Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2023

Pearson Edexcel International Advanced Level
In Statistics S2 (WST02) Paper 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2023
Publications Code WST02_01_2306_ER

Introduction

Whilst students performed well on familiar calculations and routine hypothesis tests, there were a number of questions that required written reasoning and explanations and the standard on these questions requires improvement. Questions 2, 3(d)(e), 4(c)(ii) fell into that category. 5(e) and 7(c) provided discrimination at the top end.

Question 1

This question proved to be a good start to the paper for a majority of students with nearly 1/3 earning all 11 marks.

Full marks were frequently obtained in part (a). Most used the formula for Binomial probability or indeed their calculator to obtain the correct answer in part (i). A few students provided the answer 0.026, thus failing to implement the instructions on the front of the examination paper: "Inexact answers should be given to three significant figures unless otherwise stated". A more serious problem was the failure to distinguish between the required probability$\mathrm{P}(X = 26)$ and the cumulative probability $\mathrm{P}(X \leq 26)$ which was occasionally seen.

A few students struggled with the inequality in part (ii), writing $1 - \mathrm{P}(X \leq 26)$ or, occasionally, $1 - \mathrm{P}(X \leq 24)$

The correct answer of k = 19 was frequently seen in part (iii). The most frequent incorrect answers were one either side of this. However, k = 14 was not uncommon: it is possible that such students were using $\mathrm{P}(X \leq k) > 0.04$ instead of 0.4.

A few students ignored the instruction in part (b)(i): "using a Normal approximation". However, a large majority were familiar with the Normal distribution, and this was a useful source of marks for many. Full marks were often scored. There were small errors in detail in other scripts:

- an incorrect (or occasionally missing) 'continuity correction'
- missing final stage (subtraction from 1).

The response to (b)(ii) was excellent. The most common problem was the inappropriate response: "*p* is small".

Question 2

The overall response to this question was somewhat disappointing with 1/3 of students making no progress whatsoever.

In part (a), too few students seemed to focus on the essence of the question. Some responses attempted to describe and distinguish between a census and a sample. Others attempted to compare the advantages and disadvantages of a census and a sample. There were even references to destructive and non-destructive testing.

The concept of 'sampling frame' was not entirely unfamiliar in part (b)(i). So 'list' or register' were seen in many scripts, but the key feature "**all** members" was too rarely seen. A majority of students scored just one out of the four marks available for this question, and this was usually for (b)(ii). A common misunderstanding in part (b) was the focus on the opinions of the members.

Part (c) was perhaps more technical. Some students were well-versed with the concept of a 'statistic', but there were many attempts that failed to address the issue at all, but even after giving a correct definition many were still unable to select *C* as the only statistic from the list. Many thought *A* was the statistic.

Question 3

Many fully correct solutions to part (a) were seen with students realising the need to show full steps for a 'show that' question including the substitution of limits and equating their integral to 1.

Almost all students used the standard method in the mark scheme. An alternative approach involved finding the cumulative distribution function. Some used indefinite integration: $\mathrm{F}(x) = \int \frac{1}{48}(x^2 - 8\mathrm{x} + c)\mathrm{d}x$ which leads to $\mathrm{F}(x) = \frac{x^3}{144} - \frac{x^2}{12} + \frac{cx}{48} + d$.

These students then had to use both $\mathrm{F}(2) = 0$ and $\mathrm{F}(5) = 1$, which lead to a pair of simultaneous equations in *c* and *d*.

Part (b) was straightforward, as intended, for many students. These students realised that most of the work had already been done in part (a). All that was required was to replace the upper limit in the intermediate working in part (a), $\frac{1}{48}\left[\frac{x^3}{3} - 4x^2 + 31x\right]_2^5$, by 3. However, many students effectively made a fresh start.

The mark allocation in part (c) should have alerted students to the fact that very little work is involved. No further calculation is required: simply the interpretation of evidence already available. Many correct answers were seen, using the already obtained information. However, a few students attempted to find the median by solving $\mathrm{F}(x) = 0.25$ and then concluding that the median must be less than 3 since 2.67 < 3. More serious misunderstandings encountered included $\mathrm{f}(3) = \frac{1}{3} > 0.25$ or use of $\mathrm{f}(0.25)$ or even $\mathrm{F}(0.25)$.

In part (d) many recognised that Kei's method found the minimum value of f(x) and not the maximum as the mode requires. Here a quick sketch of the graph would have been a good aid. Others did not appear to have a grasp of the shape of f(x) and just wrongly stated, for example, that you should never differentiate f(x).
In part (e) many students reproduced the working in part (d): solving $\mathrm{f}'(x) = 0$to give the same (incorrect) answer as before. Some believed that the value of $\mathrm{f}(4)$ should be the mode.

The correct mode was, however, given by some students. The standard method was to evaluate $\mathrm{f}(x)$at the end-points, which provides conclusive evidence for the mode. Others drew an accurate sketch, with the coordinates of the end-points either marked or implied. Yet others argued from symmetry that the mode must be $x = 2$ since 2 is further from the vertex/axis of symmetry/minimum than $x = 5$.

Question 4

A large majority of students were familiar with the conditions under which a Binomial distribution may be reasonably approximated by a Poisson distribution.

Part (b) was an excellent source of marks for almost all students. A very few ignored the hint from part (a) that a Poisson approximation would be appropriate. The simple inequality "no more than six" occasionally caused problems, leading to $\mathrm{P}(C \leq 5)$or $1 - \mathrm{P}(C \leq 6)$.

'Significance testing' is a familiar topic for most students and part (c)(i) was well attempted with many fully correct contextual conclusions.

In part (c)(ii) very few students recognised the unusual feature of this significance test: that, whatever the outcome, it is not possible to reject the null hypothesis. Alternatively, "there is no critical region" was occasionally seen. The most common response, however, was to state that "the sample size is too small". This comment is relevant, but it is the consequences of a small sample size that are critical here.

Many more students earned one or two marks from part (d). It was perhaps disappointing that those who had the insight to score both marks for part (d) did not return to (c)(i), applying the same idea, and replacing their original "the sample size is too small" with a comment about the impossibility of rejecting the null hypothesis.

One or two students used logarithms to calculate that a sample size of 59 or more would be required to make the test more 'appropriate'. The question did not require this additional information, but it was welcome, nevertheless.

Question 5

Parts (a), (b), (c) and (d) were generally well-attempted with part (e) providing the most challenge. Full marks for part (a) were frequently seen. A few students failed to obtain the correct value of *c* due to simple arithmetic errors. Other students attempted to find the value of *a* using the incorrect method $\mathrm{F}(3) = 1$. In fact, "= 1" was seen in many inappropriate situations such as $\mathrm{F}(5) = 1$.

Some common errors included one of the following:

- $\int_3^5 \frac{1}{16}(y^2 - 6\mathrm{y} + a)\mathrm{d}y = 1$
- $\int_5^9 \frac{1}{12}(y + b)\mathrm{d}y = 1$
- $\int_9^{10} \frac{1}{12}(100y - 5y^2 + c)\mathrm{d}y = 1$

Part (b) was usually more successful, with the two methods on the mark scheme implemented correctly.

Many students found part (c) to be straightforward. The most common errors related to inequality signs. The probability $\mathrm{P}(6 < Y \leq 9)$was sometimes implemented, incorrectly, as $\mathrm{P}(Y \leq 9) - \mathrm{P}(Y \leq 7) = \mathrm{F}(9) - \mathrm{F}(7)$.

Almost all students scored the single mark in part (d) for a correct probability density function. However, it was disappointing that too many students were unable to take advantage of this in part (e). The major problem with part (e) was a failure to implement the clear instruction in the question: "Using the information...".

Many excellent solutions were seen: these were invariably clear, accurate and concise. In contrast, students who ignored the instruction often produced large quantities of irrelevant work. It appeared, for example, that some students were under the impression that they should verify the information given.

Many students failed to identify the correct version of $\int f(y)(6\text{y} - 5)dy$even when the correct pdf had already been obtained in (d). The most common of the incorrect attempts seen was to attempt $\int_5^9 \frac{1}{12}(6y - 5)(y - 2)\text{d}y$ which is equivalent to $\int (6y - 5)\text{F}(y)\text{d}y$.

Question 6

Many strong performances were seen on this question and nearly 40% of students scored full marks here.

It was part (a) that tended to cause the most difficulty for some. Successful students either used the expression $\text{P}(17 < W < k) = \text{P}(W < k) - \text{P}(W < 17)$ or else a diagram to indicate the required area. A key feature of such a diagram was that $k < 17$. Some unsuccessful students used $\text{P}(W > 17)$ instead of $\text{P}(W < 17) = 1 - \text{P}(W > 17)$

In part (b)(i), most students earned the mark for obtaining the correct equation from the information $\text{Var}(W) = 75$

For a small number of students this was the only mark scored in question 6. Many went on find one of the two other possible equations, both of which contain the unknowns *a* and *b* and most solutions to the simultaneous equations were efficient, though those that did not immediately recognise that $b - a = 30$ sometimes ended up solving quadratics and then needed to realise that one of the solutions needed to be rejected.

A correct value of *k* was generally found in (b)(ii) by those successful in part (b)(i). Some students were able to earn partial credit in parts (b)(ii), (c) and (d) following incorrect values of *a* and *b* in part (b)(i). But this only applied to those students who provided the necessary details of their method and working.

Part (d) was routine for a majority of students. Most used $\text{Var}(X) = \text{E}(X^2) - (\text{E}(X))^2$. Though, of these, some forgot to square the mean whilst others made slips in signs. Other students opted for $\text{E}(W^2) = \int_a^b \frac{1}{b-a} w^2 \text{d}w$ and were generally successful in this approach.

Question 7

Part (a) was a good source of marks for many students. Some had issues with inequality signs attempting e.g. $\mathrm{P}(X \leq 7) - \mathrm{P}(X \leq 3)$ or $\mathrm{P}(X \leq 8) - \mathrm{P}(X \leq 4)$.

Most earned the first two marks in part (b) for using the Poisson distribution to find the correct intermediate probability, but many did not know what to do with this – as some just squared it. However, a large number of fully correct responses were seen.

Part (c) was perhaps the most discriminating part of the paper. There were many incomplete attempts made. Those making a partial attempt usually attempted "3 in the first 15 minutes and 1 in the last 45 minutes". Some students recognised the need for the use of conditional probability giving $\mathrm{P}(R = 4)$from Po(8) as the denominator of a probability expression (but with an incorrect/incomplete numerator). A common incorrect attempt at the numerator included $\mathrm{P}(X \geq 3) \times \mathrm{P}(X \leq 1) = 0.3233 \times 0.0174$

The use of the Binomial distribution was efficient and effective for the few students who adopted this alternative approach on the mark scheme.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom