A Level
Statistics

PEARSON Edexcel

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This specification is Issue 2. Key changes are summarised on the next page. We will inform centres of any changes to this issue. The latest issue can be found on our website.

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All information in this specification is correct at time of publication.

Summary of Pearson Edexcel Level 3 Advanced GCE in Statistics (9ST0) Specification
Issue 2 changes

Summary of change made between previous issue and this current issue	Page of PDF
Removal of references to 'AS'	Throughout
Inequality symbols amended, e.g. from $\geq$ to $\geqslant$	Throughout
The *Co-teachable AS and A Level qualifications* paragraph has been removed	2
The *Trusted, expert support for the specifications.* paragraph has been updated	2
The *Mathematics Emporium - support whenever you need it* section has been updated	3
In *Additional information section 6.2* the font for $\mu \pm 2\sigma$ has been changed to Times New Roman	10
In *Additional information section 6.6* – fixed typo – 'us' changed to 'use'	10
In *Additional information section 12.2* – $E(aX \mp bY) = aE(X) \mp bE(Y)$ has been changed to: $E(aX \pm bY) = aE(X) \pm bE(Y)$	14
In *Additional information section 15.1* – n changed to italic	15
In *Subject content section 20.2* the word 'replicates' has been changed to 'replication'	19
A Initial planning: point 6 – typo fixed – the word 'to' added between 'regards' and 'ensuring'	20
The *Discount code and performance tables* section has been updated.	25
The *Candidate malpractice* and *Staff/centre malpractice* sections have been updated.	27
In *Formula required section 1* $\dfrac{x}{\text{total}} \times 360$ has been changed to: $\dfrac{x}{\text{total}} \times 360°$	31
In *Formula required section 12* – All λ changed to italic	33
In *Formula required section 12* – All E changed to non italic	33
In *Statistical tables given in the 'Statistical Formulae and Tables* the t and f used for table 5 and 7 have been changed to italic	35
The *Use of calculators* section has been updated	38

Summary of change made between previous issue and this current issue	Page of PDF
In *Use of other technology: Graph-plotting software* – in the paragraph following the bullet points, the word 'visualisation' has changed font	39
In *Appendix 8: Codes*, under the table www.gov.uk/government/publications/2018-performance-tables-discount-code has been changed to: https://www.gov.uk/government/publications/16-to-19-qualifications-discount-codes-and-point-scores	45

If you need further information on these changes or what they mean, contact us via our website at:

qualifications.pearson.com/en/support/contact-us.html.

Contents

1 Introduction

Why choose Pearson Edexcel A Level Statistics?

Using and understanding data is becoming increasingly important in many areas of study and employment. Understanding of statistics is a crucial skill, and this specification aims to give students the tools needed to help them prepare for higher education and the workplace.

A Level Statistics might appeal to the student seeking to pursue the study of a numerate post-16 subject but not wishing to study pure mathematics. It sits well with subjects such as A level Biology, Psychology, Geography, Business Studies and Economics. The emphasis is on using and applying statistics; appropriate interpretation of contexts and the outcomes of statistical procedures will be required.

We've listened to feedback from the mathematics subject community. We've used this opportunity of curriculum change to redesign qualifications so that they reflect the demands of a wide variety of end users – a qualification that enables your students to apply themselves and give them the logical, problem-solving and numerical skills to succeed in their chosen pathway.

We will provide:

Straightforward assessment structure. Our qualification has a straightforward structure, with three papers of equal size and weighting: one paper assessing data and probability, another on statistical inference, and a third paper assessing the specification as a whole. The statistical enquiry cycle is integrated with the statistical methods, supporting an integrated approach to statistics teaching, learning and exam preparation.

Accessible question papers that support a range of abilities. Our exam papers follow the same clear design that you've told us makes them so accessible, with careful ramping also ensuring a range of challenge to support students of all abilities in achieving their potential.

Real-world data and context for transferable skills. Our qualifications will help students to develop the skills of statistical enquiry, and practise the underpinning statistical calculations and interpretation using real-world data and authentic contexts. Our approach supports skills development for progression to a range of other subjects and develops an awareness of statistics beyond the classroom.

Trusted, expert support for the specifications. You will receive the support you know and trust from Pearson Edexcel. With a large number of resources available throughout the year on our Qualifications website and the Maths Emporium, we will ensure that you have the support you need to teach this qualification.

Supporting you in planning and implementing this qualification

Planning

- Our *Getting Started* guide gives you an overview of the A Level qualification to help you to get to grips with the changes to content and assessment, as well as helping you to understand what these changes mean for you and your students.
- We will give you an editable **course planner** and **scheme of work** that you can adapt to suit your department.
- **Our mapping documents** highlight key differences between the new specification and the legacy AQA Statistics 6380 specification.

Teaching and learning

- We are developing **free teaching and learning support** to help you deliver the new qualification, including support for the statistical enquiry cycle.

Preparing for exams

We will also provide a range of resources to help you prepare your students for the assessments, including marked exemplars of student work with examiner commentaries.

ResultsPlus and ExamWizard

ResultsPlus provides the most detailed analysis available of your students' exam performance. It can help you identify the topics and skills where further learning would benefit your students.

ExamWizard is a data bank of past exam questions (and sample and specimen paper questions) allowing you to create bespoke test papers.

Get help and support

Mathematics Emporium – support whenever you need it

The Mathematics Emporium helps you keep up to date with all areas of maths throughout the year, as well as offering a rich source of past questions and, of course, access to our team of in-house maths experts.

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Over 12,000 documents relating to past and present Edexcel mathematics and statistics qualifications available free. Visit www.edexcelmaths.com/ to register for an account.

Qualification at a glance

Content and assessment overview

The Pearson Edexcel Level 3 Advanced GCE in Statistics consists of three externally-examined papers.

Students must complete all assessment in May/June in any single year.

Paper 1: Data and Probability	(*Paper code: 9ST0/01)
Written examination: 2 hours *33⅓% of the qualification* *80 marks*	
Content overview Questions may be set on any of the following topics: 1 – Numerical measures, graphs and diagrams 2 – Probability 3 – Population and samples 4 – Introduction to probability distributions 5 – Binomial distribution 6 – Normal distribution 7 – Correlation and linear regression (except 7.2) 11 – Bayes' theorem 12 – Probability distributions 13 – Experimental design 18 – Exponential and Poisson distributions Statistical Enquiry Cycle (SEC)	
Assessment overview ● Students must answer all questions. ● Calculators can be used in the assessment. ● The booklet 'Statistical Formulae and Tables' will be provided for use in the assessments.	

*See *Appendix 8: Codes* for a description of this code and all other codes relevant to this qualification.

Paper 2: Statistical Inference	**(Paper code: 9ST0/02)**

Written examination: 2 hours

33⅓% of the qualification

80 marks

Content overview

Questions may be set on any of the following topics:

7 – Correlation and linear regression (7.2 only)

8 – Introduction to hypothesis testing

9 – Contingency tables

10 – One and two sample non-parametric tests

13 – Experimental design

14 – Sampling, estimates and resampling

15 – Hypothesis testing, significance testing, confidence intervals and power

16 – Hypothesis testing for 1 and 2 samples

17 – Paired tests

19 – Goodness of fit

20 – Analysis of variance

21 – Effect size

Statistical Enquiry Cycle (SEC)

Assessment overview

- Students must answer all questions.
- Calculators can be used in the assessment.
- The booklet 'Statistical Formulae and Tables' will be provided for use in the assessments.

Paper 3: Statistics in Practice	**(Paper code: 9ST0/03)**

Written examination: 2 hours

33⅓% of the qualification

80 marks

Content overview

Questions may be set on any of the topics within the specification, including the Statistical Enquiry Cycle (SEC).

Assessment overview

- Students must answer all questions.
- Calculators can be used in the assessment.
- The booklet 'Statistical Formulae and Tables' will be provided for use in the assessments.

2 Subject content and assessment information

Qualification aims and objectives

The aims and objectives of this qualification are to encourage students to:

- understand the application of techniques within the framework of the statistical enquiry cycle and the research methodologies used in experiments and surveys

- apply statistical techniques to data sourced from a variety of contexts, appreciating when samples or population data could be used and applying appropriate sampling techniques

- generate and interpret the diagrams, graphs and measurement techniques used in performing statistical investigations

- have an understanding of how visualisations of multivariate data are used to gain a qualitative understanding of the multiple factors that interact in real life situations, including, but not limited to, population characteristics, environmental considerations, production variables etc.

- understand how technology has enabled the collection, visualisation and analysis of large data sets to inform decision-making processes in public, commercial and academic sectors

- develop skills in interpretation and critical evaluation of methodology including justifying the techniques used for statistical problem solving

- apply appropriate statistical formulae, as set out in *Appendices 1* and *2*.

Content

Appendix 1 lists the statistical formulae that students are expected to know and recall.

Appendix 2 lists the statistical formulae and tables that will be available to students during the examination.

Appendix 4 contains information on the expectations relating to the use of calculators and knowledge of language and techniques associated with the use of spreadsheets and databases.

1 Numerical measures, graphs and diagrams

Subject content	Additional information
1.1 Interpret statistical diagrams including bar charts, stem and leaf diagrams, box and whisker plots, cumulative frequency diagrams, histograms (with either equal or unequal class intervals), time series and scatter diagrams.	Students will not be required to draw or construct statistical diagrams. Students may be required to comment on or interpret the main features of published visualisations (for example those listed opposite) or critically assess published visualisations. This may include examples which draw upon multivariate data.*
1.2 Know the features needed to ensure an appropriate representation of data using the above diagrams, and how misrepresentation may occur.	
1.3 Justify appropriate graphical representation and comment on those published.	
1.4 Compare different data sets, using appropriate diagrams or calculated measures of central tendency and spread: mean, median, mode, range, interquartile range, percentiles, variance and standard deviation.	Students may be required to comment on or interpret the main features of published visualisations (for example those listed in section 1.1). This may include examples which draw upon multivariate data.*
1.5 Calculate measures using calculators and manual calculation as appropriate.	Where raw data is given candidates will be expected to obtain the values of the mean, standard deviation and variance directly from a calculator.
1.6 Identify outliers by inspection and using appropriate calculations.	
1.7 Determine the nature of outliers in reference to the population and original data collection process.	
1.8 Appreciate that data can be misrepresented when used out of context or through misleading visualisation.	This may include examples which draw upon multivariate data.*

*Please see *Appendix 4: Use of calculators and other technology*.

2 Probability

Subject content		Additional information
2.1	Know and use language and symbols associated with set theory in the context of probability.	The complement of the set A will be denoted by the symbol A'.
2.2	Represent and interpret probabilities using tree diagrams, Venn diagrams and two-way tables.	
2.3	Calculate and compare probabilities: single, independent, mutually exclusive and conditional probabilities.	
2.4	Use and apply the laws of probability to include conditional probability.	To include addition and multiplication laws.
2.5	Determine if two events are statistically independent.	

3 Population and samples

Subject content		Additional information
3.1	Know both simple (without replacement) and unrestricted (with replacement) random samples.	Students should know that for a random sample of size n: • every member of the population is equally likely to be included • all subsets of the population of size n must be possible or that • every possible sample of size n must be equally likely to occur.
3.2	Know how to obtain a random sample using random numbers tables or random numbers generated on a calculator.	
3.3	Evaluate the practical application of random and non-random sampling techniques: simple random, systematic, cluster, judgmental and snowball, including the use of stratification (in proportional and disproportional ratios) prior to sampling taking place.	Students should appreciate that snowball sampling can be used to reach populations that are difficult to sample when using other sampling methods e.g. drug users.
3.4	Know the advantages and limitations of sampling methods.	

3　Population and samples (continued)

Subject content	Additional information
3.5　Make reasoned choices with reference to the context in which the sampling is to take place. Examples include, but are not limited to: market research, exit polls, experiments and quality assurance.	
3.6　Understand the practical constraints of collecting unbiased data.	

4　Introduction to probability distributions

Subject content	Additional information
4.1　Know and use terms for variability: random, discrete, continuous, dependent and independent.	With reference to random variables.
4.2　Calculate probabilities and determine expected values, variances and standard deviations for discrete distributions.	Such distributions may be explained in words, given in a table or by definition of the discrete probability function.
4.3　Use discrete random variables to model real-world situations.	
4.4　Know the properties of a continuous distribution.	
4.5　Interpret graphical representations or tabulated probabilities of characteristic discrete random variables.	
4.6　Interpret rectilinear graphical representations of continuous distributions.	With reference to the uniform distribution only.

5　Binomial distribution

Subject content	Additional information
5.1　Know when a binomial model is appropriate (in real world situations including modelling assumptions).	
5.2　Know methods to evaluate or read probabilities using formula and tables.	Students may use calculator functions to obtain binomial probabilities and are advised to do so.
5.3　Calculate and interpret the mean and variance.	Students will not be expected to derive the formulae for the mean and variance.

6   Normal distribution

Subject content		Additional information
6.1	Know the specific properties of the normal distribution, and know that data from such an underlying population would approximate to having these properties, with different samples showing variation.	Students should be aware that the normal distribution has a bell-shaped probability density curve.
6.2	Apply knowledge that approximately $\frac{2}{3}$ of observations lie within $\mu \pm \sigma$, and equivalent results for 2σ and 3σ.	Students should learn that approximately 95% of observations lie within $\mu \pm 2\sigma$ and approximately 99.8% of observations lie within $\mu \pm 3\sigma$
6.3	Determine probabilities and unknown parameters with a normal distribution.	Students may use calculator functions to obtain information for a normal distribution directly and are advised to do so.
6.4	Apply the normal distribution to model real-world situations.	
6.5	Use the fact that the distribution of $\overline{X}$ has a normal distribution if X has a normal distribution.	Students are expected to know that $$\overline{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$
6.6	Use the fact that the normal distribution can be used to approximate a binomial distribution under particular circumstances.	Students should learn that, as an alternative to using the exact binomial distribution, the normal distribution may be used to approximate a binomial distribution when: • $n \geqslant 20$ and $p \approx 0.5$ • $np > 10$ or $n(1-p) > 10$ Students will be expected to use a continuity correction when finding a probability if a normal approximation to a binomial distribution is used.

7 Correlation and linear regression

Subject content	Additional information
7.1 Calculate (only using appropriate technology – calculator) and interpret association using Spearman's rank correlation coefficient or Pearson's product moment correlation coefficient.	When evaluating Spearman's coefficient, candidates will be expected to: • rank both variables consistently • rank tied values appropriately • use a calculator to obtain the value of Spearman's rank correlation coefficient Students will be expected to find Pearson's product moment correlation coefficients directly from the calculator. Interpretation of correlation coefficients should always be in the context of the question.
7.2 Use tables to test for significance of a correlation coefficient.	A test on a Pearson's correlation coefficient requires the assumption that the population has a bivariate normal distribution.
7.3 Know the appropriate conditions for the use of each of these methods of calculating correlation and determine an appropriate approach to assessing correlation in context.	Pearson's product moment correlation coefficient measures the strength of the linear relationship between 2 variables. For Spearman's rank correlation coefficient, no assumptions are necessary regarding the distribution used.
7.4 Calculate (only using appropriate technology – calculator) and interpret the coefficients for a least squares regression line in context; interpolation and extrapolation, and use of residuals to evaluate the model and identify outliers.	Students will be expected to find the coefficients for a least squares regression line directly from the calculator. Students will be expected to know that $\text{residual} = y_i - a - bx_i$ for a least squares regression line of the form $y = a + bx$ Students will be expected to make a numeric evaluation of a residual when asked for the value of a specific residual(s) but may be asked to make general comments regarding residuals visually from a scatter graph with a line of best fit drawn on it.

8   Introduction to hypothesis testing

Subject content	Additional information
8.1 Use and demonstrate understanding of the terms parameter, statistic, unbiased and standard error.	Students will be expected to know that: • a parameter is a numerical property of a population • a statistic is a numerical property of a sample and is a function only of the values in the sample and contains no unknown parameters. Students should be familiar with the notations μ and σ^2 for a population mean and variance respectively.
8.2 Know and use the language of statistical hypothesis testing: null hypothesis, alternative hypothesis, significance level, test statistic, 1- tail test, 2-tail test, critical value, critical region, and acceptance region and p-value.	Students will be expected to use the convention of a 5% significance level unless directed otherwise.
8.3 Know that a sample is being used to make an inference about the population and appreciate the need for a random sample and of the necessary conditions.	Students should be aware that a conclusion to a hypothesis test should not be stated as definite.
8.4 Choose the appropriate hypothesis test to carry out in particular circumstances.	
8.5 Conduct a statistical hypothesis test for the proportion in the binomial distribution and interpret the results in context using exact probabilities or, where appropriate, a normal approximation.	In a hypothesis test on a population proportion, candidates may use either π or p as the parameter in their hypotheses.
8.6 Conduct a statistical hypothesis test for the mean of a normal distribution with known or assumed variance, from a large sample, and interpret the results in context.	
8.7 Know the importance of appropriate sampling when using hypothesis tests and be able to critique the conclusions drawn from rejecting or failing to reject a null hypothesis by considering the test performed.	

9 Contingency tables

Subject content	Additional information
9.1 Construct contingency tables from real data, combining data where appropriate, and interpret results in context.	
9.2 Use a χ^2 test with the appropriate number of degrees of freedom to test for independence in a contingency table and interpret the results of such a test.	Students will be expected to know how to find the number of degrees of freedom and that questions set will not require the use of Yates' correction.
9.3 Know that expected frequencies must be greater than, or equal to, 5 for a χ^2 test to be carried out and understand the requirement for combining classes if that is not the case.	Students must combine classes when expected frequencies are smaller than 5, and 'pooling' is sensible.

10 One and two sample non-parametric tests

Subject content	Additional information
10.1 Use sign or Wilcoxon signed-rank tests to investigate population median in single sample tests and also to investigate for differences using a paired model.	Students will be expected to use the sign test or the Wilcoxon signed-rank test to: • test the value of a single population median based on a single sample • test for a difference between two population medians based on a sample of 'paired' data. Students will be expected to learn and recall necessary conditions for the validity of these tests, and may be required to use these to select the test that is most appropriate in a given context. Sign test – no assumptions necessary regarding the distribution for test to be valid. Wilcoxon signed-rank test – assumption that the distribution is symmetrical, or that the distribution of differences is symmetrical in the case of a paired test, for test to be valid.
10.2 Use the Wilcoxon rank-sum test to investigate for difference between independent samples.	Students will be expected to test for a difference between two population medians, based on two independent samples, using the Wilcoxon rank-sum test (this is also known as the Mann-Whitney test).

11 Bayes' theorem

Subject content	Additional information
11.1 Calculate and use conditional probabilities to include Bayes' theorem for up to three events, including the use of tree diagrams.	

12 Probability distributions

Subject content	Additional information
12.1 Know the use and validity of distributions which could be appropriate in a particular real world situation: binomial, normal, Poisson and exponential.	
12.2 Evaluate the mean and variance of linear combinations of independent random variables through knowledge that if X_i are independently distributed $\left(\mu_i, \sigma_i^2\right)$ then $\sum a_i X_i$ is distributed $\left(\sum a_i \mu_i, \sum a_i^2 \sigma_i^2\right)$.	Students should know that $$\mathrm{E}\left(aX \pm bY\right) = a\mathrm{E}\left(X\right) \pm b\mathrm{E}\left(Y\right)$$
12.3 Evaluate probabilities for linear combinations of two or more independent normal distributions and apply this knowledge to practical situations.	

13 Experimental design

Subject content	Additional information
13.1 Know and discuss issues involved in experimental design: experimental error, randomisation, replication, control and experimental groups, and blind and double blind trials.	Students will be expected to explain and discuss these concepts in a given context. (applies to all of section 13)
13.2 Know the benefits of use of paired comparisons and blocking to reduce experimental error.	
13.3 Use completely random and randomised block designs.	

14 Sampling, estimates and resampling

Subject content	Additional information
14.1 Use and demonstrate understanding of terms parameter, statistic, unbiased and standard error.	Students will be expected to know that: • a parameter is a numerical property of a population • a statistic is a numerical property of a sample and is a function of only the values in the sample and contains no unknown parameters.
14.2 Know the use of the central limit theorem in the distribution of $\bar{X}$ where the initial distribution, X, is not normally distributed and the sample is large.	Students are expected to know that: • the central limit theorem may be used when the sample size (of random samples) is sufficiently large ($n \geqslant 30$) • it is only necessary to use the central limit theorem when the underlying population is not normally distributed.

15 Hypothesis testing, significance testing, confidence intervals and power

Subject content	Additional information
15.1 Use confidence intervals for the mean using z or t as appropriate, interpreting results in practical contexts.	Students are expected to use the t-distribution when the sample size is small ($n < 30$) and the population standard deviation, σ, is unknown. Students should be familiar with the notation $\bar{x}$ and s^2 as statistics evaluated from a sample for respective estimates of μ and σ^2. Students should know that the $(n-1)$ divisor is used when evaluating s^2. Students will be expected to learn the formulae for constructing a confidence interval for a population mean: $\bar{x} \pm (z \text{ or } t) \times (\text{standard error})$
15.2 Know that a change in sample size will affect the width of a confidence interval.	Students will be expected to be able to find the sample size required in order to obtain a confidence interval with a specified width.
15.3 Evaluate the strength of conclusions and misreporting of findings from hypothesis tests, including the calculation and importance of the power of a hypothesis test.	See 15.6
15.4 Know that sample size can be changed to potentially elicit appropriate evidence in a hypothesis test.	

15 Hypothesis testing, significance testing, confidence intervals and power (continued)

Subject content		Additional information
15.5	Interpret Type I and Type II errors, in hypothesis testing and know their practical meaning.	Students will be expected to know that: • a Type I error is when the null hypothesis is true but is rejected • a Type II error is when the null hypothesis is false but is accepted and that these should be interpreted in the given context. Students should understand the link between the significance level of a test and the probabilities of Type I and Type II errors for the test. Also, the impact on these errors of selecting a different significance level.
15.6	Calculate the risk of a Type II error.	Students are expected to know that the power of a test is given by Power = 1 – P(Type II error). Students will not be required to draw a power curve.
15.7	Know the difference and advantages of using critical regions or p-values as appropriate in real life contexts in all tests in this subject content.	In hypothesis tests on population correlation coefficients, p-values will not be used.

16 Hypothesis testing for 1 and 2 samples

Subject content		Additional information
Know how to apply knowledge about carrying out hypothesis testing to conduct tests for the:		
16.1	mean of a normal distribution with unknown variance using the t-distribution	Students are expected to use the t-distribution when the sample size is small ($n < 30$) and the population standard deviation, σ, is unknown. t-test – assumption required is that the distribution is normal for test to be valid.
16.2	difference of two means for two independent normal distributions with known variances	

16 Hypothesis testing for 1 and 2 samples (continued)

Subject content	Additional information
16.3 difference of two means for two independent normal distributions with unknown but equal variances	Students should be aware that a test for a difference of two means for two independent normal distributions with unknown variances is valid only if equal variances can be assumed. Candidates will be expected to use a pooled estimate for an unknown common population variance. Candidates will not be expected to test for equality of variances. t-test – assumptions required are that both distributions are normal and have equal variances for test to be valid.
16.4 difference between two binomial proportions	Candidates will be expected to use a pooled estimate for an unknown population proportion.
16.5 interpret results for these tests in context.	

17 Paired tests

Subject content	Additional information
17.1 Use sign, Wilcoxon signed-rank or paired t-test, understanding appropriate test selection and interpreting the results in context.	Students will be expected to use the sign and Wilcoxon signed-ranked tests for paired data. Students will be expected to learn and recall necessary conditions for the validity of these tests, and may be required to use these to select the test that is most appropriate in a given context. Sign test – no assumption necessary regarding the distribution for test to be valid. Wilcoxon signed-rank test – assumption that the distribution of differences is symmetrical for test to be valid. Paired t-test – assumption required is that the distribution of differences is normal for test to be valid.

18 Exponential and Poisson distributions

Subject content	Additional information
18.1 Determine when a Poisson model is appropriate (in real world situations including modelling assumptions).	Students will be expected to know the conditions necessary for a Poisson model to be appropriate and to explain or discuss whether these conditions are likely to be present in a given context.
18.2 Determine when an exponential distribution is appropriate (and its relationship to the Poisson distribution as a model of the times between randomly occurring Poisson events).	Students will be expected to know and use the relationship between corresponding Poisson and exponential distributions, in a given context, for Poisson events occurring randomly in time or in space.
18.3 Evaluate probabilities for Poisson and exponential distributions and know the corresponding mean and variance.	Students will not be expected to derive the formulae for the mean and variance.

19 Goodness of fit

Subject content	Additional information
19.1 Conduct a statistical goodness of fit test for binomial, Poisson, normal and exponential distributions or for a specified discrete distribution using $\sum \frac{(O-E)^2}{E}$ as an approximate χ^2 statistic.	Students will be expected to know how to find the number of degrees of freedom and that questions set will not require the use of Yates' correction. Students must follow the rule to combine classes when expected frequencies are smaller than 5, and 'pooling' is sensible.

20 Analysis of variance

Subject content	Additional information
20.1 Conduct one-way analysis of variance, using a completely randomised design with appreciation of the underlying model with additive effects and experimental errors distributed as $N(0, \sigma^2)$.	Students will only be required to use one-factor ANOVA or two-factor ANOVA (and will not be required to use a Latin square). (applies to all of section 20)
20.2 Conduct two-way analysis of variance without replication, using a randomised block design with blocking.	
20.3 Identify assumptions and interpretations in context.	ANOVA - assumptions that the distributions from which the samples are taken are normal and have equal variances for the test to be valid.

21 Effect size

Subject content	Additional information
21.1 Know the notion of effect size as a complementary methodology to standard significance testing, and apply in authentic contexts.	Students should be aware that interpretation of effect size depends on the context involved and that effect size simply quantifies the size of the difference between two means (rather than its statistical significance). Students should also be aware that a p-value, in the context of testing for statistical significance, depends on both the effect size and the sample size.
21.2 Know and use Cohen's d in simple situations.	Students should be aware of the standard guideline boundaries for interpreting the value of Cohen's d. $0.2 \leqslant d < 0.5$ small effect size $0.5 \leqslant d < 0.8$ medium effect size $0.8 \leqslant d$ large effect size

Statistical Enquiry Cycle (SEC)

The Statistical Enquiry Cycle (SEC) underpins the study of Statistics. Students need to be able to apply the knowledge and techniques outlined in this section within the framework of the SEC. The cycle covers five stages:

- initial planning
- data collection
- data processing and presentation
- interpretation of results
- evaluation and review.

The detail of the SEC is provided below. During their learning students should develop their understanding of the SEC through a variety of authentic contexts. Practical experience of the cycle is integral to their understanding of the principles of the SEC.

Students should anticipate that they may occasionally be presented, within the context of applying elements of the SEC cycle, unfamiliar acronyms or scenarios in real-life data.

A Initial planning
Students must understand the importance of initial planning when designing a line of enquiry or investigation including:
1   identifying factors that may be related to the problem under investigation
2   defining a question or hypothesis (or hypotheses) to investigate
3   deciding what data to collect, and how to collect and record it, giving reasons
4   engaging in exploratory data analysis in order to investigate the situation
5   developing a strategy for how to process and represent the data giving reasons
6   justifying the proposed plan with regards to ensuring a lack of bias.

B Data collection
Students must recognise the constraints involved in sourcing data including:
1   when designing unbiased collection methods for primary sample data
2   when researching sources of secondary data, including from reference publications, the internet and the media
3   the importance of declaring the data collection methodology, including appreciating the importance of acknowledging sources
4   appreciating the inherent bias that may be incorporated through the use of leading questions either by accident or through agenda driven design.

C Data processing and presentation
Students must understand a range of techniques in order to process, represent and discuss data including:
1   organising and processing data, including an understanding of how technology can be used
2   make inferences about the population using appropriately chosen diagrams and summary measures to represent data including an understanding of outputs generated by appropriate technology
3   appreciating how to avoid misrepresentation of data.

D Interpretation of results
Students must appreciate the need to consider the context of the problem when interpreting results:
1   analysing/interpreting diagrams and calculations/measures
2   drawing together conclusions that relate to the questions and hypotheses addressed
3   using appropriate tests to determine the statistical significance of the findings
4   discussing the reliability of findings
5   Students must show an understanding of the importance of the clear and concise communication of findings and key ideas, and awareness of target audience.

E Evaluation and review
Students must be able to understand the importance of evaluating statistical work including:
1   identifying weaknesses in approaches used to collect or display data
2   recognising the limitations of findings by considering sample size and sampling technique
3   suggesting improvements to statistical processes or presentation
4   refining processes to elicit further clarification of the initial hypothesis.

3 Assessment information

Paper 1: Data and Probability	**(Paper code: 9ST0/01)**

- First assessment: May/June 2019.
- The assessment is 2 hours.
- The assessment is out of 80 marks.
- Students must answer all questions.
- Calculators can be used in the examination.
- The booklet 'Statistical Formulae and Tables' will be provided for use in the assessments.

Content assessed

Questions may be set on any of the following topics:

1 – Numerical measures, graphs and diagrams

2 – Probability

3 – Population and samples

4 – Introduction to probability distributions

5 – Binomial distribution

6 – Normal distribution

7 – Correlation and linear regression (except 7.2)

11 – Bayes' theorem

12 – Probability distributions

13 – Experimental design

18 – Exponential and Poisson distributions

Statistical Enquiry Cycle (SEC)

Paper 2: Statistical Inference   **(Paper code: 9ST0/02)**

- First assessment: May/June 2019.
- The assessment is 2 hours.
- The assessment is out of 80 marks.
- Students must answer all questions.
- Calculators can be used in the examination.
- The booklet 'Statistical Formulae and Tables' will be provided for use in the assessments.

Content assessed

Questions may be set on any of the following topics:

7 – Correlation and linear regression (7.2 only)

8 – Introduction to hypothesis testing

9 – Contingency tables

10 – One and two sample non-parametric tests

13 – Experimental design

14 – Sampling, estimates and resampling

15 – Hypothesis testing, significance testing, confidence intervals and power

16 – Hypothesis testing for 1 and 2 samples

17 – Paired tests

19 – Goodness of fit

20 – Analysis of variance

21 – Effect size

Statistical Enquiry Cycle (SEC)

Paper 3: Statistics in Practice   **(Paper code: 9ST0/03)**

- First assessment: May/June 2019.
- The assessment is 2 hours.
- The assessment is out of 80 marks.
- Students must answer all questions.
- Calculators can be used in the examination.
- The booklet 'Statistical Formulae and Tables' will be provided for use in the assessments.

Content assessed

Questions may be set on any of the topics within the specification, including the Statistical Enquiry Cycle (SEC).

Assessment Objectives

	Students must:	% in GCE A Level
AO1	Demonstrate knowledge and understanding, using appropriate terminology and notation, of standard statistical techniques used - to collect and represent data - to calculate summary statistics and probabilities - in relation to hypotheses and inference.	55
AO2	Interpret statistical information and results in context and reason statistically to make predictions, construct arguments, make decisions and draw conclusions.	25
AO3	Critically assess the reliability and validity of statistical methodologies and the conclusions drawn through the application of the statistical enquiry cycle.	20
	Total	**100%**

Breakdown of Assessment Objectives

Paper	Assessment Objectives			Total for all Assessment Objectives
	AO1 %	**AO2 %**	**AO3 %**	
Paper 1	18⅓	8⅓	6⅔	33⅓%
Paper 2	18⅓	8⅓	6⅔	33⅓%
Paper 3	18⅓	8⅓	6⅔	33⅓%
Total for GCE A Level	**55±2%**	**25±2%**	**20±2%**	**100%**

NB Totals have been rounded either up or down.

Sample assessment materials

Sample papers and mark schemes can be found in the *Pearson Edexcel Level 3 Advanced GCE in Statistics Sample Assessment Materials (SAMs)* document.

4 Administration and general information

Entries

Details of how to enter students for the examinations for this qualification can be found in our *UK Information Manual*. A copy is made available to all examinations officers and is available on our website: qualifications.pearson.com

Discount code and performance tables

Centres should be aware that students who enter for more than one GCE qualification with the same discount code will have only one of the grades they achieve counted for the purpose of the school and college performance tables. This will be the grade for the larger qualification (i.e. the A Level grade rather than the AS grade). If the qualifications are the same size, then the better grade will be counted (please see *Appendix 8: Codes*).

Students should be advised that if they take two GCE qualifications with the same discount code, colleges, universities and employers they wish to progress to are likely to take the view that this achievement is equivalent to only one GCE. The same view may be taken if students take two GCE qualifications that have different discount codes but have significant overlap of content. Students or their advisers who have any doubts about their subject combinations should check with the institution they wish to progress to before embarking on their programmes.

Access arrangements, reasonable adjustments, special consideration and malpractice

Equality and fairness are central to our work. Our equality policy requires all students to have equal opportunity to access our qualifications and assessments, and our qualifications to be awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Language of assessment

Assessment of this qualification will be available in English. All student work must be in English.

Access arrangements

Access arrangements are agreed before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

The intention behind an access arrangement is to meet the particular needs of an individual student with a disability, without affecting the integrity of the assessment. Access arrangements are the principal way in which awarding bodies comply with the duty under the Equality Act 2010 to make 'reasonable adjustments'.

Access arrangements should always be processed at the start of the course. Students will then know what is available and have the access arrangement(s) in place for assessment.

Reasonable adjustments

The Equality Act 2010 requires an awarding organisation to make reasonable adjustments where a person with a disability would be at a substantial disadvantage in undertaking an assessment. The awarding organisation is required to take reasonable steps to overcome that disadvantage.

A reasonable adjustment for a particular person may be unique to that individual and therefore might not be in the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, including:

- the needs of the student with the disability
- the effectiveness of the adjustment
- the cost of the adjustment; and
- the likely impact of the adjustment on the student with the disability and other students.

An adjustment will not be approved if it involves unreasonable costs to the awarding organisation, or affects timeframes or the security or integrity of the assessment. This is because the adjustment is not 'reasonable'.

Special consideration

Special consideration is a post-examination adjustment to a student's mark or grade to reflect temporary injury, illness or other indisposition at the time of the examination/assessment, which has had, or is reasonably likely to have had, a material effect on a candidate's ability to take an assessment or demonstrate their level of attainment in an assessment.

Further information

Please see our website for further information about how to apply for access arrangements and special consideration.

For further information about access arrangements, reasonable adjustments and special consideration, please refer to the JCQ website: www.jcq.org.uk.

Malpractice

Candidate malpractice

Candidate malpractice refers to any act by a candidate that compromises or seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

Candidate malpractice in examinations **must** be reported to Pearson using a *JCQ Form M1* (available at www.jcq.org.uk/exams-office/malpractice). The form should be emailed to candidatemalpractice@pearson.com. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Staff/centre malpractice

Staff and centre malpractice includes both deliberate malpractice and maladministration of our qualifications. As with candidate malpractice, staff and centre malpractice is any act that compromises or seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

All cases of suspected staff malpractice and maladministration **must** be reported immediately, before any investigation is undertaken by the centre, to Pearson on a *JCQ Form M2(a)* (available at www.jcq.org.uk/exams-office/malpractice).

The form, supporting documentation and as much information as possible should be emailed to pqsmalpractice@pearson.com. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice itself constitutes malpractice.

More detailed guidance on malpractice can be found in the latest version of the document *General and Vocational Qualifications Suspected Malpractice in Examinations and Assessments Policies and Procedures,* available at www.jcq.org.uk/exams-office/malpractice.

Awarding and reporting

This qualification will be graded, awarded and certificated to comply with the requirements of Ofqual's General Conditions of Recognition.

This A Level qualification will be graded and certificated on a six-grade scale from A* to E using the total subject mark. Individual papers are not graded.

Students whose level of achievement is below the minimum judged by Pearson to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

The first certification opportunity for this qualification will be 2019.

Student recruitment and progression

Pearson follows the JCQ policy concerning recruitment to our qualifications in that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Prior learning and other requirements

There are no prior learning or other requirements for this qualification. However, the qualification builds upon the statistics and probability components of GCSE Mathematics (please see *Appendix 3: Numerical skills*).

Students who would benefit most from studying this qualification are likely to have a Level 2 qualification such as a GCSE in Mathematics or GCSE in Statistics.

Progression

Students can progress from this qualification to:

- a range of different, relevant academics or vocational higher education qualifications
- employment in a relevant sector
- further training.

In particular, this qualification provides a foundation in statistics for students seeking to undertake higher education in social sciences, biological sciences or medicine and related health studies.

Appendices

Appendix 1: Formulae that students must know

Statistical formulae for A Level Statistics that students are expected to learn and will not be given in the exams.

Topic reference	Formula required
1	Calculating the angle for a sector in a pie chart: $\dfrac{x}{\text{total}} \times 360°$
1	Frequency density for a histogram: $\text{frequency density} = \dfrac{\text{frequency}}{\text{class width}}$
1	Calculation of arithmetic mean: $\bar{x} = \dfrac{\sum fx}{\sum f}$
1	Range = highest value – lowest value
1	Interquartile range (IQR) = upper quartile – lower quartile
1	Identification of an outlier: Lower outlier is < LQ – 1.5IQR Upper outlier is > UQ + 1.5IQR Outlier is also outside $\mu \pm 3\sigma$
2	Formulae for independent events: P(A∩B) = P(A)P(B) P(A|B) = P(A) and P(B|A) = P(B)
3	In order to carry out stratification, calculating the percentage or proportion of an amount: $\dfrac{x}{100} \times \text{amount}$
4	Properties of discrete random variables: expectation (mean): $E(X) = \mu = \sum x_i p_i$ variance: $\text{Var}(X) = \sigma^2 = \sum (x_i - \mu)^2 p_i = \sum x_i^2 p_i - \mu^2 = E(X^2) - \mu^2$
15	Confidence intervals for a mean μ: $\bar{x} \pm z\dfrac{\sigma}{\sqrt{n}}$ (if σ known) $\bar{x} \pm t_{n-1}\dfrac{s}{\sqrt{n}}$ (if σ not known)

Appendix 2: Formulae and statistical tables that students will be given in the exams

Statistical formulae and tables for A Level Statistics that students are expected to be familiar with and will be given in the booklet 'Statistical Formulae and Tables' for use in the exams.

Topic reference	Formula required
1	Population variance, $\sigma^2, =$ $$\left(\frac{\sum x^2}{N} - \mu^2\right) = \frac{1}{N}\sum(x-\mu)^2$$ Population standard deviation, $\sigma, =$ $$\sqrt{\left(\frac{\sum x^2}{N} - \mu^2\right)} = \sqrt{\frac{1}{N}\sum(x-\mu)^2}$$
1	Sample variance, $s^2, =$ $$\frac{1}{n-1}\left(\sum x^2 - \frac{(\sum x)^2}{n}\right) = \frac{1}{n-1}\sum(x-\overline{x})^2$$ Sample standard deviation, s, $=$ $$\sqrt{\frac{1}{n-1}\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)} = \sqrt{\frac{1}{n-1}\sum(x-\overline{x})^2}$$
5	Binomial probability calculations: $$P(X=x) = \binom{n}{x}p^x(1-p)^{n-x}$$ Mean $= np$ Variance $= np(1-p)$
6	For a random sample of n_x observations from $N(\mu, \sigma^2)$: $$\frac{\overline{X}-\mu}{\frac{\sigma}{\sqrt{n}}} \sim N(0, 1)$$ Test statistic for a binomial proportion using normal distribution: $$\frac{\hat{p}-p}{\sqrt{\frac{p(1-p)}{n}}} \sim N(0, 1)$$

Topic reference	Formula required
7	Product moment correlation coefficient: $$r = \frac{S_{xy}}{\sqrt{S_{xx} \times S_{yy}}} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\left\{\sum (x_i - \bar{x})^2\right\}\left\{\sum (y_i - \bar{y})^2\right\}}} = \frac{\sum x_i y_i - \dfrac{\left(\sum x_i\right)\left(\sum y_i\right)}{n}}{\sqrt{\left(\sum x_i^2 - \dfrac{\left(\sum x_i\right)^2}{n}\right)\left(\sum y_i^2 - \dfrac{\left(\sum y_i\right)^2}{n}\right)}}$$
7	Coefficients for least squares regression line: least squares regression line of y on x is $y = a + bx$, where $a = \bar{y} - b\bar{x}$ the regression coefficient of y on x is $b = \dfrac{S_{xy}}{S_{xx}} = \dfrac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$
9	Test for association: $\sum \dfrac{(O_i - E_i)^2}{E_i}$ is approximately distributed as χ^2
11	Bayes' theorem for up to three events: $$P\left(A_j \mid B\right) = \frac{P\left(A_j\right) \times P\left(B \mid A_j\right)}{\displaystyle\sum_{i=1}^{n} P\left(A_i\right) \times P\left(B \mid A_i\right)}$$
12	The Poisson probability formula: $P(X = x) = e^{-\lambda} \dfrac{\lambda^x}{x!}$ Poisson mean $= \lambda$ Poisson variance $= \lambda$
12	The exponential cumulative probability formula: $P(X \leqslant x) = 1 - e^{-\lambda x}$ Exponential mean $= \dfrac{1}{\lambda}$ Exponential variance $= \dfrac{1}{\lambda^2}$
12	$E(aX \pm bY) = a E(X) \pm b E(Y)$ For independent variables X and Y, $\text{Var}(aX \pm bY) = a^2 \text{Var}(X) + b^2 \text{Var}(Y)$

Topic reference	Formula required
16	For a random sample of n_x observations from $N(\mu, \sigma^2)$: $\dfrac{\overline{X} - \mu}{\dfrac{S}{\sqrt{n}}} \sim t_{n-1}$ (also valid in matched-pairs situations)
16	For a random sample of n_x observations from $N(\mu_x, \sigma_x^2)$ and, independently, a random sample of n_y observations from $N(\mu_y, \sigma_y^2): \dfrac{(\overline{X} - \overline{Y}) - (\mu_x - \mu_y)}{\sqrt{\dfrac{\sigma_x^2}{n_x} + \dfrac{\sigma_y^2}{n_y}}} \sim N(0, 1)$
16	For a random sample of n_x observations from $N(\mu_x, \sigma_x^2)$ and, independently, a random sample of n_y observations from $N(\mu_y, \sigma_y^2)$ where $\sigma_x^2 = \sigma_y^2 = \sigma^2$ (unknown): $\dfrac{(\overline{X} - \overline{Y}) - (\mu_x - \mu_y)}{\sqrt{S_p^2\left(\dfrac{1}{n_x} + \dfrac{1}{n_y}\right)}} \sim t_{n_x + n_y - 2}$ where $S_p^2 = \dfrac{(n_x - 1)S_x^2 + (n_y - 1)S_y^2}{n_x + n_y - 2}$
16	Test statistic for the difference in two binomial proportions: $\dfrac{p_1 - p_2}{\text{standard error}}$ where standard error $= \sqrt{p \times (1 - p) \times \left(\dfrac{1}{n_1} + \dfrac{1}{n_2}\right)}$ where $p = \dfrac{p_1 \times n_1 + p_2 \times n_2}{n_1 + n_2}$
19	Test for association and goodness of fit test: $\sum \dfrac{(O_i - E_i)^2}{E_i}$ is approximately distributed as χ^2

Topic reference	Formula required
20	Analysis of variance (one-way and two-way): one-factor model $x_{ij} = \mu + \alpha_i + \varepsilon_{ij}$, where $\varepsilon_{ij} \sim N\left(0, \sigma^2\right)$ total sum of squares $SS_T = \sum_i \sum_j x_{ij}^2 - \dfrac{T^2}{n}$ between groups sum of squares $SS_B = \sum_i \dfrac{T_i^2}{n_i} - \dfrac{T^2}{n}$ two-factor model (with m rows and n columns) $x_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$, where $\varepsilon_{ij} \sim N\left(0, \sigma^2\right)$ total sum of squares $SS_T = \sum_i \sum_j x_{ij}^2 - \dfrac{T^2}{mn}$ between rows sum of squares $SS_R = \sum_i \dfrac{R_i^2}{n} - \dfrac{T^2}{mn}$ between columns sum of squares $SS_C = \sum_j \dfrac{C_j^2}{m} - \dfrac{T^2}{mn}$
21	Cohen's d formula: $d = \dfrac{\left(\bar{x}_1 - \bar{x}_2\right)}{s}$ where $s = \sqrt{\dfrac{\left(n_1 - 1\right)s_1^2 + \left(n_2 - 1\right)s_2^2}{n_1 + n_2 - 2}}$

Statistical tables given in the 'Statistical Formulae and Tables' booklet

Table 1: Cumulative Binomial Distribution Function

Table 2: Cumulative Poisson Distribution Function

Table 3: Normal Distribution Function

Table 4: Percentage Points of the Normal Distribution

Table 5: Percentage Points of the student's t-distribution

Table 6: Percentage Points of the Chi-Squared Distribution

Table 7: Percentage Points of the f-distribution

Table 8: Critical Values of the Product Moment Correlation Coefficient

Table 9: Critical Values of Spearman's Rank Correlation Coefficient

Table 10: Critical Values of the Wilcoxon Signed Rank Statistic

Table 11: Critical Values of the Wilcoxon Rank-Sum

Appendix 3: Numerical skills

The numerical skills, developed in GCSE (9-1) mathematics, required for A Level Statistics.

Integers, fractions, decimals and percentages

- Work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and $\frac{7}{2}$ or 0.375 and $\frac{3}{8}$), and recognise that some fractions can be written as recurring decimals.
- Identify and work with fractions in ratio problems.
- Interpret fractions and percentages as operators.

Structure and calculation

- Order positive integers, decimals and fractions.
- Understand and use the symbols =, ≠, <, >, ⩽ and ⩾
- Apply the four operations to integers, decimals and simple fractions (proper and improper), and mixed numbers.
- Understand and use place value (e.g. when working with very large or very small numbers, and when calculating with decimals).
- Recognise, use and manipulate numbers in standard form.
- Recognise and use relationships between operations, including inverse operations (e.g. cancellation to simplify calculations and expressions; use conventional notation for priority of operations, including brackets, powers, roots and reciprocals).
- Substitute numerical values into formulae and expressions, including scientific formulae.
- Understand and use standard mathematical formulae, and rearrange formulae to change the subject.
- Solve algebraic equations, including simultaneous equations.
- Work with coordinates on Cartesian grid.

Measures and accuracy

- Use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate.
- Estimate answers and check calculations using approximation and estimation, including answers obtained using technology.
- Use compound units such as speed, rates of pay and unit pricing including working out a unit for a rate.
- Round numbers and measures to an appropriate degree of accuracy (e.g. to a specified number of decimal places or significant figures), and use inequality notation to specify simple error intervals due to truncation or rounding.

Ratio, proportion and rates of change

- Express one quantity as a fraction of another, where the fraction is less than 1 or greater than 1.

- Use ratio notation, including reduction to simplest form.

- Divide a given quantity into two parts in a given part, part or part, and whole ratio; express the division of a quantity into two parts as a ratio; and apply ratio to real contexts and problems (such as those involving probability).

- Relate ratios to fractions and vice versa.

- Define percentage as 'number of parts per hundred'; interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively; express one quantity as a percentage of another; and compare two quantities using percentages.

Appendix 4: Use of calculators and other technology

Use of calculators

Students may use a calculator in all A Level Statistics examinations. Students are responsible for making sure that their calculators meet the guidelines set out in this appendix.

The use of technology permeates the study of A Level Statistics. Calculators used **must** include the following features:

- the ability to compute summary statistics (to include mean, standard deviation, regression and correlation coefficients).
- the ability to access probabilities from standard statistical distributions (to include binomial, Poisson and normal).

The use of a graphics calculator with additional statistical functions is encouraged.

In addition, students **must** be told these regulations before sitting an examination:

During an examination a calculator must not be able to offer any of these facilities: - language translators; - symbolic algebra manipulation; - symbolic differentiation or integration; - communication with other machines or the internet;
During an examination a calculator must not give access to pre-stored information. This includes: - databanks; - dictionaries; - mathematical formulae; - text.
A calculator must not be borrowed from another candidate during an examination.
Some calculators have an 'exam mode'. This is acceptable in examinations where the exam mode is activated and the exam mode results in the calculator becoming compliant with the above requirements.
An invigilator may give a candidate a replacement calculator.

Use of other technology

Students are expected to be familiar with the following language and techniques when working with databases and spreadsheets.

Spreadsheets

Students should understand:

- how to use a 'filter'
- how to 'sort' data
- how to use basic functions that count or sum data points
- how to use basic functions that find an average or a measure of spread.

Databases

Students should understand

- what a 'field' and a 'record' are.
- how to use a 'filter'
- how to 'sort' data
- how to produce a 'query' which will…
  - …group by data values from a given field
  - …count or sum data from a given field
  - …produce a basic join between two data tables.

Graph-plotting software

Students are expected to be able to interpret outputs from graph-plotting software, such as:

- Bar charts & pie charts
- Scatter diagrams, including regression lines
- Stem and leaf diagrams
- Box and whisker plots
- Cumulative frequency diagrams
- Histograms
- Time series, including trend lines

Students should be familiar with those visualisation types available in Section 1.1 of the content, together with pie charts (assumed knowledge), and should explore such visualisations in published visualisations. These visualisations are the only visualisations that may appear in questions which contain visualisations of univariate or multivariate data, other than published tabulated results. Questions may require students to comment on or analyse such visualisations. For example, a scatter graph illustrating petal length and petal width for 3 species of Iris, from Edgar Robinson's Iris data (readily available on the internet), is an example of visualisation of multivariate data.

Additionally, students should be familiar with the nature of outputs from standard ICT packages or calculator displays, including common abbreviations such as 'df' for 'degrees of freedom'. They should be able to identify those parts of such an output that are relevant when answering questions.

Appendix 5: The context for the development of this qualification

All our qualifications are designed to meet our World Class Qualification Principles[1] and our ambition to put the student at the heart of everything we do.

We have developed and designed this qualification by:

- reviewing other curricula and qualifications to ensure that it is comparable with those taken in high-performing jurisdictions overseas
- consulting with key stakeholders on content and assessment, including learned bodies, subject associations, higher-education academics, teachers and employers to ensure this qualification is suitable for a UK context
- reviewing the legacy qualification and building on its positive attributes.

This qualification has also been developed to meet criteria stipulated by Ofqual in their documents *GCE Qualification Level Conditions and Requirements* and *GCE Subject Level Conditions and Requirements for Statistics*, published in May 2016.

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[1] Pearson's World Class Qualification Principles ensure that our qualifications are:

- **demanding**, through internationally benchmarked standards, encouraging deep learning and measuring higher-order skills
- **rigorous**, through setting and maintaining standards over time, developing reliable and valid assessment tasks and processes, and generating confidence in end users of the knowledge, skills and competencies of certified students
- **inclusive**, through conceptualising learning as continuous, recognising that students develop at different rates and have different learning needs, and focusing on progression
- **empowering**, through promoting the development of transferable skills, see *Appendix 6*.

From Pearson's Expert Panel for World Class Qualifications

May 2014

"The reform of the qualifications system in England is a profoundly important change to the education system. Teachers need to know that the new qualifications will assist them in helping their learners make progress in their lives.

When these changes were first proposed we were approached by Pearson to join an 'Expert Panel' that would advise them on the development of the new qualifications.

We were chosen, either because of our expertise in the UK education system, or because of our experience in reforming qualifications in other systems around the world as diverse as Singapore, Hong Kong, Australia and a number of countries across Europe.

We have guided Pearson through what we judge to be a rigorous qualification development process that has included:

- extensive international comparability of subject content against the highest-performing jurisdictions in the world
- benchmarking assessments against UK and overseas providers to ensure that they are at the right level of demand
- establishing External Subject Advisory Groups, drawing on independent subject-specific expertise to challenge and validate our qualifications
- subjecting the final qualifications to scrutiny against the DfE content and Ofqual accreditation criteria in advance of submission.

Importantly, we have worked to ensure that the content and learning is future oriented. The design has been guided by what is called an 'Efficacy Framework', meaning learner outcomes have been at the heart of this development throughout.

We understand that ultimately it is excellent teaching that is the key factor to a learner's success in education. As a result of our work as a panel we are confident that we have supported the development of qualifications that are outstanding for their coherence, thoroughness and attention to detail and can be regarded as representing world-class best practice."

Sir Michael Barber (Chair)

Chief Education Advisor, Pearson plc

Professor Lee Sing Kong

Director, National Institute of Education, Singapore

Bahram Bekhradnia

President, Higher Education Policy Institute

Professor Jonathan Osborne

Stanford University

Dame Sally Coates

Principal, Burlington Danes Academy

Professor Dr Ursula Renold

Federal Institute of Technology, Switzerland

Professor Robin Coningham

Pro-Vice Chancellor, University of Durham

Professor Bob Schwartz

Harvard Graduate School of Education

Dr Peter Hill

Former Chief Executive ACARA

All titles correct as at May 2014.

Appendix 6: Transferable skills

The need for transferable skills

In recent years, higher education institutions and employers have consistently flagged the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning.' [1]

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, we identified the National Research Council's (NRC) framework as the most evidence-based and robust skills framework. We adapted the framework slightly to include the Program for International Student Assessment (PISA) ICT Literacy and Collaborative Problem Solving (CPS) Skills.

The adapted National Research Council's framework of skills involves: [2]

Cognitive skills

- **Non-routine problem solving** – expert thinking, metacognition, creativity.
- **Systems thinking** – decision making and reasoning.
- **Critical thinking** – definitions of critical thinking are broad and usually involve general cognitive skills such as analysing, synthesising and reasoning skills.
- **ICT literacy** – access, manage, integrate, evaluate, construct and communicate. [3]

Interpersonal skills

- **Communication** – active listening, oral communication, written communication, assertive communication and non-verbal communication.
- **Relationship-building skills** – teamwork, trust, intercultural sensitivity, service orientation, self-presentation, social influence, conflict resolution and negotiation.
- **Collaborative problem solving** – establishing and maintaining shared understanding, taking appropriate action, establishing and maintaining team organisation.

Intrapersonal skills

- **Adaptability** – ability and willingness to cope with the uncertain, handling work stress, adapting to different personalities, communication styles and cultures, and physical adaptability to various indoor and outdoor work environments.
- **Self-management and self-development** – ability to work remotely in virtual teams, work autonomously, be self-motivating and self-monitoring, willing and able to acquire new information and skills related to work.

Transferable skills enable young people to face the demands of further and higher education, as well as the demands of the workplace, and are important in the teaching and learning of this qualification. We will provide teaching and learning materials, developed with stakeholders, to support our qualifications.

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[1] OECD – *Better Skills, Better Jobs, Better Lives* (OECD Publishing, 2012)

[2] Koenig J A, National Research Council – *Assessing 21st Century Skills: Summary of a Workshop* (National Academies Press, 2011)

[3] PISA – *The PISA Framework for Assessment of ICT Literacy* (2011)

Appendix 7: Level 3 Extended Project qualification

What is the Extended Project?

The Extended Project is a standalone qualification that can be taken alongside GCEs. It supports the development of independent learning skills and helps to prepare students for their next step – whether that be higher education or employment. The qualification:

- is recognised by higher education for the skills it develops
- is worth half of an Advanced GCE qualification at grades A*–E
- carries UCAS points for university entry.

The Extended Project encourages students to develop skills in the following areas: research, critical thinking, extended writing and project management. Students identify and agree a topic area of their choice for in-depth study (which may or may not be related to a GCE subject they are already studying), guided by their teacher.

Students can choose from one of four approaches to produce:

- a dissertation (for example an investigation based on predominately secondary research)
- an investigation/field study (for example a practical experiment)
- a performance (for example in music, drama or sport)
- an artefact (for example creating a sculpture in response to a client brief or solving an engineering problem).

The qualification is non-examination assessment based and students are assessed on the skills of managing, planning and evaluating their project. Students will research their topic, develop skills to review and evaluate the information, and then present the final outcome of their project.

The Extended Project has 120 guided learning hours (GLH) consisting of a 40-GLH taught element that includes teaching the technical skills (for example research skills) and an 80-GLH guided element that includes mentoring students through the project work. The qualification is 100% internally assessed and externally moderated.

How to link the Extended Project with statistics

The Extended Project creates the opportunity to develop transferable skills for progression to higher education and to the workplace, through the exploration of either an area of personal interest or a topic of interest from within the statistics qualification content.

Through the Extended Project, students will develop skills that support their study of statistics, including:

- conducting, organising and using research
- independent reading in the subject area
- planning, project management and time management
- defining a hypothesis to be tested in investigations or developing a design brief
- collecting, handling and interpreting data and evidence
- evaluating arguments and processes, including arguments in favour of alternative interpretations of data and evaluation of experimental methodology
- critical thinking.

In the context of the Extended Project, critical thinking refers to the ability to identify and develop arguments for a point of view or hypothesis and to consider and respond to alternative arguments. This supports the development of evaluative skills, through evaluating qualitative and quantitative evidence to support informed judgements and propose evidence-based solutions to statistics issues.

Types of Extended Project related to statistics

Students may produce a dissertation on any topic that can be researched and argued, for example a controversial business issue such as child labour, executive pay or advertising to children.

A dissertation might involve an investigation such as:

- the impact of digital downloads on the music industry
- the ease of doing business in a chosen country.

The dissertation uses secondary research sources to provide a reasoned defence or a point of view, with consideration of counter-arguments.

An alternative might be an investigative project or field study involving the collection of data from primary research, for example:

- a study of the impact of unemployment on the local community
- a statistical survey of changing social attitudes towards online purchasing.

A field study might consider an issue that lends itself to primary research, for example an investigation into the motivation techniques used in a chosen business.

Using the Extended Project to support breadth and depth

In the Extended Project, students are assessed on the quality of the work they produce and the skills they develop and demonstrate through completing this work. Students should demonstrate that they have extended themselves in some significant way beyond what they have been studying in statistics. Students can demonstrate extension in one or more dimensions:

- ***deepening understanding*** – where a student explores a topic in greater depth than in the specification content. This could be an in-depth exploration of one aspect of the broad pre-release context
- ***broadening skills*** – where a student learns a new skill. This might be learning how to design a website or learning a new statistical technique that can be used in the analysis of either primary or secondary data collected by the student
- ***widening perspectives*** – where the student's project spans different subjects. A student studying statistics with geography may wish to research the impact of tourism on a particular region or locality. A student studying statistics with may wish to use statistical techniques to analyse market data and research one aspect of a market in more detail.

A wide range of information to support the delivery and assessment of the Extended Project, including the specification, teacher guidance for all aspects, an editable scheme of work and exemplars for all four approaches, can be found on our website.

Appendix 8: Codes

Type of code	Use of code	Code
Discount codes	Every qualification eligible for performance tables is assigned a discount code indicating the subject area to which it belongs. Discount codes are published by the DfE.	Please see the GOV.UK website*
Regulated Qualifications Framework (RQF) codes	Each qualification title is allocated an Ofqual Regulated Qualifications Framework (RQF) code. The RQF code is known as a Qualification Number (QN). This is the code that features in the DfE Section 96 and on the LARA as being eligible for 16–18 and 19+ funding, and is to be used for all qualification funding purposes. The QN will appear on students' final certification documentation.	The QN for this qualification is: 603/2260/3
Subject codes	The subject code is used by centres to enter students for a qualification. Centres will need to use the entry codes only when claiming students' qualifications.	A Level – 9ST0
Paper codes	These codes are provided for reference purposes. Students do not need to be entered for individual papers.	Paper 1: 9ST0/01 Paper 2: 9ST0/02 Paper 3: 9ST0/03

*https://www.gov.uk/government/publications/16-to-19-qualifications-discount-codes-and-point-scores

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