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Examiners' Report
October 2025

International Advanced Level in Statistics S2

WST02/ 01A

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October 2025
Question Paper Log Number P87447A
Publication Code WST02_01A_2510_ER
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General Introduction

Overall, this paper allowed all learners to demonstrate their ability and knowledge of the WST02_01A specification. There were several places where learners struggled to translate the context into correct statistical processes/calculations. Questions asking learners to prove something require all steps in their work to be shown.

Report on Individual Questions

Question 1

This was a well-answered question with a majority of responses scoring at least 6 of the 10 marks available.

Part (a)

In part (a), most learners gave a correct solution by applying $1-\mathrm{F}(4)$. Common errors in this part included finding $\mathrm{F}(4)$ or writing down $\mathrm{P}(X>4)=1-\mathrm{F}(3)$.

Part (b)

In part (b), many learners used the probability statement $\mathrm{P}(3<X<a)=0.642$ to write $\mathrm{F}(a)-\mathrm{F}(3)=0.642$, which was usually manipulated correctly to give $\mathrm{F}(a)=0.892$. While some learners found a correct $a=4.73$ from solving $\frac{1}{5}(2a-5)=0.892$, a considerable number did not use the hint in part (a) and found the value of *a* by solving an incorrect $\frac{1}{20}(a^2-4)=0.892$. Some responses showed a poor understanding of continuous functions by using $\mathrm{P}(3<X<a)=0.642$ to write $\mathrm{F}(a-1)-\mathrm{F}(3)=0.642$; whilst others incorrectly applied the probability statement to give $\mathrm{F}(a)-(1-\mathrm{F}(3))=0.642$.

Part (c)

In part (c), most learners differentiated each part of $\mathrm{F}(x)$ correctly and wrote down a fully defined probability density function with the required limits. Some responses lost the final mark for this part for defining $\mathrm{f}(x) = 1$, when $x > 5$.

Question 2

Part (a) and Part (b)

Though this question was generally well answered overall, correct responses to parts (a) and (b) were rarely seen. Many responses focused on opinions rather than the customers and few indicated any sort of list for part (a). Some responses tried to give textbook definitions of 'sampling frame' and 'sampling units' without making any contextual reference to the customers at Bill's restaurant.

Part (c)

Part (c) was done well by most learners, and many were able to give a correct advantage and a correct disadvantage of taking a census. Some responses were not appropriately labelled whilst others focused on taking a sample survey rather than a census.

Part (d)

The attempts at the hypothesis test in part (d) were generally done well and many fully correct solutions were given. Most responses correctly used *p* for the hypotheses but some used *l* or indeed gave no letter. Learners had little difficulty identifying the correct binomial distribution, B(50, 0.3), but a significant number calculated 1 – P($X \leq 20$) rather than 1 – P($X \leq 19$). Those responses opting to use the critical region had mixed success. After identifying P($X \geq 21$) = 0.0478, many compared this value to 0.05 to correctly reject the null hypothesis. A correct contextual conclusion was given by a large number of learners who have been

trained to use the wording given in the question. Still a significant minority simply offer no context to their conclusion.

Question 3

Part (a)

Learners had a high success rate with this question with just over half of all responses scoring at least 9 marks here. Many learners correctly identified the Binomial distribution B(60, 0.1) and followed the instructions in the question accurately. Some, however, rushed into an approximation before being asked whilst others gave an expression for $P(Y = 1)$ rather than $P(Y < 1)$.

Part (b) and Part (c)

Part (b) was better answered overall, as learners were told to use a Poisson approximation in the question. It is pleasing to see many responses correctly applying the Normal approximation with continuity correction in part (c). Many fully correct solutions were seen. Where responses were less successful, the most common error was to use N(6, 6) as an approximation to the Po(6) approximation, rather than N(6, 5.4), the appropriate approximation to the original B(60, 0.1). It is encouraging that other potential errors such as forgetting to use a continuity correction or standardising with variance instead of standard deviation were less frequently seen on this paper.

Part (d)

Learners had a number of correct reasons to select from and, overall, the response to part (d) was good. Stating 'n is large and p is small' was the most popular. Answers listing the assumptions required for a Poisson model rather than referring to the Poisson approximation were quite common and generally failed to score the mark.

Question 4

Part (a)

In part (a) sketches of f(x) were generally of a poor standard. Many neglected the range and drew the entire quadratic. Others tried to plot point by point, often resulting in a straight line instead of a curve. Those offering a reason why f(x) could not by a probability density function often had flawed logic. Many said that probabilities cannot be greater than 1 demonstrating a misunderstanding as to what a p.d.f. shows. Another common incorrect comment focused unnecessarily on the fact that the graph was continuous.

Part (b)

Most learners were able to use differentiation to find the mode in part (b). A few did not use differentiation but calculated g(1), g(2) and g(3) and used these values to take a guess of the mode. Sometimes responses had difficulty expanding g(y) or differentiating correctly.

Part (c)

Learners were most confident with part (c) of this question and most completed this accurately displaying knowledge that the integral of the p.d.f. must equate to 1.

Part (d)

In part (d), many were able to find the median with a correct integration and accurately solving the resulting polynomial to obtain the correct solution (and reject the solution out of range). Some responses incorrectly used $\int g(y)dy=0.5$ with no limits nor any attempt to include and evaluate an arbitrary constant. Some in fact thought that g(0.5) was the median.

Part (e)

Most learners were able to compare their mode and their median in part (e). Some tried to evaluate the mean, although this was not required, and use this in their comparison. Notably very few responses judged that the 'mean ≈ median' and concluded the distribution is 'almost symmetrical' or had 'no skew'. Most opted to state that the distribution had a negative skew.

Question 5

Part (a)

Part (a) was answered well by the majority of learners but in part (i) some failed to appreciate that the tables gave P(X „ 7) rather than P(X = 7). The usual problem of interpreting "more than 7" occurred in part (ii) with some using 1 – P(X „ 6).

Part (b)

Part (b) was more challenging and provided a good discriminator for the A grade responses. Many realised that the starting point was a Poisson distribution (though a few used a normal approximation to B(n , 0.6)) and could state an appropriate normal distribution. Learners then fell at the various hurdles on the way through: some forgot the continuity correction or used it incorrectly, most could standardise and many had a correct z value but forming and solving a correct quadratic equation was quite challenging and only the strongest responses arrived at $\sqrt{\lambda} = 6$. Of course, at some stage they needed to realise that λ = 0.6n and this step was applied at various stages in the solution, sometimes making the working considerably more complicated.

Question 6

This question was answered well by learners, and many fully correct solutions were seen.

Part (a)

In part (a) a few responses only scored 1 mark as they missed one of the 6 required possibilities. Part (a) was the simplest part and many learners set up a correct and solve an equation for *q*.

Part (b)

In part (b) those learners that understood sampling distributions usually provided fully correct solutions. When errors were made it was usually in setting up incorrect equations for *r* and *s*. Common error for the equation for *r* was $qr+r^2=\frac{13}{80}$, failing to multiply the term *qr* by 2. Common error for the equation for s was $qs+rs+s^2=\frac{319}{400}$, again failing to multiply the terms *qs* and *rs* by 2. A few learners misread the question and gave expressions for the number coins in the bag. The mark scheme allowed for this, and all method marks were available.

Question 7

Part (a) and Part (b)

This question was answered well by many learners, but the algebraic demands of part (b) proved too tricky for some. Most knew what to do in part (a) and apart from the inevitable signs errors, due to improper use of brackets, it posed few problems. Part (b) proved more challenging with many failing to form a correct expression: some forgot to subtract $\left(\frac{1}{3}b+\frac{2}{3}a\right)$ from *b* on the numerator and

others trying a 1 – …. approach failed to subtract a from $\left(\frac{1}{3}b+\frac{2}{3}a\right)$. Some responses reached $\frac{\frac{2}{3}b-\frac{2}{3}a}{b-a}$ but could not see how to simplify this.

Part (c)

The most successful approaches in part (c) usually started by finding E(X^2) and then dealing with $3X^2$. Most used the variance formula rather than integration and usually they realised that E(X) = 0 told them that $b = -a$ and used this to reach the correct answer. Apart from the small minority who didn't realise that the range was $b - a$, part (d) was answered well either by using $\frac{18^2}{12}$ or first finding b = 9.