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EDEXCEL A LEVEL FURTHER MATHEMATICS: QUESTIONS BY TOPIC

Central Limit Theorem (5)

Further Statistics 1 · Topic 5

1 questions · 15 marks · Mark schemes included

Pearson Edexcel A Level Further Mathematics (9FM0), June 2019 - June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic and run from the lowest mark tariff to the highest within each one.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
5.1 THE CENTRAL LIMIT THEOREM		1 Qs · 15 marks	3
1. Q7	Option 3B: Further Statistics 1 October2020	15	4



QUESTIONS

1 questions · 15 marks · 1 sub-topics



SUB-TOPIC 5.1

THE CENTRAL LIMIT THEOREM

Sub-topic 5.1 · 1 question · 15 marks · lowest tariff first



7. A six-sided die has sides labelled 1, 2, 3, 4, 5 and 6

The random variable S represents the score when the die is rolled.

Alicia rolls the die 45 times and the mean score, $\bar{S}$, is calculated.

Assuming the die is fair and using a suitable approximation,

- (a) find, to 3 significant figures, the value of k such that $P(\bar{S} < k) = 0.05$

(8)

- (b) Explain the relevance of the Central Limit Theorem in part (a).

(2)

Alicia considers the following hypotheses:

H_0 : The die is fair

H_1 : The die is not fair

If $\bar{S} < 3.1$ or $\bar{S} > 3.9$, then H_0 will be rejected.

Given that the true distribution of S has mean 4 and variance 3

- (c) find the power of this test.

(3)

- (d) Describe what would happen to the power of this test if Alicia were to increase the number of rolls of the die.

Give a reason for your answer.

(2)









MARK SCHEMES

official mark schemes



Qu.	Scheme	Marks	AOs
7(a)	Realising S has a discrete uniform distribution over $\{1, \dots, 6\}$	M1	3.3
	$E(S) = 1 \times \frac{1}{6} + 2 \times \frac{1}{6} + 3 \times \frac{1}{6} + 4 \times \frac{1}{6} + 5 \times \frac{1}{6} + 6 \times \frac{1}{6}$	M1	1.1b
	$\text{Var}(S) = \frac{6^2-1}{12}$ or $1^2 \times \frac{1}{6} + 2^2 \times \frac{1}{6} + 3^2 \times \frac{1}{6} + 4^2 \times \frac{1}{6} + 5^2 \times \frac{1}{6} + 6^2 \times \frac{1}{6} - 3.5^2$	M1	1.1b
	$E(S) = 3.5$ and $\text{Var}(S) = \frac{35}{12}$	A1	1.1b
	$\bar{S} \sim N(3.5, \dots)$	M1	3.1a
	$\text{Var}(\bar{S}) = \frac{\frac{35}{12}}{45} = \frac{7}{108}$, $\bar{S} \sim N(3.5, 0.0648\dots)$	A1	1.1b
	$P(\bar{S} < k) = 0.05 \rightarrow \frac{k - 3.5}{\sqrt{\frac{7}{108}}} = -1.6449$	M1	3.4
	$k = 3.08122\dots$ awrt 3.08	A1	1.1b
		(8)	
(b)	CLT applies since the sample size is large	B1	3.5b
	CLT states that the sample mean/ $\bar{S}$ is (approximately) normally distributed	B1	3.5b
		(2)	
(c)	True $\bar{S} \sim N(4, \frac{3}{45})$	M1	3.3
	$P(\bar{S} < 3.1) + P(\bar{S} > 3.9)$ or $1 - P(3.1 < \bar{S} < 3.9)$	dM1	3.4
	Power = awrt 0.651	A1	1.1b
		(3)	
(d)	E.g. The increase in sample size would decrease the variance of $\bar{S}$ [leading to an increase in $P(\bar{S} > 3.9)$ and the decrease in $P(\bar{S} < 3.1)$ would be negligible]	B1	2.4
	So the power would increase.	dB1	2.2a
		(2)	
(15 marks)			
Notes			
(a)	M1: Setting up model for S		
	M1: Attempt at expression for $E(S)$		
	M1: Attempt at expression for $\text{Var}(S)$		
	A1: Correct mean and variance for S (may be implied by a correct distribution for $\bar{S}$)		
	M1: Use of CLT to find distribution for $\bar{S} \sim N(3.5, \dots)$ f.t. their 3.5 but variance $\neq \frac{35}{12}$		
(b)	A1: Correct distribution with correct variance, allow $\sigma^2 = \text{awrt } 0.0648$ or $\sigma = \text{awrt } 0.255$		
	M1: Standardising using their model and equating to a z-value $1 < z < 2$		
	A1: awrt 3.08		
	B1: Correct explanation about appropriateness of the CLT given large sample size (allow > 30)		
	B1: Requires both <u>sample</u> and <u>mean</u> or $\bar{S}$		
(c)	M1: Writing or using $\bar{S} \sim N(4, \frac{3}{45})$ allow $\sigma^2 = \text{awrt } 0.0667$ or $\sigma = \text{awrt } 0.258$		
	dM1: (dep on 1 st M1) correct probability statement for power		
(d)	A1: awrt 0.651		
	B1: Correct reasoning which refers to decrease in variance		
(d)	dB1: (dep on 1 st B1) Correct deduction with no incorrect reasoning		

