an effective solution strategy. If errors are made in their calculations or logic, these are sometimes noticed and corrected.

Candidates recall or recognise almost all the standard models that are needed, and select appropriate ones to represent a wide variety of situations in the real world. They refer results from calculations using the model to the original situation correctly; they give sensible interpretations of their results in the context of the original realistic situation. They make intelligent comments on the modelling assumptions and possible refinements to the model.

Candidates comprehend or understand the meaning of almost all translations into statistics of common realistic contexts. They refer the results of calculations back to the given context correctly and usually make sensible comments or predictions. They can distil the essential statistical information from extracts of prose having statistical content. They comment meaningfully on the statistical information.

Candidates make appropriate and efficient use of contemporary calculator technology and other permitted resources, and are aware of any limitations to their use. They present results to an appropriate degree of accuracy.

Grade C

Candidates recall or recognise most of the statistical facts, concepts and techniques that are needed, and usually select appropriate ones to use in a variety of contexts.

Candidates manipulate statistical expressions and use graphs, sketches and diagrams, all with a reasonable level of accuracy and skill. They use statistical language with some skill and sometimes proceed logically through extended arguments. When confronted with unstructured problems, they sometimes devise and implement an effective and efficient solution strategy. They occasionally notice and correct errors in their calculations.

Candidates recall or recognise most of the standard models that are needed and usually select appropriate ones to represent a variety of situations in the real world. They often refer results from calculations using the model to the original situation correctly; they sometimes give sensible interpretations of their results in the context of the original realistic situation. They sometimes make intelligent comments on the modelling assumptions and possible refinements to the model.

Candidates comprehend or understand the meaning of most translations into statistics of common realistic contexts. They often refer the results of calculations back to the given context correctly and sometimes make sensible comments or predictions. They distil much of the essential statistical information from extracts of prose having statistical content. They give some useful comments on this statistical information.

Candidates usually make appropriate and effective use of contemporary calculator technology and other permitted resources, and are sometimes aware of any limitations to their use. They usually present results to an appropriate degree of accuracy.

Grade E

Candidates recall or recognise some of the statistical facts, concepts and techniques that are needed, and sometimes select appropriate ones to use in some contexts.

Candidates manipulate statistical expressions and use graphs, sketches and diagrams, all with some accuracy and skill. They sometimes use statistical language correctly and occasionally proceed logically through extended arguments.

Candidates recall or recognise some of the standard models that are needed and sometimes select appropriate ones to represent a variety of situations in the real world. They sometimes refer results from calculations using the model to the original situation correctly; they try to interpret their results in the context of the original realistic situation.

Candidates sometimes comprehend or understand the meaning of translations in statistics of common realistic contexts. They sometimes refer the results of calculations back to the given context correctly and attempt to give comments or predications. They distil some of the essential statistical information from extracts of prose having statistical content. They attempt to comment on this statistical information.

Candidates often make appropriate and efficient use of contemporary calculator technology and other permitted resources. They sometimes present results to an appropriate degree of accuracy.

5 Subject Content

5.1 ASSUMED KNOWLEDGE

There is no formal prerequisite for a student wishing to embark on AS GCE Statistics (MEI).

The unit specifications are written with the same assumption about prior knowledge as that used for the Mathematics Subject Criteria, that students embarking on AS GCE study in statistics are expected to have achieved at least grade C in GCSE Mathematics, or its equivalent, and to have covered all the material in the Intermediate Tier. Consequently everything which is in the National Curriculum up to and including that level is also implicit in this specification. In a number of cases such material is included in the specification for clarity and completeness and is indicated by an asterisk; such material will not form the focus of an examination question.

5.2 COMPETENCE STATEMENTS

The unit specifications include competence statements. These are designed to help users by clarifying the requirements, but the following three points need to be noted:

- work that is covered by a competence statement may be asked in an examination question without further assistance being given;
- examination questions may require candidates to use two or more competence statements at the same time without further assistance being given;
- where an examination question requires work that is not covered by a competence statement, sufficient guidance will be given within the question.

Competence statements have an implied prefix of the words: 'A student should …'

The letters used in assigning reference numbers to competence statements are as follows.

b	bivariate data	D	Data presentation
p	mathematical processes	H	Hypothesis testing
u	probability (uncertainty)	I	Inference
x	experimental design	N	Normal distribution
		P	Poisson Distribution
		R	Random variables
		S	Sampling

6 Unit Specifications

6.1 AS STATISTICS 1, UNIT Z1 (G241)

Objectives

To enable students to build on and extend the data handling and sampling techniques they have learnt at GCSE.

To enable students to apply theoretical knowledge to practical situations using simple probability models.

To give students insight into the ideas and techniques underlying hypothesis testing.

Assessment

Examination (72 marks)
1 hour 30 minutes
The examination paper has two sections:

Section A: five to seven questions, each worth at most 8 marks.
Section Total: 36 marks

Section B: two questions, each worth from 17 to 19 marks.
Section Total: 36 marks

Assumed Knowledge

Candidates are expected to know the content for Intermediate Tier GCSE Mathematics. In addition, they need to know the binomial expansion for positive integer exponents.

Calculators

Candidates are expected to have calculators with the standard statistical functions.

Questions may be set requiring interpretation of tabular and/or graphical output from calculators, spreadsheets and statistical computing packages. Knowledge of any particular software is **not** required.

*The use of an asterisk * in a competence statement indicates assumed knowledge. These items will not be the focus of examination questions and are included for clarity and completeness. However, they may be used within questions on more advanced statistics.*

AS STATISTICS 1, Z1		
Specification	**Ref.**	**Competence Statements**
PROCESSES		
This section is fundamental to all the units in this specification. In this unit, the ideas may be used in examination questions but will not be their main subject.		
Statistical modelling.	Z1p1	Be able to abstract from a real world situation to a statistical description (model).
	2	Be able to apply an appropriate analysis to a statistical model.
	3	Be able to interpret and communicate results.
	4	Appreciate that a model may need to be progressively refined.
Sampling.	5	* Understand the meanings of the terms population and sample.
	6	* Be aware of the concept of random sampling.
DATA PRESENTATION		
Classification and visual presentation of data.	Z1D1	* Know how to classify data as categorical, discrete or continuous.
	2	* Understand the meaning of and be able to construct frequency tables for ungrouped data and grouped data.
	3	* Know how to display categorical data using a pie chart or a bar chart.
	4	Know how to display discrete data using a vertical line chart.
	5	Know how to display continuous data using a histogram for both unequal and equal class intervals.
	6	* Know how to display and interpret data on a stem and leaf diagram.
	7	* Know how to display and interpret data on a box and whisker plot.
	8	Know how to display and interpret a cumulative frequency distribution.
	9	Know how to classify frequency distributions showing skewness.

AS STATISTICS 1, Z1			
Ref.	**Notes**	**Notation**	**Exclusions**
	PROCESSES		
	This section is fundamental to all the units in this specification. **In this unit, the ideas may be used in examination questions but will not be their main subject.**		
Z1p1	Approximation and simplification involving appropriate distributions and probability models.		Formal definitions.
2			
3	Their implications in real-world terms.		
4	Check against reality.		
5			
6			
	DATA PRESENTATION		
Z1D1			
2	Define class intervals and class boundaries.		
3			
4			
5	Area proportional to frequency. Use of the term frequency density will be expected.		
6	The term stemplot is also widely used. Stem and leaf diagrams will be expected to be sorted.		
7	The term boxplot is also widely used. The term outlier can be applied to data which are at least $1.5 \times$ IQR beyond the nearer quartile.		
8			
9	Positive and negative skewness.		Measures of skewness.

AS STATISTICS 1, Z1		
Specification	**Ref.**	**Competence Statements**
		DATA PRESENTATION (continued)
Measures of central tendency and dispersion.	10	Know how to find median*, mean*, mode* and midrange.
	11	Know the usefulness of each of the above measures of central tendency.
	12	Know how to find range*, percentiles, quartiles* and interquartile range*.
	13	Know how to calculate and interpret mean squared deviation, root mean squared deviation, variance and standard deviation.
	14	Be able to use the statistical functions of a calculator to find mean, root mean square deviation and standard deviation.
	15	Know how the mean and standard deviation are affected by linear coding.
	16	Understand the term outlier.

AS STATISTICS 1, Z1			
Ref.	**Notes**	**Notation**	**Exclusions**

	DATA PRESENTATION (continued)		
10	For raw data, frequency distributions, grouped frequency distributions.	Mean = $\overline{x}$	
11			
12			
13	For raw data, frequency distributions, grouped frequency distributions. The term outlier can be applied to data which are at least 2 standard deviations from the mean. $msd = \frac{S_{xx}}{n} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2$, $rmsd = \sqrt{msd}$. Sample variance: $s^2 = \frac{S_{xx}}{n-1} = \frac{1}{(n-1)}\sum_{i=1}^{n}(x_i - \overline{x})^2$. (†) Sample standard deviation: $s = \sqrt{\text{variance}}$. (‡)	*msd, rmsd* s^2 s	Corrections for class interval in these calculations.
14			
15	$y_i = a + bx_i \Rightarrow \overline{y} = a + b\overline{x}$, $s_y{}^2 = b^2 s_x{}^2$		Proof of equivalence will not be tested.
16	The term outlier can be applied to data which are: (a) at least 2 standard deviations from the mean; (b) at least 1.5 × IQR beyond the nearer quartile.		

DATA PRESENTATION	
Notation for sample variance and sample standard deviation	
The notations s^2 and s for sample variance and sample standard deviation, respectively, are written into both British Standards (BS3534-1, 1993) and International Standards (ISO 3534). The definitions are those given above in equations (†) and (‡). The calculations are carried out using divisor $(n-1)$. In this specification, the usage will be consistent with these definitions. Thus the meanings of 'sample variance', denoted by s^2, and 'sample standard deviation', denoted by s, are uniquely defined, as calculated with divisor $(n-1)$.	In early work in statistics it is common practice to introduce these concepts with divisor n rather than $(n-1)$. However there is no recognised notation to denote the quantities so derived. In this specification, in order to ensure unambiguity of meaning, these quantities will be referred to by the functional names of 'mean square deviation' and 'root mean square deviation'. The letters *msd* and *rmsd* will be used to denote their values. Students should be aware of the variations in notation used by manufacturers on calculators and know what the symbols on their particular models represent.

AS STATISTICS 1, Z1		
Specification	**Ref.**	**Competence Statements**
PROBABILITY		
Probability of events in a finite sample space.	Z1u1	Know how to calculate the probability of one event.
	2	Understand the concept of a complementary event and know that the probability of an event may be found by finding that of its complementary event.
Probability of two or more events which are:	3	Know how to draw sample space diagrams to help calculate probabilities.
	4	Know how to calculate the expected frequency of an event given its probability.
(i) mutually exclusive;	5	Understand the concepts of mutually exclusive events and independent events.
	6	Know to add probabilities for mutually exclusive events.
	7	Know to multiply probabilities for independent events.
	8	Know how to use tree diagrams to assist in the calculation of probabilities.
(ii) not mutually exclusive.	9	Know how to calculate probabilities for two events which are not mutually exclusive.
Conditional probability.	10	Be able to use Venn diagrams to help calculations of probabilities for up to three events.
	11	Know how to calculate conditional probabilities by formula, from tree diagrams or sample space diagrams
	12	Know that $P(B\|A) = P(B) \Leftrightarrow B$ and A are independent.
DISCRETE RANDOM VARIABLES		
Probability distributions.	Z1R1	Be able to use probability functions, given algebraically or in tables.
Calculation of probability, expectation (mean) and variance.	2	Be able to calculate the numerical probabilities for a simple distribution.
	3	Be able to calculate the expectation (mean), $E(X)$, in simple cases and understand its meaning.
	4	Be able to calculate the variance, $Var(X)$, in simple cases.

AS STATISTICS 1, Z1			
Ref.	**Notes**	**Notation**	**Exclusions**
	PROBABILITY		
Z1u1			
2		P(A) A' is the event 'Not A'	
3			
4		Expected frequency: n P(A)	
5			Formal notation and definitions.
6	To find P(A or B).		
7	To find P(A and B) Including the use of complementary events. e.g. finding the probability of at least one 6 in five throws of a die.		
8			
9			
10	Candidates should understand, though not necessarily in this form, the relation: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.		Probability of a general or infinite number of events. Formal proofs.
11	$P(A \cap B) = P(A).P(B\|A)$	$P(B\|A)$	
12	In this case $P(A \cap B) = P(A).P(B)$.		
	DISCRETE RANDOM VARIABLES		
Z1R1	In *Z1* questions will only be set on simple finite distributions.		
2		$P(X = x)$	
3		$E(X) = \mu$	
4	Knowledge of $Var(X) = E(X^2) - \mu^2$.	$Var(X) = E[(X - \mu)^2]$	

AS STATISTICS 1, Z1		
Specification	**Ref.**	**Competence Statements**
THE BINOMIAL DISTRIBUTION AND ITS USE IN HYPOTHESIS TESTING		
Situations leading to a binomial distribution.	Z1H1	Recognise situations which give rise to a binomial distribution.
	2	Be able to identify the binomial parameter p, the probability of success.
Calculations relating to binomial distribution.	3	Be able to calculate probabilities using the binomial distribution.
	4	Know that ${}^{n}C_{r}$ is the number of ways of selecting r objects from n.
	5	Know that $n!$ is the number of ways of arranging n objects in line.
Knowledge of mean.	6	Understand and apply mean = np.
Calculation of expected frequencies.	7	Be able to calculate the expected frequencies of the various possible outcomes from a series of binomial trials.
Hypothesis testing for a binomial probability p.	8	Understand the process of hypothesis testing and the associated vocabulary.
	9	Be able to identify Null and Alternative Hypotheses (H_0 and H_1) when setting up a hypothesis test on a binomial probability model.
	10	Be able to conduct hypothesis tests at various levels of significance.
	11	Be able to identify the critical and acceptance regions.
	12	Be able to draw a correct conclusion from the results of a hypothesis test on a binomial probability model.
	13	Understand when to apply 1-tail and 2-tail tests.

AS STATISTICS 1, Z1			
Ref.	**Notes**	**Notation**	**Exclusions**
	THE BINOMIAL DISTRIBUTION AND ITS USE IN HYPOTHESIS TESTING		
Z1H1			
2	As a model for observed data.	B(n, p), $q = 1 - p$ ~ means 'has the distribution'.	
3	Including use of tables of cumulative binomial probabilities.		
4		${}^{n}\mathrm{C}_{r} = \binom{n}{r} = \frac{n!}{(n-r)!r!}$	
5			
6			Formal proof of variance of the binomial distribution.
7			
8	Null hypothesis, alternative hypothesis. Significance level, 1-tail test, 2-tail test. Critical value, critical region, acceptance region.		
9		H_0, H_1	
10			Normal approximation.
11			
12			
13			

6.2 AS STATISTICS 2, UNIT Z2 (G242)

Objectives

To extend students' experience of probability models so that they can apply their theoretical knowledge to an extended range of practical situations.

To give students further insight into ideas of inference from sample data, both in terms of estimating population parameters from sample data and in terms of further applications of hypothesis testing.

Assessment

Examination (72 marks)
1 hour 30 minutes
There will be five questions each worth from 13 to 16 marks.

Assumed Knowledge

Candidates are expected to know the content of *Z1*.

Calculators

Candidates are expected to have calculators with the standard statistical functions.

Questions may be set requiring interpretation of tabular and/or graphical output from calculators, spreadsheets and statistical computing packages. Knowledge of any particular software is **not** required.

AS STATISTICS 2, Z2		
Specification	**Ref.**	**Competence Statements**
PROBABILITY MODELS		
The general concept of a probability model.	Z2u1	Understand the concept of a probability model and know that, for continuous distributions, probability is represented by the area under a graph.
POISSON DISTRIBUTION		
Situations leading to a Poisson distribution.	Z2P1	Know the situations under which the Poisson distribution is likely to be an appropriate model.
Calculations of probability and of expected frequencies.	2	Be able to calculate the probabilities within a Poisson distribution.
	3	Be able to use the Poisson distribution as an approximation to the binomial distribution, and know when to do so.
NORMAL DISTRIBUTION		
The use of the Normal distribution.	Z2N1	Be able to use the Normal distribution as a model.
	2	Be able to standardise a Normal variable and use the Normal distribution tables.
	3	Be able to solve problems using the Normal distribution as a model, including problems involving a simple sum or difference of variables.

AS STATISTICS 2, Z2			
Ref.	**Notes**	**Notation**	**Exclusions**
	PROBABILITY MODELS		
Z2u1	e.g. The Normal distribution.		The use of calculus.
	POISSON DISTRIBUTION		
Z2P1		$X \sim$ Poisson (λ)	
2	Including use of tables of cumulative Poisson probabilities.		
3			
	NORMAL DISTRIBUTION		
Z2N1			
2		$X \sim \mathrm{N}(\mu, \sigma^2)$	
3	Making appropriate use of tables.		Proof.

AS STATISTICS 2, Z2		
Specification	**Ref.**	**Competence Statements**

SAMPLE DATA: ESTIMATION AND HYPOTHESIS TESTING

When asked to conduct a hypothesis test, candidates are expected to select an appropriate test for a given situation, carry it out and interpret the results. Mathematical justification for tests is not required, but candidates are expected to know informally the conditions required for use of each test.

Candidates are expected to understand that all statistical procedures may make errors, but Type I and Type II errors will not be referred to by name.

Interpretation of sample data.	Z2I1	Be able to interpret sample data so as to make inferences about the underlying population.
	2	Understand that sample statistics can only be estimates of population parameters.
	3	Recall the process of hypothesis testing and the associated vocabulary.
	4	Understand the relationship between *p*-values, significance levels and the conclusions of hypothesis tests.
Point estimation of a population parameter using a sample statistic in simple cases.	5	Be able to use sample data to estimate a population proportion using relative frequency.
	6	Be able to estimate population mean from sample data.
	7	Be able to estimate population variance using the sample variance, s^2.
The sample mean.	8	Understand the inherent variability of sample means.
	9	Understand that the variability may be measured by the standard error of the sample mean.
	10	Understand that the variability gives rise to the sampling distribution of the sample means.
	11	Understand how and when the Central Limit Theorem may be applied to the sampling distribution of sample means.
Test for a mean using the Normal distribution.	12	Recognise situations when it is appropriate to carry out a hypothesis test for a population mean using the Normal distribution.
	13	Be able to carry out this test.
	14	Be able to interpret the result of the test in the context of the original problem.

AS STATISTICS 2, Z2			
Ref.	**Notes**	**Notation**	**Exclusions**

SAMPLE DATA: ESTIMATION AND HYPOTHESIS TESTING

Z2I1	Candidates will be expected to have developed some understanding of the limitations of statistical inference.	
2	This is due to the inherent variability of sampling.	
3	From Unit *Z*1.	
4	The *p*-value is the probability of obtaining a result as, or more, extreme than that actually obtained, if the null hypothesis is true.	
5		
6		Proof.
7	$s^2 = \frac{S_{xx}}{n-1} = \frac{1}{(n-1)}\sum_{i=1}^{n}(x_i - \bar{x})^2$	Proof.
8		
9	The standard error of the sample mean is $\frac{\sigma}{\sqrt{n}}$, if σ is known, otherwise it is estimated as $\frac{s}{\sqrt{n}}$.	
10	$\mathrm{E}(\bar{X}) = \mu,\ \mathrm{Var}(\bar{X}) = \frac{\sigma^2}{n}$.	
11	The distribution is approximately Normal in large samples.	Formal statement and derivation of the Central Limit Theorem.
12	Situations where: *either* (a) the population variance is known *or* (b) the population variance is unknown but the sample size is large.	
13		
14		

AS STATISTICS 2, Z2		
Specification	**Ref.**	**Competence Statements**

SAMPLE DATA: ESTIMATION AND HYPOTHESIS TESTING (continued)

When asked to conduct a hypothesis test, candidates are expected to select an appropriate test for a given situation, carry it out and interpret the results. Mathematical justification for tests is not required, but candidates are expected to know informally the conditions required for use of each test.

Candidates are expected to understand that all statistical procedures may make errors, but Type I and Type II errors will not be referred to by name.

Test for a mean using the *t* distribution.	Z2I15	Recognise situations when it is appropriate to carry out a hypothesis test for a population mean using the *t* distribution.
	16	Be able to carry out this test.
	17	Be able to interpret the result of the test in the context of the original problem.
Interval estimation of a population parameter in simple cases.	18	Understand and be able to interpret confidence intervals.
	19	Be able to construct confidence intervals for a population mean using the Normal or *t* distribution.
Wilcoxon signed rank test for a median.	20	Recognise situations when it is appropriate to carry out a hypothesis test for a population median using the Wilcoxon signed rank test.
	21	Be able to carry out this test.
	22	Be able to interpret the result of the test in the context of the original problem.
χ^2 test for goodness of fit, including use of estimated parameters.	23	Know when it is appropriate to carry out a χ^2 test for goodness of fit of a model.
	24	Be able to carry out this test, understanding and using degrees of freedom.
	25	Be able to interpret the result of the test in the context of the original problem.
χ^2 test for association in contingency tables.	26	Be able to apply the χ^2 test to a contingency table.
	27	Be able to interpret the result of the test in the context of the problem.

AS STATISTICS 2, Z2			
Ref.	**Notes**	**Notation**	**Exclusions**

SAMPLE DATA: ESTIMATION AND HYPOTHESIS TESTING (continued)

Z2I15	Situations where the sample is small and the population variance is unknown, but the population may be assumed to have a Normal distribution.		
16	Use of tables of critical values for the *t* test.		
17			
18	Only the case of confidence intervals for a population mean using the Normal or *t* distribution will be considered.		
19	In situations where: *either* (a) the population variance is known (Normal) *or* (b) the population variance is unknown but the sample size is large (Normal) *or* (c) the sample is small and the population variance is unknown, but the population may be assumed to have a Normal distribution (*t*).		
20			
21	Use of tables of critical values.		Use of the Normal approximation.
22			
23	Simple discrete and continuous cases that arise in applications e.g. binomial distribution, Poisson distribution.		
24	Calculations of expected frequencies will be limited to simple cases. Use of tables of critical values for the χ^2 test.		
25			
26	The use of Yates' continuity correction for 2×2 contingency tables will not be required in examination questions. Candidates who use it appropriately will, however, be eligible for full marks.		
27	This may involve considering the individual cells in the contingency table.		

6.3 AS STATISTICS 3, UNIT Z3 (G243)

Objectives

To provide students with a clear understanding of the principles underlying sampling and experimental design.

To extend students' repertoire of hypothesis tests to cover those that are likely to arise from experimental work across the whole curriculum.

To introduce students to work with bivariate data.

Assessment

Examination (72 marks)
1 hour 30 minutes
The examination paper has two sections:

Section A:	three questions, each worth 15 or 16 marks. Section Total: from 45 to 48 marks
Section B:	one question, worth from 24 to 27 marks. Section Total: from 24 to 27 marks

Assumed Knowledge

Candidates are expected to know the content of *Z1* and *Z2*.

Calculators

Candidates are expected to have calculators with the standard statistical functions.

Questions may be set requiring interpretation of tabular and/or graphical output from calculators, spreadsheets and statistical computing packages. Knowledge of any particular software is **not** required.

AS STATISTICS 3, Z3		
Specification	**Ref.**	**Competence Statements**
SAMPLING		
Surveys and censuses.	Z3S1	Know the difference between a survey and a census and when it is appropriate to consider sampling.
Sampling methods.	2	Know the vocabulary associated with sampling.
	3	Be able to explain the use, advantages and limitations of a variety of sampling techniques (possibly used in combination): simple random sampling; systematic sampling; stratified sampling; cluster sampling; quota sampling.
DESIGN OF EXPERIMENTS		
Basic concepts of experimental design	Z3x1	Be able to explain the need for randomisation and replication in a particular experimental design.
	2	Understand the need for control and experimental groups where appropriate.
Paired comparison	3	Be able to explain the purpose of paired comparisons in a particular situation.
ESTIMATION AND HYPOTHESIS TESTING		
When asked to conduct a hypothesis test, candidates are expected to select an appropriate test for a given situation, carry it out and interpret the results. Mathematical justification for tests is not required, but candidates are expected to know informally the conditions required for use of each test. *Candidates are expected to understand that all statistical procedures may make errors, but Type I and Type II errors will not be referred to by name.*		
Paired and two-sample tests.	Z3I1	Recognise situations that lead to paired tests and to two-sample tests, and understand the differences between those tests.
Paired *t* test.	2	Recognise situations when it is appropriate to carry out a *t* test for the difference of means for paired data.
	3	Be able to carry out this test.
	4	Be able to interpret the result of the test in the context of the original problem.
Tests for the difference of means for unpaired samples.	5	Recognise situations when it is appropriate to use the Normal distribution and when it is appropriate to use the *t* distribution in testing for differences in population means for unpaired samples.
	6	Be able to carry out these tests.
	7	Be able to interpret the results of the tests in the context of the original problems.
Wilcoxon signed rank test for paired samples.	8	Recognise situations when it is appropriate to carry out a hypothesis test for paired data using the Wilcoxon signed rank test.
	9	Be able to carry out this test.
	10	Be able to interpret the result of the test in the context of the original problem.
Wilcoxon rank sum test.	11	Recognise situations when it is appropriate to carry out the Wilcoxon rank sum (Mann-Whitney) test for the difference of population medians.
	12	Be able to carry out this test.
	13	Be able to interpret the result of the test in the context of the original problem.

AS STATISTICS 3, Z3			
Ref.	**Notes**	**Notation**	**Exclusions**
	SAMPLING		
Z3S1			
2	Target population, sampling frame, sampling unit, sampling fraction.		
3	Candidates should be aware of the problems likely to arise from non-random sampling, e.g. opportunity sampling.		
	DESIGN OF EXPERIMENTS		
Z3x1			
2			
3			
	ESTIMATION AND HYPOTHESIS TESTING		
Z3I1			
2			
3	Use of tables of critical values for the *t* test.		
4			
5	Normal: population variance known or estimated from large samples. *t*: population variance estimated from small samples from populations which may be assumed to be Normal.		
6	Use of pooled estimate. Use of tables of critical values for the *t* test.	$s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$	
7			
8			
9	Use of tables of critical values.		Use of the Normal approximation.
10			
11			
12	Use of tables of critical values.		Use of the Normal approximation.
13			

AS STATISTICS 3, Z3		
Specification	**Ref.**	**Competence Statements**
CORRELATION		
Scatter diagrams.	Z3b1	Be able to draw and make an informal statistical interpretation of a scatter diagram.
Product moment correlation.	2	Recognise situations when it is appropriate to consider correlation.
	3	Be able to calculate the Pearson product moment correlation coefficient (pmcc) from raw sample data or summary statistics.
	4	Know how to carry out a hypothesis test using the pmcc and tables of critical values.
	5	Be able to interpret the result of the test in the context of the original problem.
Spearman's rank correlation coefficient.	6	Recognise situations when it is appropriate to consider rank correlation.
	7	Be able to calculate Spearman's rank correlation coefficient.
	8	Know how to carry out a hypothesis test using Spearman's rank correlation coefficient.
	9	Be able to interpret the result of the test in the context of the original problem.

AS STATISTICS 3, Z3			
Ref.	**Notes**	**Notation**	**Exclusions**
	CORRELATION		
Z3b1			
2	For correlation both variables must be random. The scatter diagram must suggest that it is reasonable to assume that the underlying population is bivariate Normal; the data should lie, approximately, within an ellipse. Candidates will not be required to know the formal meaning of bivariate Normality.		
3		Sample value r Population value ρ	
4	Only H_0: $\rho = 0$ will be tested. The scatter diagram must suggest that it is reasonable to assume that the underlying population is bivariate Normal; the data should lie, approximately, within an ellipse. Candidates will not be required to know the formal meaning of bivariate Normality.		
5			
6			
7			
8	Only H_0: No association will be tested. Hypothesis tests using Spearman's rank correlation coefficient requires no modelling assumption about the underlying distribution.	Sample value r_s	
9			

7 Further Information and Training for Teachers

The specifications are supported by MEI and OCR.

On-line Support

- Web-based resources covering this specification (www.mei.org.uk).

Teaching Materials

- Textbook, written for this specification.
- Students' Handbook.

INSET and Teacher Support

- One-day INSET courses provided by both MEI and OCR.
- The MEI annual three-day conference.
- MEI branch meetings.
- Help from both MEI and OCR at the end of the telephone.
- Regular newsletters from MEI.

Examinations

- Specimen examination papers and mark schemes.
- Past examination papers and mark schemes.
- Examiners' reports.
- Practice examination papers.

Addresses

The MEI Office
Albion House
Market Place
Westbury, Wilts
BA13 3DE

OCR
1 Hills Road
Cambridge
CB1 2EU

Appendix: Notation

A, B, C, etc.	events
$A \cup B$	union of the 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
$\mathrm{P}(A \mid B)$	probability of the event A conditional on 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
$\mathrm{p}(x)$	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
$\mathrm{E}(X)$	expectation of the random variable X
$\mathrm{E}[g(X)]$	expectation of $\mathrm{g}(X)$
$\mathrm{Var}(X)$	variance of the random variable X
$\mathrm{B}(n, p)$	binomial distribution with parameters n and p
$\mathrm{Poisson}(\lambda)$	Poisson distribution with parameter λ
$\mathrm{N}(\mu, \sigma^2)$	Normal distribution with mean μ and variance σ^2
μ	population mean
σ^2	population variance
σ	population standard deviation
$\overline{x}$	sample mean
S_{xx}	sum of squares $S_{xx} = \sum_{i=1}^{n}(x_i - \overline{x})^2 = \sum_{i=1}^{n} x_i^2 - n\overline{x}^2 = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2$
s^2	sample variance $s^2 = \frac{S_{xx}}{n-1}$
s	sample standard deviation
msd	mean square deviation $msd = \frac{S_{xx}}{n}$

rmsd	root mean square deviation
ϕ	probability density function of the standardised normal variable with distribution N(0, 1)
Φ	corresponding cumulative distribution function
ρ	population product moment correlation coefficient
S_{xy}	sum of products $S_{xy} = \sum_{i=1}^{n}\left[(x_i - \bar{x})(y_i - \bar{y})\right] = \sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y} = \sum_{i=1}^{n} x_i y_i - \frac{1}{n}\sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i$
r	sample product moment correlation coefficient $r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$
r_s	sample Spearman's rank correlation coefficient
X^2	test statistic for χ^2 test
z	test statistic for a test using the Normal distribution
t	test statistic for a *t* test